MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE
(UGC – AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

M.TECH. – ADVANCED MANUFACTURING SYSTEMS (AMS)

COURSE STRUCTURE – (2016-17)

I YEAR - I Semester

S. No	Course code	Subject	Credits
1.	16AMS101	Automation in Manufacturing	4
2.	16AMS102	Advanced Manufacturing Processes	4
3.	16AMS103	Material Technology	4
4.	16AMS104	Product Design & Development	4
5.	16AMS105	Theory of Metal Cutting & Tool Design	4
6.	**Elective-I**		4
	16AMS401	FEA in Manufacturing	
	16AMS402	Advanced Computer Aided Design	
	16AMS403	Advanced Metal Forming	
	16AMS404	Simulation & Modeling of Manufacturing Systems	
7	16AMS201	Advanced Computer Aided Design & Manufacturing Lab	2
		Total	**26**

I YEAR - II Semester

S. No	Course code	Subject	Credits
1.	16AMS106	Industrial Robotics	4
2.	16AMS107	Intelligent Manufacturing Systems	4
3.	16AMS108	Total quality management	4
4.	16AMS109	Design For Manufacturing and Assembly	4
5	16AMS110	Advanced Production & Operation Management	4
6.	**Elective-II**		4
	16AMS405	Precision Engineering	
	16AMS406	Rapid Prototyping and Tooling	
	16AMS407	Design and Manufacturing of MEMS and MICRO systems	
	16AMS408	Optimization Techniques and its applications	
7.	16AMS202	Manufacturing Simulation Lab	2
		Total	**26**

II YEAR (III & IV Semesters)

S. No	Course code	Subject	Credits
1	16AMS501	Seminar	02
2	16AMS602	Project work	16

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	Th	C
M.Tech. I SEMESTER (AMS)	**4**	**4**

AUTOMATION IN MANUFACTURING
(16AMS101)

Course Objective:

At the end of this course

- The course should enable to understand the principles of automation, importance of automated flow lines and its types.
- The Student should be able to understand outline the system configurations used in automated production
- Students should be able to recognize and articulate the foundational assumption of the transfer mechanism, types of transfer mechanism that may be used for work part transfer
- Student able to describe automated assembly systems, and their associated system configurations , list the hardware components used for parts delivery at workstations Outline typical automated assembly processes

Course Outcome:

- After completion of this unit students are able to understand to know what is automation, types of
- automation, components of automation, strategies and levels of automation
- After completion of this course students are able to understand to know what is automation, types of automation, components of automation, strategies and levels of automation
- After completion of this course students are able to understand the types of flow lines, quantitative analysis of flow lines, how the assembly is carried out on automated flow line without interruption and how to balance the line and flexible assembly lines
- Students are able to understand automated transfer and storage system, recognize the equipments used in automated transfer and storage system

UNIT-I

Introduction to Automation: Automation in Production Systems-Automated Manufacturing Systems, Computerized Manufacturing Support Systems, Reasons for Automation, Automation Principles and Strategies. Basic Elements of an Automated Systems, Advanced Automation Functions, Levels of automation. Manufacturing operations, Production Concepts and Mathematical Models. Costs of Manufacturing Operations.

UNIT-II

Introduction to Material Handling, Overview of Material Handling Equipment, Considerations in Material Handling System Design, The 10 Principles of Material Handling. Material Transport Systems, Automated Guided Vehicle Systems, Monorails and other Rail Guided Vehicles, Conveyor Systems, Analysis of Material Transport Systems.

UNIT-III

Storage Systems, Storage System Performance, Storage Location Strategies, Conventional Storage Methods and Equipment, Automated Storage Systems, Engineering Analysis of Storage Systems. Automatic data capture-overview of Automatic identification methods, bar code technology, other ADC technologies.

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Transfer lines, Fundamentals of Automated Production Lines, Storage Buffers, and Applications of Automated Production Lines. Analysis of Transfer Lines with no Internal Storage, Analysis of Transfer lines with Storage Buffers.

Manual Assembly Lines - Fundamentals of Manual Assembly Lines, Alternative Assembly Systems, Design for Assembly, Analysis of Single Model Assembly Lines

UNIT -V

Line balancing problem, largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights Method, Mixed Model Assembly Lines, Considerations in assembly line design. Automated Assembly Systems, Fundamentals of Automated Assembly Systems, Design for Automated Assembly, and Quantitative Analysis of Assembly Systems - Parts Delivery System at Work Stations, Multi- Station Assembly Machines, Single Station Assembly Machines, Partial Automation.

TEXT BOOKS:

1. Automation, Production systems and computer integrated manufacturing, Mikel P. Groover, Pearson Eduction.

REFERENCE BOOKS:

1. CAD CAM: Principles, Practice and Manufacturing Management, Chris Mc Mohan, Jimmie Browne, Pearson edu. (LPE)
2. Automation, Buckinghsm W, Haper & Row Publishers, New York, 1961
3. Automation for Productivity, Luke H.D, John Wiley & Sons, New York, 1972

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M.Tech. I SEMESTER (AMS)	**4**	**4**

ADVANCED MANUFACTURING PROCESSES
(16AMS102)

Course Objective:

- To teach the students to understand the fundamentals of manufacturing and prototyping for product design and development.
- To teach the students to gain practical experience in manufacturing and prototyping for product design and development.
- To teach the students to develop ability to apply up-to-date technology in manufacturing products with considerations of safety and environmental factors.

Course Outcome:

- Describe the principle and operation of common manufacturing and rapid prototyping processes for product development.
- Decide on the use of appropriate manufacturing processes in the manufacture of a product at the design stage.
- Develop a prototype with modern prototyping techniques.
- Apply up-to-date technology in manufacturing products with considerations of safety and environmental factors.
- Apply the reverse engineering process for product development.
- Appreciate and report on the common practice in the product development industry.

UNIT - I:
Surface treatment: Scope, Cleaners, Methods of cleaning, Surface coating types, and ceramic and organic methods of coating, economics of coating. Electro forming, Chemical vapour deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.

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

UNIT - II:
Laser Beam Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.
Plasma Arc Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.

UNIT - III:
Electron Beam Machining - Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.
Electro Chemical Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.

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

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

UNIT - V

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

TEXT BOOKS:

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

REFERENCE BOOKS:

1. Advanced Machining Processes, V.K.Jain, Allied Publications.
2. Introduction to Manufacturing Processes, John A Schey, McGraw Hill.

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M.Tech. I SEMESTER (AMS)	**4**	**4**

MATERIALS TECHNOLOGY
(16AMS103)

Course Objective:

- To gain and understanding of the relationship between the structure, properties, processing, testing and applications of strengthening mechanism, modern metallic, smart, non-metallic, advanced structural ceramic and composite materials so as to identify and select suitable materials for various engineering applications.

Course Outcome:

- Students will get knowledge on mechanism of plastic deformation and strengthening mechanism. Students will be able to learn the structure, properties and applications of modern metallic materials, smart materials non-metallic materials and advanced structural ceramics. Students will be able to understand the importance of advanced composite materials in application to sophisticated machine and structure of components.

Unit – I
Classification of materials and their properties, Bonds in Solids, Crystallographic planes and directions, Elasticity in metals and polymers, mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening.

Unit – II
Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behavior, super plasticity, deformation of non-crystalline material.

Unit – III
Modern metallic Materials: Iron-Iron Carbide Diagram, TTT Diagram, Dual phase steels, high strength low alloy (HSLA) Steel, transformation induced plasticity (TRIP) Steel, maraging steel, intermetalics, Ni and Ti aluminides.
Smart materials Classification, shape memory alloys, metallic glass, quasi crystal and nano crystalline materials.

Unit – IV
Non-metallic materials: Polymeric materials Classification, properties and applications, production techniques for fibers, foams, adhesives and coatings, structure, properties and applications of engineering polymers.
Advanced structural ceramics: Ceramic materials Classification, properties and applications, WC, TiC, TaC, Al2O3, SiC, Si3 N4, CBN and diamond-properties, processing and applications.

Unit – V
Advanced structural composites: Introduction, types of composite materials, properties, processing and application. Motivation of selection, cost basis and service requirements, selection for mechanical properties, strength, toughness, fatigue and creep.

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1. Mechanical behavior of materials/Thomas H.Courtney/2nd Edition, McGraw-Hill, 2000
2. Mechanical Metallurgy/George E.Dieter/McGraw Hill, 1998
3. Introduction to Physical Metallurgy, Sidney H. Avner, US, 2nd Edition, 2007 Tata McGrawHill, Noida, 1985.

REFERENCE BOOKS:

1. Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann.
2. Materials Science and Engineering, William D. Callister, 8th Edition, 2010.
3. Material Science and Metallurgy, kodgire V.D, 12th Edition, Everest Publishing House 2002.

TEXT BOOKS: MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE
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M.Tech. I SEMESTER (AMS)	**4**	**4**

(16AMS104) PRODUCT DESIGN AND DEVELOPMENT

Course Objective:

- Competence with a set of tools and methods for product design and development.
- Confidence in your own abilities to create a new product.
- Awareness of the role of multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production).
- Ability to coordinate multiple, interdisciplinary tasks in order to achieve a common objective.

Course Outcome:

- Understand a product design brief
- Know how to communicate product design ideas and concepts.
- Be able to develop product design proposals
- Be able to realize outcomes to a design brief.

UNIT- I:
Introduction: Need for IPPD – strategic importance of product development – integration of customer, designer, material supplier and process planner, Competitor and costumer – behavior analysis. Understanding customer – promoting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specification.

UNIT II:
Concept generation and concept selection: Activity of concept generation – Structured approaches – Five step Method: clarify – Search-Externally and internally – explore systematically – reflect on the solutions and processes – Concept selection – Integral part of PDD process-methodology – benefits. ROBUST DESIGN-introduction, various steps in robust design.

UNIT III:
Industrial design: Assessing the need for industrial design, impact – design process Integrate design process – assessing the quality of industrial design. Investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

UNIT-IV:
Product architecture: Implications – Product change – variety – component standardization – product performance – manufacturability.
Design for manufacturing: Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs –cost of supporting production. Minimizing System complexity.

UNIT-V:
Prototyping: Prototype basics – Principles of prototyping – planning for prototypes – Economic analysis. Understanding and representing tasks – baseline project planning – accelerating the project execution. Competitive Aspects of Product Design, Product Quality, Reliability, Concurrent engineering aspects, Substitution of materials, SQC and SPC

TEXT BOOKS: MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE
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4 4

1. Product Design and Development, Kari T. Ulrich and Steven D. Eppinger, McGraw Hill International Edns. 1999.
2. Effective Product Design and Development, Stephen Rosenthal, Business One Orwin, Homewood, 1992, ISBN, 1-55623-603-4.

REFERENCE BOOKS:

1. Concurrent Engg, integrated Product development , Kemnneth Crow , DRM Associates,26/3, Via Olivera, Palos Verdes, CA 90274(310)377-569, Workshop Book
2. Tool Design – Integrated Methodds for Successful Product Engineering, Staurt Pugh, Addison Wesley Publishing, Neyourk, NY, 1991, ISBN 0-202-41639-5.

TEXT BOOKS: MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE
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M.Tech. I SEMESTER (AMS)	**4**	**4**

THEORY OF METAL CUTTING AND TOOL DESIGN
(16AMS105)

Course Objective:

- To provide knowledge on Mechanics of Metal Cutting.
- To provide knowledge on cutting tool geometries and their effects.
- To provide knowledge on temperatures developed while cutting and tool life.
- To gain and understanding principles of grinding.
- To provide knowledge on tool and work holding designs.
- To gain and understanding of tool material and fluids used while cutting.

Course Outcome:

- Students will be able to explain effects of tool geometry.
- Students will be able to learn tool life and cutting temperatures.
- Students will learn principles of grinding.
- Students will learn designing of tool and work piece holders.
- Students will be able understand importance of cutting fluids and tool material.

UNIT -I:
Mechanics of Metal Cutting: Geometry of Metal Cutting Process, Chip formation, Chip Thickness ratio, radius of chip curvature, cutting speed, feed and depth of cut - Types of Chips, Chip breakers. Orthogonal and Oblique cutting processes-definition, Forces and energy calculations (Merchant's Analysis).- Power consumed – MRR – Effect of Cutting variables on Forces, Force measurement using Dynamometers.

UNIT -II:
Grinding: Specifications of grinding of grinding wheel, mechanics of grinding, Effect of Grinding conditions on wheel wear and grinding ratio. Depth of cut, speed, machining time, temperature, power.

UNIT -III:
Single Point Cutting Tool: Various systems of specifications, single point cutting tool geometry and their inter-relation. Theories of formation of built-up edge and their effect, design of single point contact tools throwaway inserts.
Multipoint Cutting Tools: Drill geometry, design of drills, Rake and Relief angles of twist drill, speed, feed and depth of cut, machining time, forces, milling cutters, cutting speed and feed – machining time – design - from cutters.

UNIT-IV
Tool Life and Tool Wear: Theories of tool wear-adhesion, abrasive and diffusion wear mechanisms, forms of wear, Tool life criteria and mach inability index. Types of sliding contact, real area of contact, laws of friction and nature of frictional force in metal cutting. Effect of Tool angle, Economics, cost analysis, mean co-efficient of friction.
Cutting Temperature: Sources of heat in metal cutting influence of metal conditions. Temperature distribution, zones, experimental techniques, analytical approach. Use of tool-work thermocouple for determination of temperature. Temperature distribution in Metal Cutting.

UNIT-V

Tool Design: Determination of shank size for single point carbide tools, determining the insert thickness for carbide tools. Design of jigs and fixtures: Basic principles of location and clamping; Locating methods and devices. Jigs- Definition, Types. General consideration in the design of Drill jigs, Drill bushing, Methods of construction. Fixtures- Vice fixtures, Milling, Boring, Lathe Grinding fixtures**.**
Cutting tool Materials and Cutting fluids : Carbon and Medium alloy steels, High Speed steels, Cast-Cobalt alloys, Carbides, Coated tools, Alumina based ceramics, Carbon boron

Nitride, SNB Ceramics, Whisker-Reinforced tool materials, tool reconditioning, Types of cutting fluids , Classification and selection of cutting fluids.

TEXT BOOKS:

1. Metal Cutting Principles , M C Shaw ,Oxford and IBH Publications, New Delhi,1969
2. Fundamentals of Machining ,Boothryd, Edward Amold publishers Ltd. 1975
3. Metal Cutting, Edward M. Trent and Paul K. Wright. Butterworth Heinemann Publications.

REFERENCE BOOKS:

1. Fundamentals of Metal cutting and Machine tools ,B.L.Juneja, G. S. Sekhom and Nitin Seth , New Age International publishers
2. Tool Engineering,G.R.Nagpal, Khanna Publishers.

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M.Tech. I SEMESTER (AMS)	**4**	**4**

FEA IN MANUFACTURING
(16AMS401)
(Elective-I)

Course Objective:

- To equip the students with the Finite Element Analysis fundamentals.
- To enable the students to formulate the design problems into FEA.
- To introduce basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.

Course Outcome:

Upon completing this course, the students will be able to:

- Identify mathematical model for solution of common engineering problems.
- Formulate simple problems into finite elements.
- Solve structural, thermal, fluid flow problems.
- Use professional-level finite element software to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer.
- Derive element matrix equation by different methods by applying basic laws in mechanics and integration by parts.
- Apply the fea methods in manufacturing process like welding, casting, and deep drawing.

UNIT- I:
Introduction to FEM: basic concepts, application of FEM, general description, advantages of FEM, comparison of FEM with other methods: finite difference method, vibrational method, Galerkin Method, basic element shapes, interpolation function. Basic equations of elasticity, strain displacement relations.1-**Dstructural problems**: axial bar element–stiffness matrix, load vector, temperature effects, quadratic shape function, and analysis of trusses – plane truss and space truss elements.

UNIT- II:
Analysis of beams– introduction to beams shape functions, stiffness matrix, load vector
Problems
2-Dproblems–CST, force terms, stiffness matrix and load vector, boundary conditions.

UNIT-III
Iso-parametric element, quadric element, shape functions, Numerical Integration Jacobian matrix, stiffness matrix.
Axis Symmetric formulations, Finite Element Modeling- Triangular element, Problem modeling and Boundary conditions

UNIT- IV:
Applications of FEM in Analysis of Manufacturing process: Applications of FEM in various metal forming process-Extrusion, deep drawing, closed die forming etc... Applications of FEM in solidification of castings-Applications of FEM in welding

UNIT- V:

Computer Implementations: Pre-processing, mesh generation, elements connecting, Boundary conditions, input of material and process characteristics – solution and post processing-overview and application packages.

TEXTBOOKS:

1. Finite Element Methods, Alavala, PHI.
2. Introduction to finite elements in engineering, TirupathiK. ChandrupatlaandAshokD. Belagundu.

REFERENCEBOOKS:

1. An Introduction to Finite Element Methods, S.S.Rao,Pegamon,New York.
2. The Finite element method in Engineering Science, O.C.Aienkowitz,Mc.GrawHill.
3. Concepts and applications of finiteelementanalysis,RobertCook.
4. Finite Element Methods in Engineering analysis, K.J.Bathe.
5. Metalformingandthefiniteelementsmethods-Kobayashi.S,Soo-ik-ohandAltam.T-Oxforduniversitypress, 1989

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M.Tech. I SEMESTER (AMS)	**4**	**4**

ADVANCED COMPUTER AIDED DESIGN
(16AMS402)
(Elective-I)

Course Objective:

- Model the 3D geometric information of machine components including assemblies, and automatically generate 2- D production drawings, understand the basic analytical fundamentals that are used to create and manipulate geometric models in a computer program.
- Improve visualization ability of machine components and assemblies before their actual fabrication through modeling, animation, shading, rendering, lighting and coloring.
- Model complex shapes including freeform curves and surfaces,
- Integrate the CAD system and the CAM system by using the CAD system for modeling design Information and converting the CAD model into a CAM model for modeling the manufacturing Information.
- Use full scale CAD/CAM software systems designed for geometric modeling of machine Components and automatic generation of manufacturing information.

Course Outcome:

- Understand the concepts of wireframe, surface and solid modeling.
- Understand part modeling and part data exchange standards (VDA, IGES, and STEP).
- Develop knowledge in 2D-Transformations, 3D Transformations.
- Understand the Assembly Modeling, Assembly tree, and Assembly Methods.
- The Students become experts on Visualization and computer animation Techniques.

UNIT – I: **Introduction to CAD**
Introduction to CAD: **Introduction to CAD, CAD input devices, CAD output devices, CAD Software,** Typical Product Cycle, Implementation of CAD process, Application of CAD, **Benefits of CAD,** Requirements of geometric modeling, Geometric construction methods, Modeling features: Drafting features, modeling features, editing features, annotations, dimensioning, tolerance and hatching features, display control features, analysis and optimization features, programming features, plotting features.

UNIT – II: Modeling
Modeling Tools: Coordinate system, limits, grid, snap, line type and line weight, basic geometric commands, layers, display control commands, editing commands. Feature based Modeling: Introduction, Feature Entities, Parametric, and Feature Manipulations.
Geometric Modeling: Types of curves and curve manipulations, Types of surfaces and surface manipulations, Solid modeling: Geometry and Topology, Boundary representation (B-rep), Constructive Solid Geometry (CSG) – Euler – Poincare formula - examples, Sweeping, Solid manipulations.

UNIT – III: Transformations and Mechanical tolerancing
Transformations: 2D and 3D Transformations. Product data Exchange: Evaluation of data – exchange format, IGES data representations and structure, STEP Architecture.
Geometric tolerancing: Datums, types of tolerances, tolerance modeling and representation, tolerance analysis: worst-case arithmetic method, worst-case statistical method, Monte Carlo simulation method.

UNIT-IV: Mass properties and Mechanical assembly

Mass Property Calculations: Mass, centroid, Moment of inertia, second moments and product of inertia, property mapping. Collaborative Design: Traditional design, Collaborative Design, Principles and Approaches. Assembly Modeling: Introduction, Assembly Modeling, Assembly Tree, Assembly Planning, Mating Conditions, Bottom – Up and Top – Down Assembly Approaches with examples

UNIT-V: Visualization and Computer animations

Visualization: Introduction, Model clean up, Hidden -Line Removal, Hidden Surface Removal, Hidden Solid Removal, Shading, Colors. Computer Animation: Introduction, Conventional animation, Computer animation, Entertainment animation, Engineering animation, Animation types, Animation techniques.

TEXT BOOKS:

1. Mastering CAD/CAM, Ibrahim Zeid, TMH, New Delhi
2. CAD/CAM Concepts and Applications, Alavala, PHI, New Delhi

REFERENCE BOOKS:

1. CAD/CAM, PN Rao, PHI
2. Computer Graphics, Alavala, PHI, New Delhi
3. Computer integrated Manufacturing, Harrington, Huntington, New York.
4. Computer integrated design and Manufacturing, Bedworth D.D, McGraw Hill, New York.
5. Computer Graphics and Animation, M.C.Trivedi, JAICO
6. Computer aided Design in Manufacturing, Valliere, Prentice Hall, New Jersey.

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M.Tech. I SEMESTER (AMS)	**4**	**4**

ADVANCED METAL FORMING
(16AMS403)
(Elective-I)

Course Objective:

- To provide knowledge on various methods of analysis done on forming.
- To provide knowledge on types of rolling process simplified analysis, rolling load, rolling variables, etc.,
- To provide knowledge on forging process and forces involved in it.
- To provide knowledge on press tool design and applications.
- To provide knowledge on Extrusion such as classification, analysis of extrusion, defects, etc.,
- To provide knowledge on tube and wire drawing, analysis of wiredrawing and principles of deep drawing.
- To provide knowledge on types of sheet metal forming and limits of sheet metal forming.
- To provide knowledge on advanced metal forming process like electromagnetic forming, blank drawing in cup forming, stress in het treatment, etc.,

Course Outcome:

- Students knowledge on various methods of analysis done on forming
- Students can explain types of rolling process and solve problems on rolling.
- Student can solve problems occurring in forging.
- Students can design the press tools and apply the designed tool in the forming process.
- Can solve the problems in extrusion and drawing of components with good properties.
- Can identify a type of sheet metal forming process according to its application.
- Obtained knowledge on advanced forming techniques like electromagnetic forming, blank drawing in cup forming, stress in het treatment, etc.,

UNIT I:
Fundamentals of Metal Forming: Classification of forming processes, mechanisms of metal forming: slab method, Upper and lower bound analysis, Deformation energy method and finite element method temperature of metal working, hot working, cold working, friction and lubricants.

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

UNIT III:
Forging: Classification of forging processes, forging of plate, forging of circular discs, open die and closed-die forging, forging defects, and powder metallurgy forging. Problems on flow stress, true strain and forging load.
Press tool design: Design of various press tools and dies like piercing dies, blanking dies, compound dies and progressive blanking dies, design of bending, forming and drawing dies.

UNIT IV:

Extrusion: Classification, Hot Extrusion, Analysis of Extrusion process, defects in extrusion, extrusion of tubes and production of seamless pipes. Problems on extrusion load.

Drawing: Drawing of tubes, rods, and wires: Wire drawing dies, tube drawing process, analysis of wire, deep drawing and tube drawing. Problem on draw force.

UNIT V:

Sheet Metal forming: Forming methods, Bending, stretch forming, spinning and Advanced techniques of Sheet Metal Forming, Forming limit criteria, defect in formed parts.

Advanced Metal forming processes: HERF, Electromagnetic forming, residual stresses, in-process heat treatment and computer applications in metal forming. problems on Blanking force, Blank diagram in Cup Diagram, Maximum considering shear.

TEXT BOOKS:

1. Mechanical Metallurgy, G.E. Dieter, Tata McGraw Hill, 1998. III Edition
2. Principles of Metal Working , Sunder Kumar

REFERENCE BOOKS:

1. Principles of Metal Working processes , G.W. Rowe
2. ASM Metal Forming Hand book.

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SIMULATION AND MODELLING OF MANUFACTURING SYSTEMS
(16AMS404)
(Elective-I)

Course Objective:

- To provide knowledge simulation and simulation steps.
- To provide knowledge on parameter estimation and hypothesis.
- To provide knowledge on building simulation model how to validation and verification is done.
- To provide knowledge on Generation of random variants and variables.
- To provide knowledge on some Simulation languages.
- To provide knowledge on some Applications of Simulation.

Course Outcome:

- Students gain knowledge on various types of simulation and simulation languages steps in simulation and applications of simulation.
- Students gain knowledge on parameter estimation and hypothesis.
- Students can build simulation model and also can validation and verify model.
- Can Generation of random variants and variables.

UNIT - I:
System – ways to analyze the system – Model - types of models – Simulation – Definition – Types of simulation models – steps involved in simulation – Advantages and Disadvantages.

UNIT-II
Parameter estimation – estimator – properties – estimate – point estimate – confidence interval estimates – independent – dependent – hypothesis – types of hypothesis- steps – types 1 & 2 errors – Framing – Strong law of large numbers.

UNIT-III
Building of Simulation model – validation – verification – credibility – their timing – principles of valid simulation Modeling – Techniques for verification – statistical procedures for developing credible model. Modeling of stochastic input elements – importance – various procedures – theoretical distribution – continuous – discrete – their suitability in modeling.

UNIT - IV:
Generation of random variants – factors for selection – methods – inverse transform – composition – convolution – acceptance – rejection – generation of random variables – exponential – uniform – Weibull – normal Bernoullie – Binomial – uniform – Poisson. Simulation languages – comparison of simulation languages with general purpose languages – Simulation languages vs. Simulators – software features – statistical capabilities – G P S S – SIMAN- SIMSCRIPT –Simulation of M/M/1 queue – comparison of simulation languages. QUEST, WITNESS, PROMODEL and AUTOMOD

UNIT-V
Output data analysis – Types of Simulation with respect to output data analysis – warm up period- Welch algorithm – Approaches for Steady – State Analysis – replication – Batch means methods – comparisons. Applications of Simulation – flow shop system – job shop system –

M/M/1 queues with infinite and finite capacities – Simple fixed period inventory system – Newboy paper problem.

TEXT BOOKS:

1. Simulation Modelling and Analysis, Law, A.M.&Kelton , McGraw Hill, 2nd Edition, New York, 1991.
2. Discrete Event System Simulation, Banks J. & Carson J.S., PH , Englewood Cliffs, NJ, 1984.
3. Simulation of Manufacturing Systems, Carrie A., Wiley, NY, 1990.

REFERENCE BOOKS:

1. A Course in Simulation, Ross, S.M., McMillan, NY, 1990.
2. Simulation Modelling and SIMNET, Taha H.A., PH, Englewood Cliffs NJ, 1987
3. Performance modeling and analysis of manufacturing systems, Viswanatham & Narahari, PHI.

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M.Tech. I SEMESTER (AMS)	**3**	**2**

ADVANCED COMPUTER AIDED DESIGN AND MANUFACTURING LABORATORY
(16AMS201)

Course Objective:

- Model the 3D geometric information of machine components including assemblies, and automatically generate 2- D production drawings, understand the basic analytical fundamentals that are used to create and manipulate geometric models in a computer program.
- Improve visualization ability of machine components and assemblies before their actual fabrication through modeling, animation, shading, rendering, lighting and coloring.
- Model complex shapes including freeform curves and surfaces,
- Integrate the CAD system and the CAM system by using the CAD system for modeling design Information and converting the CAD model into a CAM model for modeling the manufacturing Information.
- Use full scale CAD/CAM software systems designed for geometric modeling of machine Components and automatic generation of manufacturing information.

Course Outcome:

- Understand the concepts of wireframe, surface and solid modeling.
- Understand part modeling and part data exchange standards (VDA, IGES, and STEP).
- Develop knowledge in 2D-Transformations, 3D Transformations.
- Understand the Assembly Modeling, Assembly tree, and Assembly Methods.
- The Students become experts on Visualization and computer animation Techniques.

Note: Conduct at least any10 exercises from the list given below:

PART-A

1. Two- dimensional drawing using CAD software.
2. Three-dimensional drawing using CAD software.
3. Various Dimensioning and tolerance techniques on typical products using CAD software.
4. Assembly and animation of simple assemblies like screw jack, bolt-nut mechanism, etc.
5. Truss analysis using FEA software.
6. Beam analysis using FEA software.
7. Frame analysis using FEA software.

PART-B

1. **Generation of part programs on CNC Lathe and milling machine to perform the following operations**

- Step turning
- Taper turning
- Thread cutting using canned cycles
- Profile milling
- Circular/ Rectangular Pocketing operation.

Cutting tool path generation using any one simulation package for different machining operations.

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INDUSTRIAL ROBOTICS
(16AMS106)

Course Objective:

- To be familiar with the automation and brief history of robot and applications.
- To give the student familiarities with the kinematics of robots.
- To give knowledge about robot end effectors and their design.
- To learn about Robot Programming methods & Languages of robot.
- To give knowledge about various Sensors and their applications in robots.

Course Outcome:

- Students will be equipped with the automation and brief history of robot and applications.
- Students will be familiarized with the kinematic motions of robot.
- Students will have good knowledge about robot end effectors and their design concepts.
- Students will be equipped with the Programming methods & various Languages of robots.
- Students will be equipped with the principles of various Sensors and their applications in robots.

UNIT - I:
Introduction: Automation and Robotics, Robot anatomy, robot configuration, motions joint notation work volume, robot drive system, control system and dynamic performance, precision of movement.
CONTROL SYSTEM AND COMPONENTS: basic concept and modals controllers control system analysis, robot actuators and feedback components (sensors): Internal and External Sensors, Positions sensors, velocity sensors - Desirable features, tactile, proximity and range sensors, uses sensors in robotics , Power Transmission Systems.

UNIT - II:
MOTION ANALYSIS AND CONTROL: Manipulator kinematics, position representation Homogeneous transformation, D-H Notation, D-H Transformation Matrix, Forward and Inverse transformations, problems on planar and spatial manipulators, Differential Kinematics, Jacobian Formulation, problems, Manipulator path control: Slew, Joint Interpolated and Straight line motions. Trajectory planning: Joint space scheme, Cartesian space scheme, Cubic Polynomial fit without and with via point, blending.

UNIT - III:
ROBOT DYNAMICS: Lagrange – Euler and Newton Euler formulations, problems on two link planar manipulators, configuration of robot controller.
END EFFECTORS: Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design.

UNIT -IV:
ROBOT LANGUAGES: Textual robot languages, Generation, Robot language structures, Elements and functions.
ROBOT PROGRAMMING: Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SINGNAL AND DELAY commands, Branching capabilities and Limitations.

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ROBOT CELL DESGIN AND CONTROL: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work cell design, Work cell control, Inter locks, Error detection, and Work cell controller.

ROBOT APPLICATIONS: Material transfer, Machine loading/unloading. Processing operations, Assembly and Inspection, Future Applications.

TEXT BOOKS:

1. Introduction to Robotics Mechanics and Co*ntro*l, John J.Craig, Pearson
2. Industrial robotics, Mikell P.Groover , McGraw Hill.
3. Modelling and Co*ntro*l of Robot Manipulators, L.Sciavicco & B.Siciliano,Springer

REFERENCE BOOKS:

1. Robotics, K.S.Fu, McGraw Hill.
2. Robot Analysis, Lung Wen Tsai, John Wiley & Sons.
3. Robotics and control, RK Mittal & IJ Nagrath, Tata McGrawHill.
4. Fundamentals of Robotics,Robert J.schilling, PHI.
5. Robotics, Saha, TMG.
6. Robotic Engineering, Richard D.Klafter, Thomas A.Chmielewski, PHI.

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M.Tech. II SEMESTER (AMS)	**4**	**4**

INTELLIGENT MANUFACTURING SYSTEMS
(16AMS107)

Course Objective:

- To understand the importance of intelligence in manufacturing systems, so as to apply the artificial intelligence in the application of manufacturing.

Course Outcome:

- Students will get knowledge on Computer Integrated Manufacturing Systems and Manufacturing Communication Systems
- Students will be able to learn the Components of Knowledge Based Systems, Machine Learning and Knowledge Based System for Equipment Selection.
- Students will be able to understand and solve the group technology problems by using knowledge based system.

UNIT - I:
Computer Integrated Manufacturing Systems – Structure and functional areas of CIM system - CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM. Manufacturing Communication Systems – MAP/TOP, OSI Model, Data Redundancy, Top-down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing – System Components, System Architecture and Data Flow, System Operation.

UNIT - II:
Components of Knowledge Based Systems – Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition.

UNIT - III:
Machine Learning – Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks - Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing. Automated Process Planning – Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning.

UNIT-IV
Knowledge Based System for Equipment Selection (KBSES) – Manufacturing system design, Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approach in KBSES, Structure of the KBSES. Introduction to Group Technology: Models and Algorithms – Visual Method, Coding Methods.

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Group Technology – Cluster Analysis Method, Matrix Formation – Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology - Group Technology in Automated Manufacturing System, Structure of Knowledge based system for group technology (KBSGT) – Data Base, Knowledge Base, Clustering Algorithm.

TEXT BOOKS:

1. Intelligent Manufacturing Systems, Andre Kusaic.
2. Artificial Neural Networks, YagnaNarayana.

REFERENCE BOOKS:

1. Automation, Production Systems and CIM, Groover M.P.
2. Neural Networks, Wassarman.

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(16AMS108) TOTAL QUALITY MANAGEMENT

Course Outcome:

- Implement the principles and concepts inherent in a Total Quality Management (TQM) approach to managing a manufacturing or service organization.
- Explain the system of documentation, implementation and assessment of quality
- Assess exactly where an organization stands on quality management with respect to the ISO 9000 quality management standard.
- Develop a strategy for implementing TQM in an organization.

Course Objective:

- Develop an understanding on quality management philosophies and frameworks.
- Develop in-depth knowledge on various tools and techniques of quality management.
- Learn the applications of quality tools and techniques.
- Develop analytical skills for investigating and analyzing quality management issues in the industry and suggest implement able solutions to those.

Unit I:
Introduction: The concept of TQM, Quality and Business performance, attitude and involvement of top management, communication, culture and management systems. Management of Process Quality**,** Definition of quality

Unit II:
Quality Control: a brief history, Product Inspection vs. Process Control, Statistical Quality Control , Control Charts and Acceptance Sampling.
Customer Focus and Satisfaction: Process vs. Customer, internal customer conflict, quality focus, Customer Satisfaction, role of Marketing and Sales, Buyer – Supplier relationships.

Unit III:
Bench Marketing : Evolution of Bench Marketing ; meaning of Bench Marketing , benefits of bench marketing, the bench marketing process , pitfalls' of bench marketing.
Organizing for TQM: The systems approach, Organizing for quality implementation, making the transition from a traditional to a TQM organizing, Quality Circles, Productivity

Unit IV:
Quality and Reengineering: The leverage of Productivity and Quality, Management systems Vs. Technology, Measuring Productivity, Improving Productivity Re-engineering.
The cost of Quality : Definition of the Cost of Quality , Quality Costs , Measuring Quality Costs, use of Quality Cost Information , Accounting Systems and Quality Management.

Unit V:
ISO9000 : Universal Standards of Quality : ISO around the world , The ISO9000 ANSI/ASQCQ-90, series standards / benefits ISO 9000 Certification , the third party audit, Documentation ISO 9000 and services , the cost of Certification implementing the system.

TEXT BOOKS:

1. Total Quality Management, JoelE.Ross.
2. beyond TQM, Robert LJ Flood.

REFERENCE BOOKS:

1. Statistical Quality Control, E.L.Grant.
2. Total Quality Management, Bestfield.

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DESIGN FOR MANUFACTURE AND ASSEMBLY
(16AMS109)

Course Objective:

- Introduce design principles, properties of materials, fits and tolerances and datum features.
- Understand the influence of materials on form design and able to select possible material and feasible design.
- Introduce design features to facilitate machining and design for mach inability, economy, accessibility and assembly.
- Know about redesign of castings, modifying the uneconomical design, group technology and applications of DFMA.
- Understand the Environmental objectives and issues and to design considering them.

Course Outcome:

- Select the design principle, suitable material, mechanism, fit and tolerance for designing a product/component.
- Select the appropriate material, proper working principle and a feasible design.
- Design (optimum) a component which requires less material removal, easy to machine, assemble, access and cost effective.
- Redesign the uneconomical casting design and know the applications of DFMA.
- Incorporate the Environmental Objectives, issues and guidelines into the design.

UNIT I:
Introduction: Design philosophy – Steps in Design process – General Design rules for Manufacturability – Basic principles of designing for economical production – Creativity in design. Materials: Selection of Materials for design – Developments in Material Technology – Criteria for material selection – Material selection interrelationship with process selection – process selection charts.

UNIT II:
MACHINING PROCESS: Overview of various machining processes – general design rules for machining - Dimensional tolerance and surface roughness – Design for Machining ease – Redesigning of components for machining ease with suitable examples, General design recommendations for machined parts

UNIT-III
METAL CASTING: Appraisal of various casting processes, Selection of casting process, Factors affecting casting design. General design considerations for casting – Use of Solidification Simulation in casting design – Product design rules for sand casting.
METAL JOINING: Appraisal of various welding processes, Factors in design of weldments – General design guidelines – pre and post treatment of welds – Effects of thermal stresses in weld joints – Design of brazed joints.

FORGING – Design factors for forging – Closed die forging design – Location of parting lines of dies – Drop forging die design – General design recommendations

EXTRUSION, SHEET METAL WORK: Design guidelines for Extruded sections - Keeler Goodman Forming Limit Diagram – Component Design for Blanking.

UNIT V:

PLASTICS: Viscoelastic and Creep behavior in plastics – Design guidelines for Plastic components – Design considerations for Injection Moulding.

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.

TEXT BOOKS:

1. Engineering design-Material and Processing Approach, George E. Deiter, Mc. Graw Hill Intl. 2nd Ed.2000.
2. Product design for Manufacture and Assembly, Geoffrey Boothroyd,Marcel Dekker Inc. NY, 1994.

REFERENCE BOOKS:

1. Product design and Manufacturing, A.K Chitale and R.C Gupta, Prentice,Hall of India, New Delhi, 2003.
2. Design and Manufacturing ,Surender Kumar &Goutham Sutradhar, Oxford & IBH Publishing Co. Pvt .Ltd., New Delhi, 1998.
3. Hand Book of Product Design, Geoffrey Boothroyd Marcel Dekken Inc. NY, 1990.
4. Product Design, Kevin Otto and Kristin Wood, Pearson Education.

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M.Tech. II SEMESTER (AMS)	**4**	**4**

ADVANCED PRODUCTION AND OPERATION MANAGEMENT
(16AMS110)

Course Objective:

- The objective is to introduce concepts and techniques related to the design, planning, control and improvement of businesses in both manufacturing and service sectors.
- This course aims at developing a focus and critical thinking important to solve problems in the operations of business. The students will be required to understand and apply the tools of management learned in the course to practical situations.
- To produce the desired product this has marketability at the most affordable price by properly planning the manpower, material and processes.
- To achieve the objective of delivering the right goods of right quantity as well as quality, at right place and at right time one needs to understand and apply the concepts of Production and operations management.
- Efficient **Advanced Production and operations management,** give benefits to various sections including consumers, investors, employees, suppliers and community in different ways.

Course Outcome:

- Able to understand the principles of production and operations Management
- Understand the operations process, be able to analyze and solve problems pertaining to operations.
- Understand some of the mathematical models of production management.
- Appraise how other functional areas of business are integrated with Operations Management.

UNIT- I

Overview of Production and Operations Management (POM): Introduction-Definition-Importance-Historical Development of POM-POM scenario today

Product Development: Role of product development- Product development process-Tools for efficient product development (brief treatment).

Process Design and Value Analysis

Determination of process characteristics- Types of processes and operations systems- Continuous – Intermittent-Technology issues in process design- Flexible Manufacturing Systems- Automated Material Handling Systems

UNIT –II

Value Analysis: Definition- Objectives; Types of Values-Phases- Tools; FAST diagram-Steps-Advantages-Matrix method-Steps.

Plant Location and Plant layout: Factors affecting locations, decisions-Location planning methods-Location factor rating -Centre of Gravity method-Load distance method. Plant layout- Definition-Objectives-Types of layouts-Design of product layout-Line balance-Terminology-RPW method.

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Aggregate Planning: Definition- Objectives-Basic strategies for aggregate production planning-Aggregate production planning method-Transportation model- Master Production Scheduling- MRP-I & MRP-II Systems.

Material Requirement Planning: Terminology-Logic-Lot sizing methods-Advantages and Limitations, MRP for multilevel multi product environments.

UNIT -I V
Work Study: Work study: method study –definition-objectives-steps-Charts used- Work measurement-Time study- Definition-steps- Determination of standard time- Performance rating- Allowances. Work sampling- steps- comparison with time study.
Quality Management: Economics of quality assurance-Control charts for variables and for attributes – Acceptance sampling plans-Total Quality Management-ISO 9000 series standards-Six sigma

UNIT - V
Scheduling: Need-basis for scheduling- Scheduling rules- Flow shop and Job shop scheduling. Line of Balance and dispatching rules in scheduling.
Project management: PERT- Critical path determination- Probability of completing project in a given time- CPM- Types of floats- Critical path determination- Crashing of simple networks- Optimum project schedule.

TEXT BOOKS:

1. Production and Operations Management: R.Panneerselvam
2. Operations Management for Competitive Advantages- Chase Aquinano - TMH, 2009
3. Operations Management: Theory and Practice: B.Mahadevan Pearson.
4. Industrial Engineering and Mangement: Dr.Ravi Shankar- Golgotha.

REFERENCE BOOKS:

1. Modern Production and Operations Managemet: Buffa, Wiley
2. Theory and Problems in Production and Operations Managemet:SN Chary TMH.
3. Operations Management 8e Process and Value Chains: Lee Krajewski ET. All Pearson
4. Operations Management, Amol Gore, Roberto Pawzzolo, Lengage, 2012.

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M.Tech. II SEMESTER (AMS)	**4**	**4**

PRECISION ENGINEERING
(16AMS405)
(Elective-II)

Course Objective:

- To impart knowledge about basics of precision machining and different Manufacturing technique in precision engineering.
- Accuracy and alignment tests.
- Influences of static stiffness and thermal effects.
- Precision machining.
- Nano measuring systems.
- Various lithography techniques.

Course Outcome:

- Apply fits and tolerances for parts and assemblies according to ISO standards.
- Apply selective assembly concept for quality and economic production.
- Assign tolerances using principles of dimensional chains for individual features of a part or assembly.
- Evaluate the part and machine tool accuracies

UNIT-1
Tolerance and fits: ISO and ISI designation, calculation of clearance and interference fits, probability of clearance and interference fits in transitional fits, examples of applications of various fits, concept of selective assembly, calculation of fits in selective assembly.

UNIT-II
Concept of part and machine tool accuracy: Accuracy specification of parts and assemblies, accuracy of machine tools, alignment testing of machine tools.

UNIT-III
Theory of dimensional chains: Definitions, concept of dimensional chain or tolerance stack, Examples of right and wrong dimensioning. Basic theory of dimensional chains. Calculation of tolerances in dimensional chains.

UNIT-IV
Errors during machining: Errors due to compliance of machine-fixture-tool-work piece (MFTW) System, influence of compliance on progressive decrease of error in a series of machining operations, theory of location, location errors, errors due to geometric Inaccuracy of machine tool, errors due to tool wear, errors due to thermal effects, errors due to clamping. Statistical method of accuracy analysis.

UNIT-V
Surface roughness: Definition and measurement, surface roughness indicators, (CLA, RMS, etc,.) and their comparison, influence of machining conditions, methods of obtaining high quality surfaces, Lapping, Honing, Super finishing and Burnishing processes.
Calculation of machining allowance: In process dimensioning of work pieces with examples

Manufacturing methods of typical machine tool components: Spindles, gears, and beds.

TEXT BOOKS:

1. R.L.Murty,"Precision Engineering in Manufacturing", New Age International Publishers, 1996.
2. V.Kovan, "Fundamentals of Process Engineering", Foreign Languages Publishing House, Moscow, 1975
3. Eary and Johnson, "Process Engineering for Manufacture"
4. J.L.Gadjala, "Dimensional control in Precision Manufacturing", McGraw Hill Publishers.

REFERENCE BOOKS:

1. V.C.Venktesh, Precision Engineering, Tata McGraw Hill, New Delhi 2007
2. Kalpakjian S., Manufacturing Engineering and Technology. 3rd Ed. Addision-Wesley Publishing Co., New York, 2001.
3. Nakzavawa H, Principles of Precision Engineering, Oxford University Press, 1994.

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M.Tech. II SEMESTER (AMS)	**4**	**4**

RAPID PROTOTYPING AND TOOLING
(16AMS406)
(Elective-II)

Course Objective:

- An understanding of the various rapid prototyping and rapid tooling technologies
- The knowledge to select appropriate technologies for product development purposes.

Course Outcome:

- Apply the basic principles of rapid prototyping (RP) and rapid tooling (RT) technologies to product development.
- Decipher the limitations of RP and RT technologies for product development.
- Realize the application of RP and RT technologies for product development.

UNIT I
INTRODUCTION: Need - Development of RP systems-, – RP process chain - Impact of Rapid Prototyping and Tooling on Product Development – History of RP systems and their classification- Benefits Applications – Digital prototyping - Virtual prototyping.

UNIT II
LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS:
Stereo lithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, three dimensional printing: Working Principles, details of processes, products, materials, advantages, limitations and applications.

UNIT III
POWDER BASED RAPID PROTOTYPING SYSTEMS: Selective Laser Sintering, Direct Metal Laser Sintering, Three Dimensional Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations.

UNIT IV
REVERSE ENGINEERING AND CAD MODELING
Basic concept- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements – geometric modeling techniques: Wire frame, surface and solid modeling – data formats – Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation.

UNIT V
RAPID TOOLING: Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect – Fabrication processes, Applications.

TEXT BOOKS:

1. Rapid prototyping: Principles and applications, second edition, Chua C.K., Leong K.F., and Lim C.S., World Scientific Publishers, 2003.
2. Rapid Tooling: Technologies and Industrial Applications, Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs, CRC press, 2000.

REFERENCE BOOKS:

1. Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003.
2. Rapid Prototyping and Engineering applications: A tool box for prototype development, Liou W.Liou, Frank W.Liou, CRC Press, 2007.
3. Rapid Prototyping: Theory and practice, Ali K. Kamrani, Emad Abouel Nasr, Springer, 2006.

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DESIGN AND MANUFACTURING OF MEMS AND MICRO SYSTEMS
(16AMS407)
(Elective-II)

Course Objective:

- To learn about electromechanical design and packaging of micro devices and systems.
- To learn of the basic design principles for MEMS and Microsystems.
- To learn the basic principles of micro fabrication techniques for micro devices and micro systems, as well as integrated circuits.
- To learn the basic principles involved in micro systems packaging.
- To learn the basic principle of nano technology and nano scale engineering analysis.
-

Course Outcome:

- To be able to explain what MEMS and micro systems
- To explain the working principles of many MEMS and micro systems in the market place.
- To understand the relevant engineering science topics relating to MEMS and micro systems.
- To be able to distinguish the design, manufacture and packaging techniques applicable to micro systems from those for integrated circuits.
- To become familiar with the materials, in particular, silicon and its compounds for MEMS.
- To be able to explain the basic and relevant design principles of MEMS and micro systems.
- To learn the scaling laws for miniaturization.
- To be able to identify the optimal micro fabrication and packaging techniques for micro devices and systems.
- To be able to handle mechanical systems engineering design of micro scale devices.
- To learn the fundamentals of nanotechnology.

UNIT- I:

Overview and working principles of MEMS and Microsystems: MEMS and Microsystems, Evolution of Micro fabrication, Microsystems and Micro electronics, Microsystems and miniaturization, Applications of MEMs in Industries, Micro sensors, Micro actuation, MEMS with Micro actuators Micro accelerometers, Micro fluidics.

Engineering Science for Micro systems Design and Fabrication: Atomic structure of Matter, Ions and Ionization, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electro chemistry.

UNIT- II:

Engineering Mechanics for Microsystems Design: Static Bending of Thin plates, Mechanical Vibration, Thermo mechanics, over view of Finite Element Stress Analysis.

Thermo Fluid Engineering and Micro systems Design: Over view of Basics of Fluid Mechanics in Macro and Meso scales, Basic equations in Continuum Fluid Dynamics, Laminar Fluid Flow in Circular Conduits.

UNIT- III:

Over view of Heat conduction in Solids, Heat Conduction in Multi layered thin films and in solids in sub micrometer scale, Design Considerations, Process Design Mechanical Design, Mechanical design using FEM, Design of a Silicon Die for a Micro pressure sensor.

UNIT- IV:

Materials for MEMS and Micro systems and their fabrication: Substrates and Wafers, Active substrate materials, Silicon as a substrate material, Silicon compounds, Silicon Piezo resistors, Gallium Arsenide, Quartz, Piezo electric Crystals and Polymers.

UNIT-V:
Photolithography, Ion implantation, Diffusion and oxidation, Chemical and Physical vapor deposition, etching, Bulk micro manufacturing, Surface Micro machining, The LIGA Process.

TEXT BOOKS:

1. MEMS and Microsystems. Design and Manufacturing, Tia-Ran Hsu, TMH 2002
2. Foundation of MEMS, Chang Liu, Pearson, 2012.

REFERENCE BOOKS:

1. An Introduction to Micro electro mechanical Systems Engineering. Maluf, M., Artech House, Boston 2000.
2. "MicrorobotsandMicromechnaicalSystems", Trimmer, W.S.N., Sensors&Actuators, Vol19, 1989
3. Applied Partial Differential Equations, Trim. D.W., PWS-Kent Publishing, Boston, 1990.

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OPTIMIZATION TECHNIQUES AND APPLICATIONS
(16AMS408)
(Elective-II)

Course Objective:

- To understand the formulation of a structural optimization problem, including defining appropriate design variables, constraints, and objective functions.
- To apply various approximation methods to construct a sequence of approximate structural design problems appropriate for static strength, natural frequencies, buckling, and dynamic response.
- To apply appropriate algorithms for discrete design variables and multi objective optimization

Course Outcome:

- Strengthen the analytical skills of the students.
- Able to apply the optimization techniques in various applications.
- problems.

UNIT - I
Linear programming: Two-phase simplex method, Big-M method, duality, interpretation, applications.
Assignment problem: Hungarian's algorithm, Degeneracy, applications, unbalanced problems, traveling salesman problem.

UNIT - II
Classical optimization techniques: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions.

UNIT - III
Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

UNIT – IV
Multi-Objective GA: Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems.

UNIT V
Applications of Optimization in Design and Manufacturing systems: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

TEXT BOOKS:

1. Optimal design – Jasbir Arora, McGraw Hill (International) Publishers
2. Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers
3. Engineering Optimization – S.S.Rao, New Age Publishers

REFERENCE BOOKS:

1. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers.
2. Genetic Programming- Koza.
3. Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers.

MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE
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M.Tech. II SEMESTER (AMS)	**3**	**2**

MANUFACTURING SIMULATION LAB
(16AMS202)

1. Study of elements, entities, activities and basic models of a simulation package modeling and simulation.
2. Throughput analysis of a individual production facility using simulation.
3. Modeling of a typical manufacturing facility and study its performances.
4. Breakdown analysis of a production facility with one machine.
5. Breakdown analysis of a production system having multiple machines.
6. Modeling and Simulation of layouts.
7. Study of transport system in a shop floor.
8. Buffer size design.
9. Identification of bottleneck machine on a given shop floor.
10. Study of conjunction, collision and dead locks through simulation.

Lab Facilities

Adequate number of Computer Systems in Networked Environment

Packages:

1. QUEST
2. PROMODEL
3. FLEXSIM
4. AUTOMOD
5. WITNESS