DEPARTMENT OF MECHANICAL ENGINEERING

Scheme of Instruction and Syllabus of M.E. (Mechanical)

Specialization:

PRODUCTION

Full time / Part time (2015-16)

UNIVERSITY COLLEGE OF ENGINEERING
(Autonomous)
Osmania University
Hyderabad – 500 007, Telangana, INDIA

Scheme of Instruction & Examination

M.E. (Mechanical Engineering) 4 Semesters (Full Time)

Sl. No	Subject	Periods per week		Duration (Hrs)	Max. Marks		Credits
		L/T	D/P		SEE	CIE	
Semester - I							
1.	Core	3	--	3	70	30	3
2.	Core	3	--	3	70	30	3
3.	Core / Elective	3	--	3	70	30	3
4.	Core / Elective	3	--	3	70	30	3
5.	Elective	3	--	3	70	30	3
6.	Elective	3	--	3	70	30	3
7.	Laboratory - I	--	3	3	--	50	2
8.	Seminar - I	--	3	3	--	50	2
	Total	**18**	**6**	**23**	**420**	**280**	**22**
Semester - II							
1.	Core	3	--	3	70	30	3
2.	Core	3	--	3	70	30	3
3.	Core / Elective	3	--	3	70	30	3
4.	Core / Elective	3	--	3	70	30	3
5.	Elective	3	--	3	70	30	3
6.	Elective	3	--	3	70	30	3
7.	Laboratory - II	--	3	3	--	50	2
8.	Seminar - II	--	3	3	--	50	2
	Total	**18**	**6**	**24**	**420**	**280**	**22**
Semester - III							
1.	Project+ Seminar*	--	4	4	--	**100****	**8**
Semester – IV							
1.	Dissertation	--	6	6	**200**	-	**16**

Note: Six core subjects, six elective subjects, two laboratory courses and two seminars should normally be completed by the end of semester II.

* *One project seminar presentation.*

** *50 marks to be awarded by guide and 50 marks to be awarded by viva-voice committee comprising Guide and two internal senior faculty members (subject experts)*

Scheme of Instruction & Examination

M.E. (Mechanical Engineering) 6 Semesters (Part Time)

Sl. No	Subject	Periods per week		Duration (Hrs)	Max. Marks		Credits
		L/T	D/P		SEE	CIE	
Semester - I							
1.	Core	3	--	3	70	30	3
2.	Core / Elective	3	--	3	70	30	3
3.	Elective	3	--	3	70	30	3
4.	Lab. I / Seminar - I	--	3	3	--	50	2
	Total	**9**	**3**	**12**	**210**	**140**	**11**
Semester – II							
1.	Core	3	--	3	70	30	3
2.	Core / Elective	3	--	3	70	30	3
3.	Elective	3	--	3	70	30	3
4.	Lab. I / Seminar - I	--	3	3	--	50	2
	Total	**9**	**3**	**12**	**210**	**140**	**11**
Semester – III							
1.	Core	3	--	3	70	30	3
2.	Core / Elective	3	--	3	70	30	3
3.	Elective	3	--	3	70	30	3
4.	Lab. II / Seminar - II	--	3	3	--	50	2
	Total	**9**	**3**	**12**	**210**	**140**	**11**
Semester - IV							
1.	Core	3	--	3	70	30	3
2.	Core / Elective	3	--	3	70	30	3
3.	Elective	3	--	3	70	30	3
4.	Lab. II / Seminar - II	--	3	3	--	50	2
	Total	**9**	**3**	**12**	**210**	**140**	**11**
Semester – V							
1.	Project+ Seminar*	--	4	4	--	**100****	**8**
Semester – VI							
1.	Dissertation	--	6	6	**200**	-	**16**

Note : Six core subjects, six elective subjects, two laboratory courses and two seminars should normally be completed by the end of semester IV.

* Project seminar presentation on the topic of Dissertation only

*** 50 marks to be awarded by guide and 50 marks to be awarded by viva-voice committee comprising Guide and two internal senior faculty members (subject experts)*

M. E. Mechanical Engineering (Production Engineering)

Syllabus Ref. No. (Code)	Subject Title	Contact hrs Per week	Scheme of Examination		Credits
			CIE	SEE	
Core Subjects:					
ME2101	Advanced Casting & Joining Processes	3	30	70	3
ME2102	Material Forming	3	30	70	3
ME2103	Machining Science	3	30	70	3
ME2104	Tool Engineering	3	30	70	3
ME2105	Advanced Manufacturing Techniques	3	30	70	3
ME2106	Manufacturing Management	3	30	70	3
Elective Subjects:					
ME2301	Automation	3	30	70	3
ME2403	Computer Integrated Manufacturing	3	30	70	3
ME2303	Robotic Engineering	3	30	70	3
ME2401	Finite Element Techniques	3	30	70	3
ME2402	Computer Aided Modeling and Design	3	30	70	3
ME2308	Optimization Techniques	3	30	70	3
ME2312	Artificial Intelligence and Expert Systems	3	30	70	3
ME2107	Mechanics of Composite Materials	3	30	70	3
ME2108	Machine Tool Dynamics	3	30	70	3
ME2109	Theory of Elasticity and Plasticity	3	30	70	3
ME2110	Experimental Techniques and Data Analysis	3	30	70	3
ME2501	Advanced Metrology	3	30	70	3
ME2001	Engineering Research Methodology	3	30	70	3
ME2111	Product Design and Process Planning	3	30	70	3
ME2112	Additive Manufacturing Technologies and Applications	3	30	70	3
ME2113	Flexible Manufacturing Systems	3	30	70	3
ME2114	Non-Destructive Evaluation Techniques	3	30	70	3
Departmental Requirements:					
ME2131	Production Engineering Lab (Lab – I)	2	50	-	2
ME2032	Computation Lab (Lab –II)	2	50	-	2
ME2033	Seminar I	2	50	-	2
ME2034	Seminar II	2	50	-	2
ME2035	Project Seminar	4	100	-	8
ME2036	Dissertation	6	150		12

CIE : Continuous Internal Evaluation SEE : Semester End Examination

ME2101

ADVANCED CASTING & JOINING PROCESSES

Instructions 3 periods/week Duration of university Examination: 3 hours
Credits 3 SEE: 70 Marks CIE: 30 Marks

Objectives:

- To understand the basic concepts and advances in casting and welding processes
- To study the metallurgical concepts and applications of casting and welding process.
- To acquire knowledge in CAD of casting and automation of welding process.

UNIT - I

Casting Design: Heat transfer between metal and mould - Design considerations in casting – Designing for directional solidification and minimum stresses- principles and design of gating and risering.

UNIT - II

Casting Metallurgy:Solidification of pure metal and alloys, shrinkage in cast metals, progressive and directional solidification, Degasification of the melt-casting defects, Castability of steel , Cast Iron, Al alloys , Babbit alloy and Cu alloy.

UNIT - III

Recent Trends In Casting And Foundry Layout: Shell moulding, precision investment casting, CO_2moulding, centrifugal casting, Die casting, Continuous casting, Counter gravity low pressure casting, Squeeze casting and semisolid processes. Layout of mechanized foundry, sand reclamation, material handling in foundry pollution control in foundry, Computer aided design of casting.

UNIT - IV

Welding Metallurgy And Design: Heat affected Zone and its characteristics – Weldability of steels, cast iron, stainless steel, aluminum, Mg , Cu , Zirconium and titanium alloys – Carbon Equivalent of Plain and alloy steels Hydrogen embrittlement – Lamellar tearing – Residual stress – Distortion and its control . Heat transfer and solidification - Analysis of stresses in welded structures – pre and post welding heat treatments –weld joint design – welding defects – Testing of weldment.

UNIT - V

Recent Trends In Welding: Friction welding, friction stir welding, explosive welding, diffusion bonding, high frequency induction welding, ultrasonic welding, electron beam welding, Laser beam welding, Plasma welding, Electro slag welding, narrow gap, hybrid twin wire active TIG, Tandem MIG, modern brazing and soldering techniques, induction, dip resistance, diffusion processes, Hot gas, wave and vapour phase soldering. Overview of automation of welding in aerospace, nuclear, surface transport vehicles and under water welding.

Suggested Reading:

1. Parmer R.S., Welding Engineering and Technology,Khanna Publishers,2002
2. Srinivasan N.K., Welding Technology, Khanna TechPublishers, 2002
3. Heineloper& Rosenthal, Principles of Metal Casting, Tata McGraw Hill, 2000.
4. Jain P.L., Principles of Foundry Technology,TataMcGrawHill Publishers, 2003
5. Carrry B., Modern Welding Technology, Prentice Hall Pvt Ltd., 2002
6. Cornu.J. Advanced welding systems – Volumes I, II and III, JAICO Publishers, 1994.
7. Lancaster.J.F. – Metallurgy of welding – GeorgeAlien& Unwin Publishers, 1980

ME2102

MATERIAL FORMING

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives:

- To understand the mechanism of plastic deformation of materials
- To study the process parameters and estimation of loads
- To acquire the knowledge in bulk deformation processes
- To understand the different forming techniques

UNIT-I

Plastic Deformation: Factors affecting plastic deformation, Strain hardening behavior. Recovery, Recrystallization and grain growth.Ideal & Practical stress-strain curves. Cold working, warm working and hot working. Plasticity cycle. Tresca and Von -Mises yield criteria under complex states of stress, including Plane stress & Plane strain condition.

UNIT-II

Sheet Metal Working: Formability tests for sheet metals. Erichsen and Fukui tests. F.L.D. and Shape analysis concepts. Sheet metal dies, Process parameters and estimation of loads in shearing, bending, deep drawing and spinning operations. Superplasticforming, Stretch forming.Fine blanking.

UNIT-III

Analysis of plastic deformation: Forging, Rolling, Extrusion, rod/wire drawing and tube drawing – Effect of friction – calculation of forces, work done – Process parameters, equipment used – Defects – applications – Recent advances in Forging, Rolling, Extrusion and Drawing processes – Design consideration in forming. Hydrostatic Extrusion. Metal working lubricants.

UNIT-IV

Powder Metallurgy Technique: Advantages – applications – Powder preform forging –powder rolling – Tooling, process parameters and applications. Orbital forging –Isothermal forging – Hot and cold isostatic pressing – High speed extrusion,

UNIT-V

Unconventional Forming: High energy rate forming. Merits and limitations of HERF Processes. Principle, merits, limitations and applications ofExplosive forming, electromagnetic forming, electro -hydraulic forming and water hammer forming.Forming with rubber pads.

Suggested Reading:

1. Geoffrey W. Rowe, “An introduction to the Principles of Metal Working”, Edward Arnold Ltd, London, 1990.
2. SeropeKalpakjian, “Mechanical Processing of Materials”, D.VanNostrand Company, Inc., Princeton, New Jerseey, 1955.
3. Surender Kumar, “Principles of Metal Working”, Oxford & IBH Publishing Co. Pvt. Ltd., 1985.
4. P.C. Sharma, “A Text Book of Production Engineering”, S.Chand& Co. Ltd. New Delhi.
5. G.E. Dieter, Mechanical Metallurgy, McGraw - Hill Publications, 3rdEdition, 1988.

ME2103

MACHINING SCIENCE

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives:

- To provide the understating of cutting tool, various principles of machining processes.
- To know the cutting force in Turing & Drilling, heat distribution and temperature in machining process.
- To know Selection of cutting fluids, tool life, wear mechanisms during the machining operations.
- To develop the relations for forces in multipoint machining processes.

Unit - I

Machining: Introduction to machining, Orthogonal and Oblique cutting, Classifications of cutting tools, Chip formation, Types of chips, Cutting tool geometry, various methods of tool nomenclature and their relationships. Theoretical Determination of shear angle and cutting forces: Shear plane theory –Merchant's models, Lee and Shaffer's model. Velocity relationships, Work done in cutting, Horse power calculations, Sources of heat in metal cutting,

Unit - II

Dynamometry: Theoretical and empirical estimation of force and power in turning, drilling, milling and grinding processes optimization in cutting forces, Dynamometer requirements, Force measurements, Electric transducers. Lathe, Drilling and Milling Dynamometers, **Metal cutting friction:** Real area of contact, rules of dry sliding, stress distribution of tool face, variation of co-efficient of tool face friction with the rake angle.

Unit - III

Cutting Temperatures: Shear Plane temperature, Average chip-tool interface temperature-interface temperature by dimensional analysis, Distribution of shear plane temperature, Measurement of temperature by radiation pyrometer, Moving thermo couple, Photo cell, Photographic method. **Cutting Tool Materials**: Desirable Properties of tool materials, Characteristics of Cutting Tool Materials, Indexable inserts, Coated tools.

Unit - IV

Tool Wear, Tool life and Machinability, Mechanism of tool wear – Adhesive, Abrasive, Diffusive and Chemical wear – Taylor's tool life equation. **Cutting Fluids**: Functions, characteristics and types, Selection of cutting fluids.

Unit - V

Mechanics of Multipoint Machining processes: Drill Geometry & Mechanics of Drilling Process, Geometry of Milling Cutters and Mechanics of Milling process, Grinding, Analysis of the grinding process.

Suggested Reading:

1. David A. Stephenson, Johs S. Agapiou, Metal Cutting Theory and Practice, CRC Press, 3rd Edition, March 2016.
2. M.C. Shaw, Metal cutting principles, CBS Publishers and distributors., New Delhi, 1992
3. Bhatta Charya, Metal Cutting, Central book publishers, Calcutta, 1996.
4. Sen and Battacharya, Principles of Machine Tools, Central book publishers, Calcutta, 1995.
5. PN. Rao, Manufacturing Technology–Metal Cutting and Machine Tools, 3/e, TMH, New Delhi, 2013.
6. Mikell P. Groover, Fundamentals of Modern Manufacturing, John Wiley & Sons Inc, 2nd Edition, 2002.

ME2104

TOOL ENGINEERING

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives:

- To understand the geometry of different tools
- To study the design of press tools, Jigs and fixtures and repair of press tools
- To acquire knowledge in tooling for automats and economics of tooling
- To understand the manufacturing and sharpening of cutting tools

UNIT-I

Design of Cutting Tools: S.P. tools, geometry, design of shank, form tools, types, form correction, drills, geometry, effect of feed, axial thrust and torque. Reamers – cutting elements, geometry, tolerances, milling cutters minimum no. of teeth, geometry different types of cutters. Cutting principle by form generation gear shapers & hobs.

UNIT-II

Design of Press Tools: For blanking, piercing bending and drawing, center of pressure clearances, strip layout, punch force, blank size, number of draws, single, compound and progressive press – tools, manufacture and testing of press tools, repair of press tools and prolonging their life.

UNIT-III

Jigs and Fixtures Design: Principles of location and clamping, locating and clamping elements and their standardization, classification of jigs and their standardization. Universal jigs fixtures, steps in special location and clamping devices, quick clamping devices. Designing jig and fixture. Examples of turning and milling fixtures. Drilling – Jigs, welding fixtures, fixturing of NC machines.

UNIT-IV

Tooling for Automats: Cam design for automats, gauge design – gauge allowances and tolerance –materials for gauges. Economics of Tooling: Selection of economical method – amortization of tooling costs.

UNIT-V

Manufacturing and Sharpening of Cutting Tools: Manufacture of drills, reamers, milling cutters, broaches, gear hobs. Sharpening of single point tools, drills, reamers, milling cutters, broaches and gear hobs.

Suggested Reading:

1. ASTME, Fundamentals of Tool Design.
2. Rodin, Design and production of Metal Cutting Tools.
3. Palay, Manufacture of Metal Cutting Tools.
4. Surendra Kumar, Production Engineering Design (Tool Design).
5. G.R. Nagpal, Tool Engineering.
6. Donaldson, Lecain&Wulff, Tool Design.
7. Ham & Bhattacharya, Cutting Tool Design, Theory of Metal Cutting.

ME2105

ADVANCED MANUFACTURING TECHNIQUES

Instructions 3 periods/week Duration of university Examination: 3 hours
Credits 3 SEE: 70 Marks CIE: 30 Marks

Objectives:

- To understand the importance and have knowledge of Unconventional machining and forming processes.
- To have the knowledge of different micro machining methods.
- To understand the working principles of various Non-traditional methods in machining and forming

UNIT-I

Introduction: Need for non-traditional machining processes. Processes selection, classification, and comparative study of different processes. Mechanical Process: **Ultrasonic Machining**-Definition-Mechanism of metal elements of the process- Tool feed mechanism. Theories of mechanics of causing effect of parameter applications. **Abrasive Jet Machining**: Principles - parameters of the process, applications, advantages and disadvantages. **Water Jet Machining (WJM):** Schematic diagram, equipment used, advantages, disadvantages and applications. **Abrasive Water Jet Machining (AWJM):** Schematic sketch, equipment and abrasives used, advantages, disadvantages and applications.

UNIT-II

Thermal Metal Removal Process: Electric discharge machining Principle and operation – mechanism of metal removal, basic EDM circuitry-spark erosion. Analysis of relaxation type of circuit, material removal rate in relaxation circuits- critical resistance- parameters in RC Circuit-Dielectric fluids- flushing-Electrodes, surface finish. Applications. **Wire EDM** principle and operation. Wire materials, wire tension and its parameters. Applications.

UNIT-III

Electro Chemical and Chemical Processes: Electro chemical machining (ECM) Classification ECM process-principle of ECM Chemistry of the ECM parameters of the processes-determination of the metal removal rate - dynamics of ECM process-Hydrodynamics of ECM process-polarization. Tool Design-advantages and disadvantages - applications. Electro Chemical Grinding-Electro Chemical honing, electro chemical deburring.

UNIT-IV

Electron Beam Machining (EBM): Introduction-Equipment for production of Electron beam - Theory of electron beam machining, Thermal & Non thermal type's characteristics – applications. **Laser Beam Machining (LBM)**: Introduction-principle of generation of lasers equipment and machining procedure-types of Lasers-process characteristics-advantages and limitations-applications. **Ion Beam Machining (IBM)**: Introduction-mechanism of metal removal and associated equipment-process characteristics and applications. **Plasma Arc Machining (PAM)**: Introduction-Plasma-generation of Plasma and equipment, mechanism of metals removal, PAN parameters-process characteristics - type of torches, applications.

UNIT-V

Micro Machining Techniques: Introduction to Micro-EDM, Electrochemical Micro machining, Abrasive jet Micro machining, Chemo-Mechanical Polishing (CMP), Abrasive flow finishing (AFF), Magnetic abrasive finishing (MAF), Magnetic Float polishing (MFP), and Magnetorheological finishing (MRF).

Suggested Reading:

1. New Technology- Institution of Engineers - Bhattacharya - India
2. Production Technology - HMT - Tata McGraw Hill - ISBN-10;
3. Modern Manufacturing Method - Adithan - New Age International (p) Limited
4. Modern Machining Processes - P.K. Mishra - Narosa Publishing House, New Delhi, 1997.
5. Advanced Methods of Machining –J.A. McGeough –Springer, New Delhi-2011.
6. Introduction to Micro Machining -VK Jain-Narosa Publishing House, New Delhi.

ME2106

MANUFACTURING MANAGEMENT

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives:

- To learn the evolution of manufacturing, human resources involvement.
- To know the Inventory management systems in manufacturing
- To familiarize with design models for processing and quality assurance, automated manufacturing and measuring systems.
- To understand the new strategies, techniques, leadership and performance measurement in management

Unit-I

Introduction to Manufacturing: History of manufacturing, Selection of manufacturing processes, CIM, Global competitiveness and manufacturing costs, Environmental consciousness in Manufacturing. Terms and Definitions used in materials handling, Principles of material handling equipment, Factors in selection of Materials handling system.

Unit-II

Enterprise Resource Planning: An Overview of Enterprise Resource Planning (ERP), Benefits of ERP, ERP and Related Technologies, Business Process Reengineering (BPR) and features of ERP software - SAP.

Unit-III

Human Factors Engineering: Introduction, Focus of Ergonomics, Basic Work system, History of Ergonomics, Human performance Psychology, Fit the Man to the Job (FMJ), fitting the Job to the Man (FJM), Success of Work Humanization Programs, Modern Ergonomics, Effectiveness and Cost-effectiveness of Ergonomics.

Unit-IV

Strategic Framework: JIT Manufacturing, Benefits of JIT, Understanding to Supply Chain, push, pull and push-pull systems, Introduction to Supply Chain Management(SCM), Purchasing, Procurement and SCM, Tendering and Vendor Rating, E-procurement and Operating Resource Management,

Six Sigma: Definition, Evolution of Six Sigma, Statistical considerations, Tools for process improvement, Six sigma in Services and small Organizations.

Unit-V

Leadership and Performance Measurement: Leadership for quality, creating the leadership system, leading practices for strategic planning, Linking human resource plans and Business strategy, Creating satisfied customers, Effective complaint management, Performance measurement, Product outcomes, Customer focused outcomes, financial and market outcomes, leadership outcomes, Identifying and selecting process measures.

Suggested Reading:

1. SeropeKalpakjain and Steven R. Schmid, Manufacturing Engineering and Technology,Pearson Education Inc., 4th Edition, 2013.
2. R.S. Bridger Introduction to Ergonomics, McGraw Hill, 1995.
3. S.Sadagopan, ERP: A managerial Perspective, Tata McGraw-Hill publishing company Limited, New Delhi 1999.
4. Dr. Surender Kumar, Industiral Engineering & Management of Manufacturing Systems, SatyaPrakashan, New Delhi.
5. Evans and Lindsay, The Management and control of Quality, Cengage Learning India Prvt Ltd., 2012.
6. KanishkaBedi, Production and Operations Management, Oxford University Press, 3rd Edition, 2013.

ME2301

AUTOMATION

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT – I

Introduction: Definition of automation, Types of production, Functions of Manufacturing, Organization and Information Processing in Manufacturing, Production concepts and Mathematical Models, Automation Strategies, Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break-Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in-process.

UNIT – II

Automation Production Lines**:** Automated Flow lines, Methods of Work part Transport, Transfer Mechanism, Buffer Storage, Control Functions, Automation for Machining Operations, Design and Fabrication Considerations. *Analysis of Automated Flow Lines*: General Terminology and Analysis, Analysis of Transfer Lines Without Storage, Partial Automation, Automated Flow Lines with Storage Buffers, Computer Simulation of Automated Flow Lines.

UNIT – III

Assembly Systems and Line Balancing: The Assembly Process, Assembly Systems, Manual Assembly Lines, The Line Balancing Problem, Methods of Line Balancing, Computerized Line Balancing Methods, Other ways to improve the Line Balancing, Flexible Manual Assembly Lines. *Automated Assembly Systems:* Design for Automated Assembly, Types of Automated Assembly Systems, Part Feeding Devices, Analysis of Multi-station Assembly Machines, Analysis of a Single Station Assembly Machine.

UNIT –IV *Automated Materials Handling:* The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. *Automated Storage Systems:* Storage System Performance, Automated Storage/Retrieval Systems, Carousel Storage Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing.

UNIT – V *Automated Inspection and Testing:* Inspection and testing, Statistical Quality Control, Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods. *Modeling Automated Manufacturing Systems:* Role of Performance Modeling, Performance Measures, Performance Modeling Tools: Simulation Models, Analytical Models. *The Future Automated Factory:* Trends in Manufacturing, The Future Automated Factory, Human Workers in the Future Automated Factory, The social impact.

Suggested Reading:

1. MikellP.Grover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education Asia.
2. C.RayAsfahl, Robots and manufacturing Sutomation, John Wiley and Sons New York.
3. N.Viswanadham and Y.Narahari, Performance Modeling of Automated Manufacturing Syetms, Printice Hall India Pvt. Ltd.
4. Stephen J. Derby, Design of Automatic Machinary, Special Indian Edition, Marcel Decker, New York, Yesdee publishing Pvt. Ltd, Chennai

ME2403

COMPUTER INTEGRATED MANUFACTURING

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives:

- To understand the need for CIM, evolution of CIM, fundamentals of CIM and the Concept of Concurrent Engineering.
- To know the role of database management of CIM and understand various types of CIM technologies and systems like DFMA, CAPP, MRP, Cellular Manufacturing, and FMS etc.
- To understand the fundamental networking concepts that help in integrating all the important components of an enterprise and discuss the different types of CIM models developed by various industries and understand the new trends in manufacturing systems.

UNIT – I: Introduction to CIM

The meaning of Manufacturing, Types of Manufacturing; Basic Concepts of CIM: CIM Definition, Elements of CIM, CIM wheel, concept or technology, Evolution of CIM, Benefits of CIM, Needs of CIM: Hardware and software. Concurrent Engineering: Definition, Sequential Engineering Versus Concurrent Engineering, Benefits of Concurrent Engineering, Characteristics of concurrent Engineering, Framework for integration of Life-cycle phases in CE, Concurrent Engineering Techniques, Integrated Product Development (IPD), Product Life-Cycle Management (PLM), Collaborative Product Development.

UNIT – II: CIM database and database management systems

Introduction, Manufacturing Data: Types, sources; Database Terminology, Database requirements, Database models, Database Management System, DBMS Architecture, Query Language, Structural Query Language (SQL): Basic structure, Data definition Language (Create, Alter, Drop, Truncate, View), Data Manipulation Language (store, retrieve, update, delete). Illustration of Creating and Manipulating a Manufacturing Database. SQL as a Knowledge Base Query Language. Features of commercial DBMS: Oracle, MySQL, SQL Access, Sybase, DB2. Product Data Management (PDM), Advantages of PDM.

UNIT – III: CIM Technology and Systems

Product Design: Needs of the market, Design and Engineering, The design Process, Design for Manufacturability DFM, Design for Assembly (DFA), Design for Manufacturing and Assembly (DFMA), Computer-Aided Process Planning: Basic Steps in developing a process plan, Variant and Generative Process Planning, Feature Recognition in Computer-Aided Process Planning. Material Requirements Planning (MRP): Lot Sizing Techniques: Lot for Lot (LFL), Fixed Order Quantity (FOQ), Periodic Order Quantity (POQ), Economic Order Quantity (EOQ), Fixed Period Requirement (FPR). Manufacturing Resource Planning (MRP –II). Cellular Manufacturing: Design of Cellular Manufacturing Systems, Cell Formation Approaches: Machine–Component Group Analysis, Similarity Coefficients-Based Approaches. Evaluation of Cell Design. Flexible Manufacturing Systems: Physical Components of an FMS, Types of FMS layouts, Operational Problems of FMS. FMS benefits.

UNIT –IV: Enterprise Wide Integration in CIM and CIM Models

Introduction to Networking, Principles of Networking, Network Terminology, and Types of Networks: LAN, MAN, WAN; Selection of Network Technology: Communication medium, Network Topology, Medium access control Methods, Signaling methods; Network Architectures and Protocols: OSI Model, MAP & TOP, TCP/IP, Network Interconnection and Devices, Network Performance. Framework for Enterprise-wide Integration.

CIM Models: ESPRIT-CIM OSA Model, NIST-AMRF Model, Siemens Model of CIM, Digital Equipment Corporation Model, IBM Concept of CIM.

UNIT – V: Future Trends in Manufacturing Systems

Lean Manufacturing: Definition, Principles of Lean Manufacturing, Characteristics of Lean Manufacturing, Value of Product, Continuous Improvement, Focus on Waste, Relationship of Waste to Profit, Four Functions of Lean Production, Performance Measures, The Supply Chain, Benefits of Lean Manufacturing. Introduction to Agile and Web Based Manufacturing systems.

Suggested Reading:

1. S.Kant Vajpayee: Principles of Computer Integrated Manufacturing, Printice-Hall India.
2. Nanua Singh: Systems Approach to Computer Integrated Design and Manufacturing- John Wiley.
3. P.Radhakrishnan, S.Subramanyam: CAD/CAM/CIM, New Age International
4. Alavudeen, Venkateshwaran: Computer Integrated Manufacturing, Printice-Hall India

ME2303

ROBOTIC ENGINEERING

Instructions 3 periods/week Duration of university Examination: 3 hours
Credits 3 SEE: 70 Marks CIE: 30 Marks

The goal of the Robotics course is to familiarize the students with the concepts and techniques in robot manipulator control, enough to evaluate, chose, and incorporate robots in engineering systems

Objectives:

- To develop the student's knowledge in various robot structures and their workspace.
- To develop student's skills in performing spatial transformations associated with rigid body motions.
- To develop student's skills in perform kinematics analysis of robot systems.
- To provide the student with knowledge of the singularity issues associated with the operation of robotic systems.
- To provide the student with some knowledge and analysis skills associated with trajectory planning.

To provide the student with some knowledge and skills associated with robot control

UNIT-I

Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.

UNIT-II

Rotation matrices, Euler angle and RPY representation, Homogeneous transformation matrices, Denavit-Hartenbergnotation, representation of absolute position and orientation in terms of joint parameters, direct kinematics.

UNIT-III

Inverse Kinematics, inverse orientation, inverse locations, Singularities, Jacobian, Trajectory Planning: joint interpolation, task space interpolation, executing user specified tasks.

UNIT-IV

Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangian and Newton-Euler formulations of RR and RP type planar robots, , Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, Computed torque control, force control, hybrid control.

UNIT-V

Sensors and controllers: Internal and external sensors, position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder. Robot vision: image processing fundamentals for robotic applications, image acquisition and preprocessing. Segmentation and region characterization object recognition by image matching and based on features

Suggested Readings:

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw-Hill, 2003.
2. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and sons, 2008.
3. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, Robotics, control, sensing, Vision and Intelligence, McGraw Hill International, 1987
4.Harry Asada &Slottine "Robot Analysis& Control" , Wiley Publications, 2014
5. S K Saha, "introduction to Robotics ", 2nd edition, TMH, 2013

ME2401

FINITE ELEMENT TECHNIQUES

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives:

- *To understand the theory and application of the finite element method for analyzing structural systems.*
- *To learn Approximation theory for structural problems as the basis for finite element methods.*
- *To learn formulations for a variety of elements in one, two, and three dimensions.*
- *To understand modeling and analysis of structures using planar, solid, and plate elements.*

UNIT-I

Introduction: Finite Element Method of solving field problems. Stress and Equilibrium. Boundary conditions. Strain-Displacement relations. Stress-strain relations. One Dimensional Problem: Finite element modeling. Local, natural and global coordinates and shape functions. Potential Energy approach: Assembly of Global stiffness matrix and load vector. Finite element equations, treatment of boundary conditions. Quadratic shape functions.

UNIT-II

Analysis of trusses and frames: Analysis of plane truss with number of unknowns not exceeding two at each node. Analysis of frames with two translations and a rotational degree of freedom at each node. Analysis of Beams: Element stiffness matrix for two node, two degrees of freedom per node for beam element.

UNIT-III

Finite element modeling of two dimensional stress analysis problems with constant strain triangles and treatment of boundary conditions. Two dimensional four node iso-parametric elements and numerical integration. Finite element modeling of Axisymmetric solids subjected of axisymmetric loading with triangular elements. Convergence requirements and geometric isotropy.

UNIT-IV

Steady state heat transfer analysis: One dimensional analysis of a fin and two dimensional conduction analysis of thin plate. Time dependent field problems: Application to one dimensional heat flow in a rod. Dynamic analysis: Formulation of finite element modeling of Eigen value problem for a stepped bar and beam. Evaluation of Eigen values and Eigen vectors. Analysis of a uniform shaft subjected to torsion using Finite Element Analysis.

UNIT-V

Finite element formulation of three dimensional problems in stress analysis. Finite Element formulation of an incompressible fluid. Potential flow problems bending of elastic plates. Introduction to non-linear problems and Finite Element analysis software.

Suggested Reading:

1. Tirupathi R Chandraputla and Ashok. D. Belegundu, *Introduction of Finite Element in Engineering,* Prentice Hall of India, 1997.
2. Rao S.S., *The Finite Element Methods in Engineering,* Pergamon Press, 1989.
3. Segerland. L.J., *Applied Finite Element Analysis,* Wiley Publication, 1984.
4. Reddy J.N., *An Introduction to Finite Element Methods,* McGraw Hill Company, 1984.

ME2402

COMPUTER AIDED MODELLING & DESIGN

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT-I
Introduction to CAD, Criteria for selection of CAD workstations, Shigle Design Process, Design criteria, Geometric modeling, entities, 2D & 3D Primitives. 2D & 3D Geometric Transformations: Translation, Scaling, Rotation, Reflection and Shearing, conlatenation. Graphics standards: GKS IGES, PDES.

UNIT-II
Wire frame modeling: Curves: Curve representation. Analytic curves – lines, Circles, Ellipse, Conis. Synthetic curves – Cubic, Bezier, B-Spline, NURBS.

UNIT-III
Surface Modeling: Surface entities, Surface Representation. Analytic Surface – Plane Surface, Ruled Surface, Surface of Revolution, Tabulated Cylinder. Synthetic Surface-Cubic, Bezier, B-spline, Coons.

UNIT-IV
Solid Modeling Techniques: Graph Based Model, Boolean Models, Instances, Cell Decomposition & Spatial – Occupancy Enumeration, Boundary Representation (B-rep) & Constructive Solid Geometry (CSG).

UNIT-V
Advanced Modeling Concepts: Feature Based Modeling, Assembling Modeling, Behavioral Modeling, Conceptual Design & Top down Design. Capabilities of Modeling & Analysis Packages such as solid works, Unigraghics, Ansys, Hypermesh. Computer Aided Design of mechanical parts and Interference Detection by Motion analysis.

Suggested Reading:
1. Ibrahim Zeid, CAD/CAM, Theory and Practice, McGraw Hill, 1998.
2. Foley, Van Dam, Feiner and Hughes, Computer Graphics Principles and Practice, 2nd Ed., Addison – Wesley, 2000.
3. Martenson, E. Micheal, Geometric Modelling, John Wiley & Sons, 1995.
4. Hill Jr, F.S., Computer Graphics using open GL, Pearson Education, 2003.

ME2308

OPTIMISATION TECHNIQUES

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT – I
Simulation: Introduction, Types of Simulation, Simulation Models, Monte Carlo Simulation, Random Number, Pseudo Random Number, Mid-Square Method of generating Random Numbers, Application & Limitation, Application of Simulation to Inventory Control and Queuing Problem

UNIT – II
Decision Theory: Introduction, Decision, Decision Making & Decision Theory, Types of Decisions, decision making process, Types of Decision making Environment: **Decision making under certainty** –Expected Monetary Value (EMV), Expected Opportunity Loss (EOL) Criterion & Expected Value of Perfect Information (EVPI) Criterion **Decision making under risk**- Criterion of Pessimism or Manimax, Criterion of Optimism or Maximin, Minimax Regret Criterion, Criterion of Realism & Criterion of Rationality **Decision making under uncertainty** and **Decision tree analysis**: Introduction, Procedure of Constructing Decision Trees & Solution through Decision Tree Analysis.

UNIT – III
Integer Programming: Introduction, Types of Integer Programming Problems, Gomory's Cutting Plane method. Branch and Bound method for all Integer Programming Problems & Mixed Integer Programming Problems

UNIT – IV
Dynamic Programming: Introduction- Bellman's principle of optimality-Application of dynamic programming-Linear programming problem-Capital budgeting problem

UNIT – V
Classical Optimization: Introduction; Unconstrained problems of maxima and minima, constrained problems of maxima and minima; Constraints in the form of equations – Lagrangian method; Constraints in the form of inequalities -Kuhn-tucker conditions.

Suggested Reading:
1. S.S.Rao, Optimization Theory and Applications, NAI Publishers, Hyderabad, 1995.
2. S.D.Sharma, Operations Research, Kedarnath and Co. Publishers, Meerut, 2004.
3. V. K. Kapoor, Operations Research, S. Chand, New Delhi, 2004.
4. HamdyA.Taha, Operations Research, Pearson Education, New York, 2001.
5. Bronson-Schaum Series, Operations Research, McGraw Hill, Singapore, 1983.
6. David Goldberg, Genetic Algorithms, S Chand Publications, 2006.

ME2312

ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

Instructions 3 periods/week Duration of university Examination: 3 hours
Credits 3 SEE: 70 Marks CIE: 30 Marks

UNIT-I

Artificial Intelligence: Definition, Study of AI techniques, problems and Problems space, AI characteristics, Heuristics. Problem solving Methods: Forward and backward reasoning, problem trees, problem graph, hill climbing, search method, problem reduction, constraint satisfaction, means and analysis, game playing, mini max algorithms, alphabetic heuristics.

UNIT-II

Computer Vision: Perception, early processing, representation and recognition of scenes, Guzman's algorithms of spurting objects in a scene, Waltz algorithm.

UNIT-III

Neural Language understanding problems, syntactic analysis, semantic analysis, augmented transition networks.

UNIT-IV

Knowledge representation (Logic): Representing facts in logic predicate logic, resolution, unification, question answering, mathematical theorem proving. Knowledge representation (Structured): Declarative representation, Semantic nets, procedural representation.

UNIT-V Learning: Learning as induction, failure drive learning, learning by teaching, learning through examples (Winston's program) skill acquisition.

Suggested Reading:

1. Elaine Rich, *Artificial Intelligence,* McGraw Hill, 1985. 2. Nilson, *Principles of Artificial Intelligence.* 3. Winston, *The Psychology of Computer*.
2. Nilson, *Principles of Artificial Intelligence.* 3. Winston, *The Psychology of Computer*.
3. Winston, *The Psychology of Computer*.

ME2107

MECHANICS OF COMPOSITE MATERIALS

Instructions 3 periods/week Duration of university Examination: 3 hours
Credits 3 SEE: 70 Marks CIE: 30 Marks

UNIT-I

Introduction: Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composites carbon fibre composites.

UNIT-II

Micromechanics of Composites: Mechanical properties-Prediction of Elastic constant, micromechanical approach, Halpin-Tsai equations, Transverse stresses. Thermal properties-Hydrothermal stresses, mechanics of load transfer from matrix to fibre.

UNIT-III

Micromechanics of Composites: Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation, inter-laminar stresses and edge effects. Simplified composite beam solutions. Bending of laminated beams.

UNIT-IV

Strength, fracture, fatigue and design: Tensile and compressive strength of unidirectional fibre composites,

Fracture modes in composites: Single and multiple fracture, de-bonding, fibre pullout and de-lamination failure, fatigue of laminate composites. Effect of variability of fibre strength.

Strength of an orthotropic lamina: Max stress theory, max strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria. Designing with composite materials.

UNIT-V

Analysis of plates and stress: Plate equilibrium equations, bending of composite plates, Levy and Navier solution for plates of composite materials. Analysis of composite cylindrical shells under axially symmetric loads.

Suggested Reading:

1. Jones, R.M., *Mechanics of Composite Materials, McGraw Hill Co., 1967.*
2. Calcote, L.R., *The Analysis of Laminated Composite Structures,* Van Nostrand, 1969.
3. Whitney, I.M. Daniel, R.B. Pipes, *Experimental Mechanics of Fibre Reinforced Composite Materials,* Prentice Hall, 1984.
4. Hyer, M.W., *Stress Analysis of Fibre Reinforced Composite Materials,* McGraw Hill Co., 1998.
5. Carl. T. Herakovich, *Mechanics of Fibrous Composites,* John Wiley Sons Inc., 1998.

ME2108

MACHINE TOOL DYNAMICS

Instructions 3 periods/week Duration of university Examination: 3 hours
Credits 3 SEE: 70 Marks CIE: 30 Marks

- To understand the effect of vibrations in the machine tools and structures.

UNIT-I
Vibration theory: Review of systems with one and two degrees of freedom, damped, undamped free and forced vibrations, beat phenomenon. Transmissibility of vibration and vibration isolation. Vibration measurement.

UNIT-II
Dynamics of structures: Force and stiffness methods, Eigen value problem using lumped mass technique, application to simple structures with damping.

UNIT-III
Chatter in Machine tools: Basic pattern of chatter in metal cutting. Regenerative chatter, node coupling. Limit width of cut. Importance of negative real component of receptance. Dynamic cutting force co-efficient. Prediction of machine tools instability. Study of chatter behavior of lathe, drilling and milling machines. C.I.R.P., rig stick-slip phenomenon.

UNIT-IV Stability of Machine tools: Individual steps in the procedure-Directional factors cutting tests, Measurement of dynamic data by excitation tests. Evaluation of the test examples of the analysis of the stability of machine tools like Horizontal knee-type milling machine, vertical knee-type milling machine, center lathes.

UNIT-V
Damping in Machine tools: Material and system damping. Dampers – Dynamic, impact and active type. Methods of improving damping in machine tools. Examples of the use of dampers, practical design consideration. Dynamic measurement of forces and vibration – Oscillating tools. Vibration isolation system.

Suggested Reading:
1. F.Keeningsberager and J. Tlusty, *Machine Tool Structure*, Porgamon press, 1970.
2. G.Sweeney, *Vibration of Machine Tools*, Machinery Publishing Co. 1971.
3. Walter C. Hurty and M.F. Bubinstein, *Dynamics of Structures,* Prentice Hall, 1967.
4. W.T.Thomson, *Vibration Theory And Applications*, Prentice Hall, 1965.
5. S.A. Tobias, *Machine Tool Vibrations*, Blackie publications, 1965.

ME2109

THEORY OF ELASTICITY AND PLASTICITY

Instructions 3 periods/week Duration of university Examination: 3 hours
Credits 3 SEE: 70 Marks CIE: 30 Marks

UNIT-I

Basic Concepts of Stress: Definition, State of Stress at a point, Stress tensor, invariants of stress tensor, principle stresses, stress ellipsoid, derivation for maximum shear stress and planes of maximum shear stress, octahedral shear stress, Deviatoric and Hydrostatic components of stress, Invariance of Deviatoric stress tensor, plane stress.

UNIT-II

Basic concepts of Strain: Deformation tensor, Strain tensor and rotation tensor; invariants of strain tensor, principle strains, derivation for maximum shear strain and planes of maximum shear strain, octahedral shear strain, Deviatoric and Hydrostatic components of strain tensor, Invariance of Deviatoric strain tensor, plane strain.

UNIT-III

Generalized Hooke's Law: Stress-strain relationships for an isotropic body for three dimensional stress space, for plane stress and plane strain conditions, differential equations of equilibrium, compatibility equations, Material (D) matrix for Orthotropic Materials.

UNIT-IV

True stress and true strain, Von-Mises and Tresca yield criteria, Haigh–Westergard stress space representation of Von-Misesand Tresca yield criteria, effective stress and effective strain, St. Venants theory of plastic flow, Prandtle–Reuss and Levy–Mises constitutive equations of plastic flow, Strain hardening and work hardening theories, work of plastic deformation.

UNIT-V

Analysis methods: Slab method, Slip line field method, uniform deformation energy method, upper and lower bound solutions. Application of Slab method to forging, wire drawing, extrusion and rolling processes.

Suggested Readings:

1. Timoshenko and Goodieer, *Theory of Elasticity*, Mcgraw Hill Publications 3rd Edition,
2. Madleson, *Theory of Plasticity,*
3. J. Chakrabarty, *Theory of Plasticity, 2nd* edition, McGraw Hill Publications 1998 4. George E Dieter, *Mechanical Metallurgy,* McGraw Hill Publications 1988

ME2110

EXPERIMENTAL TECHNIQUES AND DATA ANALYSIS

Instructions 3 periods/week Duration of university Examination: 3 hours
Credits 3 SEE: 70 Marks CIE: 30 Marks

Objectives:

- To understand the working principle of instruments used for cutting forces measurement and temperature measurement.
- To have knowledge of various precision measuring instruments for metallurgical studies.
- To understand the basic concept of experiment design for collection of data
- To learn the data analysis, optimization of experimental methods for better data.

Unit - I

Measurement of Cutting Forces: Strain gauge and piezoelectric transducers and their characteristics.Dynamometer construction, Bridge circuits. Instrumentation and calibration. Displacement and strain measurements by photo-elasticity. Holography, interferometer, Moiré techniques,strain gauge rosettes.

Unit - II

Temperature Measurement: Circuits and instrumentation for different transducers viz, bimetallic, expanding fluid, electrical resistance, thermistor, thermocouples, pyrometers. Flow Measurement: Transducers for flow measurements of Non-compressible and compressible fluids.Obstruction and drag methods. Vortex shredding flow meters. Ultrasonic, Laser Doppler and Hotwire anemometer. Flow visualization techniques, Shadow graphs, Schlieren photography. Interferometer.

Unit - III

Metallurgical Studies: Optical and electron microscopy, X-Ray diffraction, Bragg's Law and its application for studying crystal structure and residual stresses. Electron spectroscopy, electron microprobe. Surface Measurements: Micro hardness, roughness, accuracy of dimensions and forms. 3 -D co-ordinate measuring machines.

Unit - IV

Experiment design & data analysis: Statistical methods, Randomized block design, Latin and orthogonal squares, factorial design,Replication and randomization, response surface methodology.Data Analysis: Deterministic and random data, uncertainty analysis, tests for significance: Chi -square,student's t-test. Regression modeling, direct and interaction effects. ANOVA, F-test. Time Series analysis, Autocorrelation and autoregressive modeling.

Unit - V

Taguchi Methods: Experiment design and planning with orthogonal arrays and linear graphs. Additive cause effect model. Optimization of response level. Identification of Design and noise factors.Performance evaluation and Optimization by signal to noise ratios. Concept of loss function and its application.

Suggested Reading:

1. Holman, J.P.: Experimental Methods for Engineers, McGraw Hill Int., New York.
2. Venkatesh, V.C., and Chandrasekharan, Experimental Methods in Metal Cutting, Prentice Hall of India, Delhi.
3. Davis, O.V.; The Design and Analysis of Industrial Experiments, Longman, London.
4. Box and Jenkins; Time Series analysis, Forecasting and control, Holden Day, Sanfrancisco.
5. Dove and Adams, Experimental stress analysis and motion measurement, Prentice Hall of India, Delhi.
6. Tapan P. Bagchi, Taguchi Methods Explained, Prentice Hall of India, Delhi.

ME2501

ADVANCED METROLOGY

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT-I

End & line standards for length, Airy & Bessel points, desirable features of end standards, slip gauge manufacture, calibration of end standards by interferometry. NPL gauge interferometer, calibration of line standards by micrometer microscope – superposition, coincidence and symmetric straddling, photoelectric microscope and Moiré fringe techniques, measurement of large displacements using lasers, calibration of Tomlinson gauges by interferometry. Photoelectric Autocollimator, calibration of polygons & circular scales. Types of interchangeability, dimensional chains.

UNIT-II

Fixed & Indicating Gauges: Taylor's principles of gauge design, limitations of ring & plug gauges, position and receiver gauges, types of indicating gauges. **Comparators:** Multirange Sigma comparator, Back pressure and free flow type pneumatic comparators, Differential back pressure gauge, usage of different types of jets, contact &non contact tooling. Amplification selection. Air to electric transducer, Differential transducer, Variation transducer, Pre process, In-process & Post process gauging, computation & match gauging. Usage of LVDT & Capacitive type gauge heads, Automatic inspection.

UNIT-III

Measuring Machines: Floating carriage diameter measuring m/c. Universal measuring m/c. Matrix internal diameter measuring machine. Optical dividing head. Coordinate measuring machine, Optical projector-light beam systems, Work tables, measurement techniques, fixturing& accessories. Sources of error in measurement. Design principles of measuring machines Abbe's rule, Kelvin coupling, flexible steel strip, advantages & limitations of hydrostatic & aerostatic bearings.

UNIT-IV

Form Errors: Evaluation of straightness & flatness, usage of beam comparator, evaluation of roundness – intrinsic & extrinsic datum's. Talyrond. PGC, RGC, MZC & LSC, methods, roundness evaluation for even & odd number of lobes. Surface Finish: stylus instrument (TALYSURF). M & E Systems, numerical assessment, vertical & horizontal descriptors, profile as a random process, usage of interferograms. Plastic replica technique.

UNIT-V

Screw Threads: Measurement of thread elements for internal & external threads, progressive periodic, drunkenness and irregular pitch errors. NPL pitch measuring machine, virtual effective diameter, thread gauging. Gears: measurement of tooth thickness, involute profile, pitch, concentricity and alignment, rolling gear test.

Suggested Reading:

1. R.K.Jain, *Engineering Metrology,* Khanna Publishers
2. ASTME, *Hand Book of Industrial Metrology,* Prentice Hall of India Pvt Ltd. 3. I.C. Gupta, *A Text Book of Engineering Metrology,* DhanpatRai& Sons.

ME2001

ENGINEERING RESEARCH METHODOLOGY

Instructions 3 periods/week Duration of university Examination: 3 hours
Credits 3 SEE: 70 Marks CIE: 30 Marks

Objectives:

- To learn the research types, methodology and formulation.
- To know the sources of literature, survey, review and quality journals.
- To understand the research design for collection of research data.
- To understand the research data analysis, writing of research report and grant proposal.

Unit - I

Research Methodology: Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research and Scientific Method, Important of Research Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general.

Defining the Research Problem: Definition of Research Problem, Problem Formulation, Necessity of Defining the Problem, Technique involved in Defining a Problem.

Unit - II

Literature Survey: Importance of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. **Literature Review**: Need of Review, Guidelines for Review, Record of Research Review.

Unit - III

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes.

Unit - IV

Data Collection: Collection of primary data, Secondary data, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Sample Design, Need for sampling, some important sampling definitions, Estimation of population, Role of Statistics for Data Analysis, Parametric V/s Non Parametric methods, Descriptive Statistics, Measures of central tendency and Dispersion, Hypothesis testing, Use of Statistical software.

Data Analysis: Deterministic and random data, Uncertainty analysis, Tests for significance: Chi-square, student's t-test, Regression modeling, Direct and Interaction effects, ANOVA, F-test, Time Series analysis, Autocorrelation and Autoregressive modeling.

Unit - V

Research Report Writing: Format of the Research report, Synopsis, Dissertation, Thesis its Differentiation, References/Bibliography/Webliography, Technical paper writing/Journal report writing, making presentation, Use of visual aids. **Research Proposal Preparation**: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

Suggested Reading:

1. C.R Kothari, Research Methodology, Methods & Technique; New Age International Publishers, 2004
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011
3. RatanKhananabis and SuvasisSaha, Research Methodology, Universities Press, Hyderabad, 2015.
4. Y.P. Agarwal, Statistical Methods: Concepts, Application and Computation, Sterling Publs., Pvt., Ltd., New Delhi, 2004
5. Vijay Upagade and AravindShende, Research Methodology, S. Chand & Company Ltd., New Delhi, 2009
6. G. Nageswara Rao, Research Methodology and Quantitative methods, BS Publications,Hyderabad, 2012.

ME2111

PRODUCT DESIGN AND PROCESS PLANNING

Instructions 3 periods/week Duration of university Examination: 3 hours
Credits 3 SEE: 70 Marks CIE: 30 Marks

Objectives:

- To learn the essential factors with innovative ideas to develop successive right product.
- To know the product reliability, copyrights, value Engineering in product design and cost estimation of product.
- To understand the various machining processes, improving tolerances methods, selection of materials and their importance.
- To understand the modern approaches, ergonomics considerations in product design, integration of design, manufacturing and production control.

Unit - I

Product design and process design functions, selection of a right product, essential factors of product design, Morphology of design, sources of new ideas for products, evaluation of new product ideas. Product innovation procedure-Flow chart. Qualifications of product design Engineer. Criteria for success/failure of a product. Value of appearance, colours and Laws of appearance.

Unit - II

Product reliability, Mortality Curve, Reliability systems, Manufacturing reliability and quality control.Patents: Definitions, classes of patents, applying for patents. Trademarks and copyrights. Cost and quality sensitivity of products, Elements of cost of a product, costing methods, cost reduction and cost control activities. Economic analysis, Break even analysis Charts. Value engineering in product design, creativity aspects and techniques. Procedures of value analysis – cost reduction, material and process selection.

Unit - III

Various manufacturing processes, degree of accuracy and finish obtainable, process capability studies. Methods of improving tolerances. Basic product design rules for Casting, Forging, Machining, Sheet metal and Welding. Physical properties of engineering materials and their importance on products. Selection of plastics, rubber and ceramics for product design.

Unit - IV

Industrial ergonomics: Man- machine considerations, ease of maintenance. Ergonomic considerations inproduct design-Anthropometry, Design of controls, man-machine information exchange. Process sheet detail and their importance, advanced techniques for higher productivity. Just -in -time and Kanban System. Modern approaches to product design; quality function development, Rapid prototyping.

Unit - V

Role of computer in product design and management of manufacturing, creation of manufacturing data base, Computer Integrated Manufacturing, communication network, production flow analysis, Group Technology, Computer Aided product design and process

Planning. Integrating product design, manufacture and production control.

Suggested Reading:

1. Niebel, B.W., and Draper, A.B., Product design and process Engineering, McGraw Hill Kogalkusha Ltd., Tokyo, 1974.
2. Chitale, A.K, and Gupta, R.C., Product Design and Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Mahajan, M. Industrial Engineering and Production Management, DhanpathRai& Co., 2000.

ME2112

ADDITIVE MANUFACTURING TECHNOLOGIES AND APPLICATIONS

Instructions 3 periods/week Duration of university Examination: 3 hours
Credits 3 SEE: 70 Marks CIE: 30 Marks

Objectives:

- To understand the fundamentals for additive manufacturing and how it is different
- and discuss about various types of liquid based, solid based and powder based AM technologies.
- To understand the various types of Pre-processing, processing, post-processing errors in AM. Also to know the various types of data formats and software's used in AM.
- To know the various applications of AM in design analysis, aerospace, automotive, biomedical and other fields

UNIT – I

Introduction:Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies.

UNIT – II

Liquid-based AM Systems: 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. Polyjet: Process, Principle, working principle, Applications, Advantages and Disadvantages, Case studies. Micro-fabrication.

Solid-based AM 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. Multi-Jet Modelling (MJM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT – III

Powder Based AM Systems: 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. Laser Engineered Net Shaping (LENS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Electron Beam Melting (EBM): 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: Arc Spray Metal Deposition, Investment Casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

UNIT – IV

AM Data Formats: Reengineering for Digital Representation, STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Mesh Refining by Sub division Techniques.

AM Software's: Need for AM software, Features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, SurgiGuide, 3-matic, Simplant, MeshLab.

UNIT –V

AM Applications: 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, Customised Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visulization of Biomolecules. Web Based Rapid Prototyping Systems

Suggested Reading:

1. Rapid prototyping: Principles and Applications - Chua C.K., Leong K.F. and LIM C.S, World Scientific publications, Third Edition, 2010.
2.Rapid Manufacturing – D.T. Pham and S.S. Dimov, Springer, 2001

3. Wholers Report 2000 – Terry Wohlers, Wohlers Associates, 2000

4. Rapid Prototyping & Engineering Applications – Frank W.Liou, CRC Press, Taylor & Francis Group, 2011.

ME2113

FLEXIBLE MANUFACTURING SYSTEMS

Instructions 3 periods/week Duration of university Examination: 3 hours
Credits 3 SEE: 70 Marks CIE: 30 Marks

Objectives:

- To learn the evolution of flexible manufacturing systems, layouts human resources involvement.
- To know the manufacturing driving force, design scheduling of jobs, classification and coding technique.
- To familiarize with design models for processing and quality assurance, automated manufacturing and measuring systems.
- To understand the working of automated movement, storage systems, tool management, fault detection and relationship with workstations. .

Unit - I

Evolution of Manufacturing Systems: FMS definition and description, General FMS considerations, Manufacturing cells, Cellular versus Flexible Manufacturing.Systems Planning: Objective, introduction planning, preparation guidelines, the project team, supplier selection, system description and sizing, facility preparation planning, FMS layouts. Human resources: staff considerations, team work, communication and involvement, the supervisor's role, personnel selection, job classifications, employee training.

Unit - II

Manufacturing Driving Force: Definition, description and characteristics. Just in-time manufacturing, definition and description, benefits and relationship to FMS, implementation cornerstones, quality and quantity application principles. Single manufacture Cell–design scheduling of jobs on single manufacturing cells. Group Technology: Concepts, classification and coding, benefits and relationship to FMS, design of group technology using rank order clustering technique.

Unit - III

FMS Design – Using Bottleneck, Extended bottleneck models, Processing and Quality Assurance: Turning centres, Machining centre, construction and operations performed, axes, programming, and format information, work-holding and work-changing equipment, automated features and capabilities, cleaning and deburring – station types and operation description, importance to automated manufacturing, coordinate measuring machines, types, construction and general function, operation cycle description, importance to flexible cells and systems.

Unit - IV

Automated movement and storage systems –AGVs, Robots, automated storage and retrieval systems,storage space design, queuing carousels and automatic work changers, coolant and chip Disposal and recovery systems, auxiliary support equipment, cutting tools and tool Management – introduction, getting control of cutting tools, Tool Management, tool strategies, data transfer, tool monitoring and fault detection, guidelines, work holding considerations, General fixturing, Modular fixturing. FMS and the relationship with workstations – Manual, automated and transfer lines design aspects.

Unit - V

FMS: computer Hardware, Software, Communications networks and Nanotechnology – general functions, and manufacturing usages, hardware configuration, programmable logic controllers, cell controllers, communications networks. FMS implementation.

Suggested Reading:

1. Parrish, D.J., “Flexible Manufacturing”- ButterWorths – Heinemann, Oxford, 1993.
2. Groover, M.P., “Automation, Production Systems and CIM”, - Prentice Hall India, 1989.
3. Kusiak, A., “Intelligent Manufacturing Systems”, - Prentice Hall, 1990.
4. Considine,D.M., &Considine,G.D., “Standard Handbook of Industrial Automation”,-Chapman & Hall, 1986
5. Ranky, P.G., “Design and Operation of FMS”, - IFS Publishers, UK, 1988

ME2114

NON-DESTRUCTIVE EVALUATION TECHNIQUES

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT-I
Types of defects and characteristics, Quantification aspects relevant for NDE including fracture aspects and stress intensity factors - NDT overview – quality assurance–visual inspection–comparative features of conventional Nondestructive Testing and Evaluation Methods including Optical, Radiography, Ultrasonic Testing, Dye penetrant testing, Eddy current testing etc.

UNIT-II
Leak testing – liquid penetrant testing – penetrant used – equipment – penetration, emulsification, solvent removal. Eddy current testing – material conductivity – coil impedance–coils and instruments–testing in non-ferromagnetic conducting materials and ferro magnetic materials – skin effect – frequency used – inspection probes – phase analysis.

UNIT-III
Radiography–sources of radiation–shadow formation, enlargement and distortion – recording media – exposures, markers. Infrared and thermal testing – imaging systems – detectors – analysis methods. Ultrasonic testing – generation of ultrasound – methodologies – transducers and equipment used – flaw detection - sensitivity and calibration. Magnetic particle testing–magnetization methods–continuous and residual methods – sensitivity – demagnetization.

UNIT-IV
Computer aided image processing methods for radiography and ultrasonics, tomography in these areas. Optical techniques of nondestructive evaluation: Principles of Photo elasticity, holographic Interferometry and Laser speckle techniques; use of fibre optics, noninvasive techniques in medical field and NDT.

UNIT-V
Machine Vision-system components, Sensors, specifications for resolution & range. Grid and Moiré NDT, acoustic, ultrasonic and shearography, Principles of Microwave, acoustic emission techniques and Infrared thermography.

Suggested Reading:
1. Barry Hull, “Non-Destructive Testing”–Vernon John, ELBS/ Macmillan, 1988.

2. Baldev Raj, T.JayaKumar, M.Thavansimuthee, “Practical Non-Destructive Testing” - Narosa Publishing House, New Delhi, 1997.

ME2131

PRODUCTION ENGINEERING LAB

Instruction 3 Periods/week ***CIE: 50 Marks***
Credits: 2

List of Experiments:

1. Study of the morphology of chips produced from different materials sand machining processes.
2. Study of cutting ratio/chip thickness ratio in simulated orthogonal cutting with different materialsand tool geometry.
3. Study of cutting ratio/chip thickness ratio in simulated orthogonal cutting with different materials and tool geometry.
4. Roughness of machined surface. Influence of tool geometry and feed rate.
5. Study of the construction and operating parameters of metal spinning Lathe.
6. Study of the water hammer equipment and hydrostatic extrusion setup.
7. Extrusion of cylindrical billets through dies of different included angles and exit diameters and their effect on extrusion pressure.
8. Practice and study of blanking and punching process and their characteristic features on mechanical press with existing dies.
9. Experiments on EDM to measure MRR and Surface roughness of different metals.
10. Programming and experiments on CNC milling for different profiles.
11. Programming and experiments on CNC lathe for cylindrical jobs.
12. Experiments on TIG and MIG welding to find out the mechanical properties of metals.
13. Testing of mechanical properties of metals by using UTM.
14. Fatigue Testing of metals on Rotary Fatigue Testing Machine.

ME2032

COMPUTATIONAL LABORATORY

Instruction 3 Periods/week ***CIE: 50 Marks***
Credits: 2

List of Experiments:

1. Introduction to Finite Element Analysis Software.
2. Static Analysis of a corner bracket.
3. Statically indeterminate reaction force analysis.
4. Determination of Beam stresses and Deflection.
5. Bending analysis of a Tee-shaped beam.
6. Analysis of cylindrical shell under pressure.
7. Bending of a circular plate using axisymmetric shell element.
8. Stress analysis in a long cylinder.
9. Solidification of a casting.
10. Transient Heat transfer in an infinite slab.
11. Transient Thermal stress in a cylinder.
12. Vibration analysis of a simply supported beam.
13. Natural frequency of a motor-generator.
14. Thermal-Structural contact of two bodies.
15. Drop test of a container (Explicit Dynamics).