VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM

SCHEME OF TEACHING AND EXAMINATION FOR
M.TECH. Computer Integrated Manufacturing

I SEMESTER **CREDIT BASED**

Subject Code	Name of the Subject	Teaching hours/week		Duration of Exam in Hours	Marks for		Total Marks	CREDITS
		Lecture	Practical / Field Work / Assignment/ Tutorials		I.A.	Exam		
16MDE 11	Applied Mathematics	4	2	3	20	80	100	4
16MCM 12	Automation and Computer Integrated Manufacturing	4	2	3	20	80	100	4
16MCM 13	Computer Aided Design	4	2	3	20	80	100	4
16MAR 16	Automation in Manufacturing Systems	4	2	3	20	80	100	4
	Elective – I	4	2	3	20	80	100	4
16MCM16	Manufacturing Engineering Lab I	--	3	--	20	80	100	2
16MCM17	Seminar	--	3	--	100		100	1
	Total	**20**	**13**	**15**	220	480	700	**23**

ELECTIVE-I

16MCM151	Finite Element Method	16MCM154	Agile Manufacturing
16MCM152	Artificial Intelligence and Expert Systems	16MAR155	Modeling of Management Information Systems
16MCM153	Rapid Prototyping	16MAR156	Modern Control Engineering

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION FOR

M.TECH. Computer Integrated Manufacturing

II SEMESTER **CREDIT BASED**

Subject Code	Name of the Subject	Teaching hours/week		Duration of Exam in Hours	Marks for		Total Marks	CREDITS
		Lecture	Practical / Field Work / Assignment / Tutorials		I.A	Exam		
16MAR21	Robotics for Industrial Automation	4	2	3	20	80	100	4
16MCM22	Flexible Manufacturing Systems	4	2	3	20	80	100	4
16MAR23	Computer Control of Manufacturing Systems	4	2	3	20	80	100	4
16MCM24	Non Traditional Machining	4	2	3	20	80	100	4
	Elective – II	4	2	3	20	80	100	4
16MCM26	Manufacturing Engineering Lab II		3	3	20	80	100	2
16MAR27	SEMINAR	--	3	--	100	--	100	1
	**PROJECT WORK PHASE-I COMMENCEMENT (6 WEEKS DURATION)	--	--	--	--	--	--	--
	Total	**20**	**13**	**15**	**220**	**480**	**700**	**23**

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME OF TEACHING AND EXAMINATION 2016-2017

M. Tech in Computer Integrated Manufacturing (MCM)

III SEMESTER: Internship **CREDIT BASED**

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credits
			Lecture Hours	Practical/ Field Work/ Assignment	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16MCM31	Seminar / Presentation on Internship (After 8 weeks from the date of commencement)	-	-	-	25	-	25	20
2	16MCM32	Report on Internship	-	-	-	25	-	25	
3	16MCM33	Evaluation and Viva-Voce of Internship	-	-	-	-	50	50	
4	16MCM34	Evaluation of Project phase -1	-	-	-	50	-	50	1
TOTAL			**-**	**-**	**-**	**100**	**50**	**150**	**21**

I SEMESTER

APPLIED MATHEMATICS

(Common to MDE,MMD,MEA,CAE,MCM,MAR,IAE,MTP,MTH,MTE,MST,MTR)

Sub Code	: 16 MDE11	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objectives:

The main objectives of the course are to enhance the knowledge of various methods in finding the roots of an algebraic, transcendental or simultaneous system of equations and also to evaluate integrals numerically and differentiation of complex functions with a greater accuracy. These concepts occur frequently in their subjects like finite element method and other design application oriented subjects.

Course Content:

1) Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model, Conservation Laws of Engineering.
   06 Hours

2) Roots of Equations: Bracketing methods-Graphical method, Bisection method, False position method, Newton- Raphson method, Secant Method. Multiple roots, Simple fixed point iteration.

   Roots of polynomial-Polynomials in Engineering and Science, Muller's method, Bairstow's Method Graeffe's Roots Squaring Method.**12 Hours**

3) Numerical Differentiation and Numerical Integration: Newton –Cotes and Guass Quadrature Integration formulae, Integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae
   06 Hours

4) System of Linear Algebraic Equations And Eigen Value Problems: Introduction, Direct methods, Cramer's Rule, Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method, error Analysis for direct methods, Iteration Methods.

   Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices, Givens method for symmetric matrices, Householder's method for symmetric matrices, Rutishauser method for arbitrary matrices, Power method, Inverse power method
   .**16 Hours**

5) Linear Transformation: Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models in Science and Engineering

Orthogonality and Least Squares: Inner product, length and orthogonality, orthogonal sets, Orthogonal projections, The Gram-schmidt process, Least Square problems, Inner product spaces**.** **12 Hours**

Text Books:

1. S.S.Sastry, Introductory Methods of Numerical Analysis, PHI, 2005.
2. Steven C. Chapra, Raymond P.Canale, Numerical Methods for Engineers, Tata Mcgraw Hill, 4th Ed, 2002.
3. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003.

Reference Books:

1. Pervez Moin, Fundamentals of Engineering Numerical Analysis, Cambridge, 2010.

2. David. C. Lay, Linear Algebra and its applications, 3rd edition, Pearson Education, 2002.

Course Outcomes:

The Student will be able to

1) Model some simple mathematical models of physical Applications.
2) Find the roots of polynomials in Science and Engineering problems.
3) Differentiate and integrate a function for a given set of tabulated data, for Engineering Applications

AUTOMATION AND COMPUTER INTEGRATED MANUFACTURING

(Common to MCM,MAR,IAE,MCS)

Sub Code :	16MCM12	IA Marks :	20
Hrs/ Week:	04	Exam Hours:	03
Total Hrs. :	50	Exam Marks:	80

Course Objectives:

To impart the knowledge of product cycle and its development.Understand the importance of prototypes, CAD/CAM & CIM. Students will get an exposure to types of Automatic material handling and storage systems.

Course Content:

1. **Production Development Through CIM:** Computers in Industrial manufacturing, Product cycle & Production development cycle, Introduction of CAD/CAM & CIM, sequential and concurrent engineering, soft and hard prototyping.

   7 Hours

2. **Computer Integrated Manufacturing and Automation:** Fundamentals of CAD/CAM, Computerized Manufacturing planning systems, shop floor control & automatic identification techniques. Computer Network for manufacturing and the future automated factor.

   Detroit Type of Automation: Flow lines, Different Transfer Mechanisms, work pattern transfer, Different methods, Numericals.

   10Hours

3. **Analysis of Automated flow lines:** Analysis of transfer lines without storage, with storage buffer, single stage, Double stage, Multistage with problems, Automated assembly systems, Design for automated assembly, parts feeding devices, analysis of Multi station assembly machine, Analysis of Single stage assembly machine, Numericals.

   Computer Process Monitoring: Process control methods, direct digital control, supervisory computer control, steady state optimal control, on line search strategies, adaptive control.

   13 Hours

4. **Fundamentals of Networking:** Principles, techniques, networking methods, network standards, Ethernet, Internet, system security, remote systems, NFS, ATM, EWN, document and work flow management.

   Automated Material Handling and Storage: Material functions, types of material handling equipment, analysis of material handling systems, design of system, conveyor system, automated guided vehicle systems, automated storage/retrieval systems, caroused storage systems work in process storage, interfacing handling & storage with manufacturing.

   13 Hours

5. **Computer Aided Quality Control:** The computer in Q.C, automated inspection principles and methods, Contact inspection methods, non-contact inspection methods, machine vision system, optical inspection method, sensors, coordinate measuring machine, Computer-Aided testing, Integration of CAQC with CAD/CAM.

7 Hours

TEXT BOOKS:

1. CAD/CAM – Zimmers& Grover, PHI.
2. CAD/CAM/CIM – P. Radhakrishna, New Age International.
3. M. P. Grover, Automation, Production Systems & Computer Aided manufacturing, Prentice Hall.

REFERENCE BOOKS:

1. CAD/CAM – Zeid, Mc-Graw Hill
2. CAD/Cam, P. N. Rao.
3. Koren.Y "Robotics for Engineering" Mc-Graw Hill.
4. Rooks. B. (ed) "Robert vision & Sensory controls vol-3 North Holland.

Course Outcome:

Students will be able to

1. Understand the importance of product development through CIM.Get knowledge of shop floor control , Computer Integrated Manufacturing andAutomation.
2. Adopt appropriate material handling and storage in an automated manufacturing environment.
3. Incorporate methods of utilization of appropriate features in CAD application enhancing productivity in design

COMPUTER AIDED DESIGN

(Common to MCM,MAR,IAE)

Sub Code	**:**	**16MCM13**	***IA Marks***	**:**	**20**
Hrs/ Week	**:**	**04**	**Exam Hours**	**:**	**03**
Total Hrs.	**:**	**50**	**Exam Marks**	**:**	**80**

Course Objectives:

To impart the basic Fundamentals of CAD, The Design Process, Computers Applications in Design, Knowledge enhancement in areas like computer graphics, database structure and software configuration in CAD systems

Course Content:

1. Introduction to Computer graphics and Database: Computer Aided Design: Definition, Fundamentals of CAD, The Design Process, Computers Applications in Design, Manufacturing Database, Benefits of CAD, Computer Graphics Software and Database: Software configuration of a Graphic system, Functions of a Graphics package, Constructing the Geometry, Database Structure and Content, Wire-Frame Features & CAD/CAM Integration.

06 Hours

2. TRANSFORMATIONS-Translation, Scaling, Reflection or Mirror, Rotation, Concatenations, Homogeneous Transformation, 3D Transformations-Translation, Scaling, Rotation about, X, Y and Z axes. Mathematics of Projections- Orthographic and Isometric Projections.Clipping, Hidden Line or Surface removal, Color and Shading.

GEOMETRIC MODELING: Requirements of Geometric Modeling, Geometric Models, Geometric Construction Methods, Constraint- Based Modeling, Other Modeling Methods- Cell Decomposition, Variant Method, Symbolic Programming, form Features. Wireframe Modeling- Definitions of Point lines, Circles, Arcs, etc.,Wireframe Data Representation.

16 Hours

3. MODELING FACILITIES AND GRAPHIC STANDARDS: Modeling Facilities- Geometric Modelling Features, Editing or Manipulating, Display Control, Drafting, Programming, Analytical and Connecting Features.

GRAPHIC STANDARDS - Standardization in Graphics, Graphical Kernel System (GKS), Other Graphic Standards-GKS 3D, PHIGS, NAPLPS, Exchange of Modeling Data-IGES, STEP, Drawing Exchange Format (DXF), Dimension Measurement Interface Specification (DMIS).

6 Hours

4. MODELING CURVES & SURFACES: Curve Representation-Line, Circle, Parabola, Hyperbola, Curve Fitting- Interpolation Techniques- Lagrangian Polynomial, B-Splines, Approximate Methods-Method of Least Squares, Polynomial Curve Fitting, Synthetic Curves-Hermite Cubic Spline, Bermestine Polynomials, Bezier Curve, Rational Curves, NURBS.

SURFACE REPRESENTATION: Methods-Analytic Surfaces, Surfaces of Revolution, Ruled Surfaces, Synthetic Surfaces- Hermite Cubic Surface, Bezier Surface, B-Spline Surface, Coons Surface Patch, Tabulated Cylinder, Sculptured Surfaces, Surfaces of Manipulation-Surface Display, Segmentation.

12 Hours

5 .MODELING OF SOLIDS: Solid Representation-Concepts, Boundary Representations (B-Rep), Constructive Solid Geometry (CSG), Half Space Method.

MECHANICAL ASSEMBLY: Introduction, Assembly Modeling, Parts Modeling and Representation, Hierarchical Relationships, Mating Conditions, Inference of Position from Mating Conditions, Representation Schemes, Graph Structure, Location Graph, Virtual Link, Generation of Assembling Sequences, Precedence Diagram, Liaison-Sequence Analysis, Precedence Graph, Assembly Analysis.

12Hours

TEXT BOOKS:

1. P.N. Rao, **CAD/CAM Principles and Applications**, 3rd Ed., McGraw Hill, Education Pvt Ltd., New Delhi

2. Ibrahim Zeid& R. Shivasubramanian, **CAD/CAM Theory & Practice,** 2nd Ed., TMH Education Pvt Ltd., New Delhi (Chapter 2,)

REFERENCE:

1. M.P. Groover and 3 E W Zimmers, **CAD/CAM Computer aided Design and Manufacture,** Prentice hall, 1984

2. C.B. Besant and E.W.K. Lui, **Computer Aided design and Manufacture**, AffiliatedEast West, press India 1988

3. Piegel ,**Mathematical Elements for Computer Graphics**,

Course Outcome:

Students will be able to

1. Configure complete design process.
2. Get complete knowledge of geometric modelling, Construction of various geometries.
3. Incorporate methods of utilization of appropriate features in CAD application enhancing productivity in design
4. Construct CAD models related to mechanical assembly leading to minimum lead time

AUTOMATION IN MANUFACTURING SYSTEMS

(Common to MCM,MAR,IAE)

Sub Code	: 16MAR16	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objectives:

Students will get an exposure to various aspects of automation in manufacturing, modeling techniques ,drives and controls used in manufacturing applications.

Course Content:

1. Fundamentals of manufacturing: Production System Facilities, Manufacturing support systems, Different types of manufacturing systems, Automation in Production Systems, Automation Principles & Strategies, Manufacturing Operations, Product, Production Relationships.

Mathematical Concepts & Models: Production Concepts & Mathematical Models, Costs of Manufacturing Operations, Numericals.

12 Hours

2. Automation and modeling automated manufacturing systems: Basic Elements of Automated System, Advanced Automation Functions, Levels of Automation, Performance Modeling Tools, Markov Chain Models, Quenching Models, Petrinet Models, Types of petrinets, Differences between Simplepetrinets and high level petrinets, Integrated PRQN-ESP Models**.**

Industrial Control and process planning: Industrial Control Systems,Sensors, Actuators, & other Control Systems, Discrete Control using PLC & PLC network, Manufacturing Support Systems, CAPP, Automated CAPP,Advanced Manufacturing, Planning, Lean Production & Agile Manufacturing.

16 Hours

3. Power Hydraulics & Pneumatics: Concepts features & parameters Governing the Selection of various components Necessary for Building the elements, Circuit Design & Analysis.

Industrial Applications of Fluid power & pneumatic systems, Electro-Hydraulic Servo System, Fluid logic control, MPL, Fluidics logic control.

12 Hours

4. PLC: Introduction, Micro PLC, Programming a PLC, Logic Functions, input & output Modules, PLC Processors, PLC Instructors, Documenting a PLC System, Timer & counter Instructions, Comparison & data Handling instructions, Sequencing Instructions, Mask Data representation. **6 Hours**

5. Typical PLC Programming Exercises for Industrial Applications and case studies.

6 Hours

TEXT BOOKS:

1. **Performance Modeling of automated Manufacturing Systems -** Viswanandham, PHI.
2. **Fluid Power System -** Goodwin, McGraw Hill Press Limited, 1976.
3. **Principles & Applications -** Webb, PLC McMillan 1992.

REFERENCE BOOKS:

1. **Principles of CIM -** Vajpayee, PHI.

2. **Automation Production Systems & CIM -** Mikell P Grover, Pearson Education, Asia
3. **Fluid Power with Applications -** Anthony Esposito, Prentice Hall, 1997.
4. **Mechatronics** - W, Bolton, Longman, Adderson Wesley.

Course Outcome:

Students will get an insight of automation in manufacturing and will be able to demonstrate knowledge of their understanding of drives, controls and modeling in automation.

Elective-I

FINITE ELEMENT METHOD

(Common to MCM,MAR,IAE)

Sub Code	: 16MCM 151	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objectives:

1) Introduce the various aspects of FEM as applied to engineering problems.
2) To present the Finite element method(FEM) as a numerical method for engineering analysis of continua and structures
3) To present Conventional Approach to Design process, product Development, implementation, Simulation of integrated Database Management system in CAE.
4) To present basic introduction of Computer Graphics transformations and Geometric modeling.

Course Content:

1. **Finite Element Modeling and Analysis:** Introduction, Basic Concepts, Engineering Applications, Features, steps in FEM. Discretisation of domain, discussion on various 1D, 2D and 3D Elements

   Discretisationand ShapeFunctions: Discretisation Process, various consideration for discretisation Process. Derivation of shape function for 1D and 2D element. Comparison of 1D linear, 1D quadratic and 1D cubic element. Convergence requirements

   10 Hours

2. **Finite Element Formulation of Solid Mechanics Problems:** Potential Energy Formulation and Closed form Solution, Weighted Residual Method, Galerkin Method. Problems on 1D elements.

   Analysis of Structures: Truss Elements, Analysis of Truss Problems by Direct Stiffness Methods, Analysis of Frames and Different Problems, Different Axi-Symmetric Truss Problems.

   16Hours

3. **Computer Aided Engineering Analysis:** Introduction, Conventional Approach to Design, Description of the Design Process, Parametric and Variation Designs, Engineering Analysis and CAD, Compute Aided Engineering, Integrated Database Management System in CAE, CAE product Development, CAE implementation, Simulation Based Design.

   8 Hours

4. **Transformation and Manipulation of Objects:** Introduction, Transformation Matrix, 2D transformation, Arbitrary Rotation about the origin, Rotation by different angles, Concatenation, 2D transformation, Projection on to a 2D plane, Overall scaling, Rotation about an Arbitrary Point, 2D Reflection, 3D Transformation, 3D scaling, 3D Rotation of Objects, 3D Rotation about an arbitrary Axis, 3D Visualisation.

   8 Hours

5. **Geometric Modeling:**Line Fitting, Non Linear Curve Fitting with a Power Function, Curve Fitting with a High Order Polynomial,Cubic Spines, Parabolic Cubic Splines, Non Parametric Cubic Spline, Boundary Conditions, Bezier Curves, Differentiation of Bezier Curve Equations, B-Spline Curve, Non Uniform Rational B-Spline(NURBS), Surface creation, Plane Surface, Ruled Surface, Rectangular Surface, Surface of Revolution, Application Software. Introduction, Construction Techniques, Representation Schemes, and Application of Solid Modeling.

   8 Hours

Text Books:

1. **"Finite Element Procedure"-** Bathe, Prentice Hall, 1996..
2. **"Finite Elements in Engineering"** – Chandrupatla, and Belagundu, Prentice Hall of India Pvt. Ltd., New Delhi/ Pearson Education, 2000.
3. **"CAD/CAM Theory and Practice**, Ibrahim-Zeid, TATA McGraw Hill, 2009.
4. **"Principles of Computer Aided Design and Manufacturing"**, 2nd Edition, Pearson Publishers, FaridAmirouche, 2006
5. **"CAD/CAM/CIM"** – P. Radhakrishnan, New age international, 2000.

Reference Books:

1. **"The Finite Element Method"** – Zienkiewicz.O.C. , TMH, New Delhi, 2000
2. **'Concepts and Applications of Finite Element Analysis**:" - COOK. D. Robert., Malus.S.David, Plesha E. Michel , John Wilely& sons 3rd Edn., New York, 2000
3. **"Finite Element Analysis"**– C.S.Krishnamoorthy, TMH, New Delhi, 1995
4. **"Introduction to the Finite Element method"**–Desai / ABEL C.B.S. Publisher, Distributors, New Delhi 2000.
5. **"An Introduction to FEM"** - J.N Reddy, TMH, 2006.
6. **"Fundamentals of Finite Element Analysis"** -David Hutton, TMH, 2005.

Course Outcome:

Students will be able to

1) Know about the FEM as a numerical method for the solution of solid mechanics, structural mechanics.
2) Seek information regarding Computer graphics and geometric modeling.

ARTIFICIAL INTELLIGENCE & EXPERT SYSTEMS

(Common to MCM,MAR,IAE)

Sub Code	: 16MCM 152	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objectives:

The course is aimed at providing a complete overview Artificial Intelligence and Expert System in order to make the student aware of significance of its application in advanced manufacturing applications.

Course Content:

1. **Human and Machine Intelligence;** Concepts of fifth generation computing, programming AI environment, developing artificial intelligence system, definition of Expert systems, Natural Language processing, neural networks.

Tools for Machine Thinking: Forward chaining, Backward chaining, use of probability and fuzzy logic.

10 Hours

2. **Expert System Development:** Choice of Domain, collection of knowledge base, selection of inference mechanism, case studies of expert system development in design and manufacturing.

Advanced Programming Techniques: Fundamentals of object oriented programming, creating structure and object, object operations, involving procedures, programming applications, object oriented expert system.

16 Hours

3. **Advanced knowledge representation for smart systems:** semantic nets-structure and objects, ruled systems for semantic nets; certainly factors, Automated learning.

Languages in AI: Using PROLOG to design expert systems, converting Rules to PROLOG, Conceptual example, introduction to LISP, Function evaluation, Lists, Predicates, Rule creation.

16 Hours

4. **Expert System Tools:** General structure of an expert system shell, examples of creation of an expert system using an expert system tool.

6 Hours

5. Industrial Application of AI and Expert systems: Robotic vision systems, Image p processing techniques, application to object recognition and inspection, automatic speech recognition.

6 Hours

Text Books:

1. Robert Levine et al; "**A Comprehensive guide to AI and Expert Systems**"- McGraw Hill Inc, 1986.
2. Henry C.Mishkoff; "**Understanding AI", BPB Publication**"-New Delhi 1986.

Course Outcome:

Student will be able to analyse and understand: Human and Machine Intelligence, tools for machine thinking and associated advanced programming techniques.

RAPID PROTOTYPING

(Common to MCM,MAR,IAE,MCS,MTE)

Sub Code	: 16MCM153	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objective

The course enables students to conceive, design, and implement products quickly and effectively, using the latest rapid prototyping methods and CAD/CAM technology .The students learn to differentiate various process parameters associated with Rapid manufacturing technique.

Course Content:

1. **Introduction:** Definition of Prototype, Types of prototype, Need for the compression in product development, History of RP systems, Survey of applications, Growth of RP industry, classification of RP systems.

Stereo lithography Systems: Principle, Process parameter, process details, Data preparation, data files and machine details, Application.

10 Hours

2. **Selective Laser Sintering:** Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Fusion Deposition Modelling**:** Principle, Process parameter, Path generation, Applications.

6 Hours

3. **Solid Ground Curing:** Principle of operation, Machine details, Applications, **Laminated Object Manufacturing**: Principle, of operation, LOM materials, process details, application.

Concepts Modelers: Principle, Thermal jet printer, Sander's model market, 3-D printer, GenisysXs printer HP system 5, object Quadra systems, **Laser Engineering Net Shaping (LENS)**

12 Hours

4. **Rapid Tooling :** Indirect Rapid tooling -Silicon rubber tooling —Aluminum filled epoxy tooling Spray metal tooling ,Cast kirksite ,3D keltool ,etc.Direct Rapid Tooling — Direct, AIM, Quick cast process, Copper polyamide, Rapid Tool ,DMILS, ProMetal ,Sand casting tooling ,Laminate tooling soft Tooling vs. hard tooling.

08 **Hours**

5. **Software For Rp:** Stl files, Overview of Solid view, magics, imics, magic communicator, etc. Internet based software, Collaboration tools,

RAPID Manufacturing Process Optimization: factors influencing accuracy, data preparation errors, Part building errors, Error in finishing, influence of build orientation.

Allied Processes: vacuum, casting, surface digitizing, surface generation from point cloud, surface modification — data transfer to solid models.

16 Hours

Text Books:

1. Paul F. Jacobs: "**Stereo 1ithography and other RP & M Technologies**"-SME NY, 1996.
2. Flham D.T &Dinjoy S.S "**Rapid Manufacturing**"- Verlog London 2001.

ReferenceBooks:

1. Terry Wohler's "**Wohler's Report 2000**"- Wohler's Association 2000

Course Outcomes:

1. Students can express the concept of product design stages and methods, thereby making him a better product designer.

2. Student can assess and implement RP techniques for specific application leading to better ROI for the company that uses RP machines

AGILE MANUFACTURING

(Common to MCM,MAR,IAE,MST)

Sub Code	: 16MCM154	***IA Marks***	: 20
Hrs/ Week	***: 04***	***Exam Hours***	***: 03***
Total Hrs.	***: 50***	***Exam Marks***	***: 80***

Course Objectives:

The Student will

1. Get an overview of Agile Manufacturing, need and strategies.
2. Know the process of developing an agile manufacturing/enterprise. Integrating Product/Process development.
3. Learn the computer control of agile manufacturing.

Course Content:

1. **Agile Manufacturing:** Definition, business need, conceptual frame work, characteristics, generic features. Four Core concepts: Strategy driven approach-integrating organization, people technology, interdisciplinary design methodology.

   6 **Hours**

2. **Developing Agile Manufacturing:** Enterprise design, System concepts as the basic manufacturing theory-joint technical & Organizational design and a model for the design of agile manufacturing enterprise. Enterprise design process insights into design processes, what is interdisciplinary design, main issues, simple design example.

   Integration of Product /Process Development: Principles, Robust design approach, Approaches to enhance ability in manufacturing, Role of QFD, Managing people in Agile organization, Approaches.

   12 Hours

3. **Application of IT/IS Concepts In Agile Manufacturing:** Strategies, Management of complexities and information. flow, approaches, applications of multimedia to improve agility in manufacturing, system concepts.

   Agile Supply Chain Management: Principles, IT/IS concepts in supply chain management, enterprise integration and management in agile manufacturing, concepts, Agility, Adaptability and learners – comparison of concepts.

   12 Hours

4. **Computer Control Of Agile Manufacturing:** CAPP for Agile Manufacturing, Aggregate capacity planning and production line design / redesign in Agile manufacturing, Cellular manufacturing, concepts, examples.

   Corporate Knowledge Management In Agile Manufacturing: Strategies, strategic options in Agile manufacturing, Role of standards.

   12 Hours

5. **Design of Skill & Knowledge**: Enhancing technology for Machine tool system, Resumption of design requirement geometry, definition, methods, decision support for selection of cutting parameters, design enhancements, parametric approach only.

   6 **Hours**

TEXT BOOKS:

1. 'Agile Manufacturing- Forging Mew Frontiers',Poul T Kidd**,** Amagow Co. UK, ISBN-0-201-63163-6, 1994.

2. ''Agile Manufacturing", A Gunasekharan, the 21st CenturyCompetitive strategy, ISBN -13 978-0-08-04 3567-1, Elsevier Press, India.

REFERENCE BOOKS:

1. O Levine Transitions to Agile Manufacturing, Joseph C Moutigomery and Lawrence – Staying Flexible for competitive advantage, ASQC quality press, Milwaukee. Wisconsin, USA, 1996.

2. Agile Development for Mass Customization, David M Anderson and B Joseph Pine, Irwin Professional Publishing, Chicago, USA, 1997.

Course Outcomes:

Students will be able to:

1. Understand conceptual frame work of agile manufacturing environment.
2. Get insight into Enterprise design process, apply interdisciplinary design concepts.
3. Develop characteristic difference between lean manufacturing and agile manufacturing and appreciate benefits that can be derived by adopting newer manufacturing strategies.

MODELING OF MANAGEMENT INFORMATION SYSTEMS

(Common to MCM,MAR,IAE)

Sub Code	: 16MCM155	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objectives:

Introduce various aspects of MIS as applied to engineering problems in a systematic manner, Impart the knowledge of fundamentals of data base, business applications.

Course Content:

1. **Information Basics:** Definition of information system, classification of IS, Need for Information system, Contemporary approaches to information system, Key system applications in the organization, Challenges of information systems. Impact of IT, IS for Knowledge work. **Managing with Information and its Resources:** Managing in 21st Century, Strategic planning and IS, Information needs for strategic planning, IS for decision support, Quality and privacy issues. Information resource management, strategic planning for IS function, justification for IS, IT/IS facilities and operations, security control and Audit.

   12 Hours

2. **Information systems and Organizations:** Relationship between organizations and information systems, feature of organizations, effect of organizations on information systems, effect of information systems on organizations.

   Information, Management and Decision-making: Role of managers, Decision making, Individual models of decision-making, Organizational models of decision-making.

   12 Hours

3. **Information System Development:** system development life cycle and methodologies, principles of system design. System analysis- Definition, Strategies and Phases.

   Object Oriented Technology: Object orientation, object oriented analysis (OOA), system development through OOT, Object Oriented Languages. OOT and MIS.

   12 Hours

4. **System modeling:** Introduction to system modeling, system concepts for data modeling, logical data modeling, and construction of data model. Process modeling: Introduction to process modeling, system concepts for process modeling, data flow diagram, logical process modeling, construction of process model.

   8 Hours

5. **Decision Support Systems:** DSS issues, Structure Constructions-approaches, generators, tools, software and cost benefits and simple examples of applications.

   6 Hours

Text Books:

1. **Management information systems organization and technology,** 4th edition - Kenneth C.Laudon and Jane P.Laudon, **,** Prentice Hall India/Pearson Education.
2. **Systems analysis and design methods, 4th edition -** Jeffery L.Whitten and Lonnie D.Bentley, Tata McGraw Hill.

Reference Books:

1. **Management Information Systems-Conceptual foundations, Structure and development -** Davis.G.B, McGraw Hill Intl.Book.Co.
2. **Management Information Systems -** Robert Schulties and Marry summer, Tata McGraw Hill Publishing Co., Ltd. New Delhi.

3. **Management Information System- A Concise Study** - S.A.Kelkar, PHI.
4. **Management Information systems -** W.S Jawadekar, TMH
5. **Information System for modern management -** Murdick Ross &Claggett ,PHI.

Course Outcomes:

Students will be able

1. To understand fundamentals of MIS and be able to compare it with other approaches.
2. Identify and utilize fundamentals of data base management as applied to the respective tasks.
3. Demonstrate the ability to define and formulate the properties and characteristics of data base management by any engineer.

MODERN CONTROL ENGINEERING

(Common to MCM,MAR,IAE)

Sub Code	: 16MCM156	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objectives

- Students get exposure to various control techniques used in industrial automatic controls with various response and system compensation methods.

1. Introduction to Automatic Controls: Representation of Control Components, Representation of Control Systems, Characteristic functions, Steady-State Operation, Laplace Transforms, Basic Control Actions and Industrial Automatic Controllers.

6 Hours

2. The Root-Locus Method: - Introduction, Root Locus Plots, Illustrations, General rules for Constructing Root Loci, Root Locus Analysis of Control Systems, Transport Lag and Root contour Plots.

8 Hours

3. Frequency Response Methods:- Introduction, Frequency Response, Logarithmic Representation, Evaluating the Gain K, Equivalent Unity-Feedback Systems.

Polar Plots, M Andα Circles, Correlation between Transient and Frequency Response, Determining the Gain K to Yield a Desired M_p, Relative Stability.

12 Hours

4. System Compensation: Nyquist Stability Criterion, Gain Margin and Phase Margin, Lead Compensation, Lag Compensation, Lag-Lead Compensation.

State-Space Methods: - Introduction, Basic materials in State-Space Analysis, Transfer Matrices, Controllability, Observability, System Representation, Signal Flow Graphs, Solution of State-Space Equations, Transform Functions and Multivariable Systems.

16 Hours

5. Digital Control Systems: - Sampled-Data Systems, The Z Transform, Inverse Z Transforms, Block-Diagram Algebra, Transient Response, Filters.

Discrete Data Systems, Sampled-Data Control Systems, Computer-Controlled Systems.

10 Hours

Text Books:

1. **Automatic Control Engineering -** Francis H. Raven, McGraw- Hill International.
2. **Modern Control Engineering -** K. Ogata, **,** PHI.

Reference Books:

1. **Automatic Control Systems -** B.C. Kuo, Prentice hall.
2. **Automatic Control Systems -** Harrison & Bollinger, International Text Book Company.
3. **Feed Back Control System -**Schaum's Series, McGraw Hill.
4. **Control Systems -**Gopal, McGraw Hill.
5. **Solutions & Problems -** Jairath, CBS Publications
6. **MATLAB for Mechanical Engineers -** Rao V. Dukkipati, 1st Edition, New Age International Publishers, 2008

Course Outcomes:

Students will be able to understand various control techniques used in modern engineering control system

Manufacturing Engineering Lab 1

Sub Code : 16MCM16	IA Marks :20
Hrs/ Week : 6	Exam Hours : 03
Total Hrs:84	Exam Marks :80

Note:

- The focus is on experimental investigations on one or more topics identified below.
- Physical experiments as well as numerical experiments are welcome.
- Parametric studies and correlation studies are implied.
- Each student must prepare and submit a comprehensive report on the problems investigated and give a presentation on the same for Internal evaluation.
- Any one of the exercises done from the following list has to be asked in the Examination for evaluation.

1. Optimizing machining time to produce mild steel components on a CNC turning Centre.
2. Characterize surface roughness of High carbon steel using a grinding machine.
3. To determine power required to machine a chosen component and evaluate suitability of the machine to manufacture the same.
4. To compare surface characteristics produced by conventional and CNC turning machines.
5. To Estimate the accuracy of taper produced on a shaft by grinding.
6. To measure cutting forces during machining of High carbon steel and optimize machining parameters.
7. To optimize a single point cutting tool for machining HC steel and to arrive at parameters like rake angle, relief angle, nose radius etc.
8. To study type of chips produced in machining Al/Composites materials/ HC alloy steels and to characterize chip thickness.
9. Construction of merchant circle diagram for turning operation of mild steel and to compute power requirement for turning operation.
10. Perform cutting/drilling/turning operations on mild steel/ high carbon steel/ composite material components and estimate power required for cutting/drilling/turning.

(Ex: for the hole, dia& feed values are provided, Student has to find the volume of metal removed and energy consumed)

11. Determine the true taper and actual taper mathematically and perform turning operations (roughing cuts) on lathe and estimate the tool life of tool on similar cuts at different speeds.

ELECTIVE-II

16MAR251	Intelligent Instrument and Management	16MCM253	Advanced Mechatronics
16MCM252	Concurrent Engineering and product life cycle management	16MAR254	Micro electro mechanical system

ROBOTICS FOR INDUSTRIAL AUTOMATION

(Common to MCM MAR, IAE)

Sub Code	: 16MAR21	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objectives:

- This course is an attempt to provide a more updated view of the available tools and technique for kinematics, dynamics and control system on various kinds of robot manipulator.
- Study of various applications

Course Content:

Module 1. Introduction: Automation and Robotics, Historical Development, Definitions, Basic Structure of Robots, Robot Anatomy, Complete Classification of Robots, Fundamentals about Robot Technology, Factors related to use Robot Performance, Basic Robot Configurations and their Relative Merits and Demerits, Types of Drive Systems and their Relative Merits, the Wrist & Gripper Subassemblies. Concepts and Model about Basic Control System, Transformation and Block Diagram of Spring Mass System, Control Loops of Robotic Systems, PTP and CP Trajectory Planning, Different Types of Controllers, Control Approaches of Robots. **10 Hours**

Module 2. End Effectors And Robot Controls: Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, cam type-Magnetic grippers-Vacuum grippers-Air operated grippers-Gripper force analysis-Gripper design-Simple problems-Robot controls-Point to point control, Continuous path control, Intelligent robot-Control system for robot joint-Control actions-Feedback devices-Encoder, Resolver, LVDT-Motion Interpolations-Adaptive control. **10 Hours**

Module 3. Time and Motion: Trajectories, Smooth One-Dimensional Trajectories, Multi Dimensional Case, Multi-Segment Trajectories, Interpolation of Orientation in 3D, Cartesian Motion, Time Varying Coordinate Frames, Rotating Coordinate Frame, Incremental Motion, Inertial Navigation Systems. Mobile Robot Vehicles, Mobility, Car-like Mobile Robots, Moving to a Point, Following a Line, Following a Path, Moving to a Pose. SLE: Flying Robots. **10Hours**

Module 4. Robot Arm Kinematics: Describing a Robot Arm, Forward Kinematics, A 2-Link Robot, A 6-Axis Robot, Inverse Kinematics, Closed-Form Solution, Numerical Solution, Under Actuated Manipulator, Redundant Manipulator, Trajectories, Joint-Space Motion, Cartesian Motion, Motion through a Singularity.
10Hours

Module 5. Robot Sensing & Vision: Various Sensors and their Classification, Use of Sensors and Sensor Based System in Robotics, Machine Vision System, Description, Sensing. Programming – powered, manual. Textual robo languages – first generation, second, future generation – VAL, VAL II, simple programming – exercises
10 Hours

Course outcomes:

1. Upon completion of the course, students will be able to understand importance of robotics in today and future goods production
2. Robot configuration and subsystems, principles of robot programming and handle with typical robot.

Text Books:

1. S.R. Deb, **Robotics Technology and flexible automation**, Tata McGraw-Hill Education., 2009
2.Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta,
3.**Industrial Robotics, Technology programming and Applications**, McGraw Hill, 2012.

Reference Books

1."A Robot Engineering Textbook "– Mohsen Shahinpoor – Harper & Row publishers, New York, 1987.
2."Robotics, control vision and intelligence ," Fu, Lee and Gonzalez. McGraw Hill International, 1987.
3."Introduction to Robotics:Mechanics and Control", John J. Craig, Pearson, 3e, 2009

Scheme of Examination:
Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

FLEXIBLE MANUFACTURING SYSTEMS
(Common to MCM MAR,IAE)

Sub Code	: 16MCM22	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Learning Objectives:

To make student understand

1. the need for flexibility in manufacturing industries
2. to learn the development and implementation of an FMS
3. to learn the different types of automated material handling systems its design and calculations for different applications both AS/RS

Course Content:

Module 1.Introduction Flexible and rigid manufacturing, F.M. Cell and F.M. System concept, Types and components of FMS, Tests of flexibility, Group Technology and FMS, unmanned factories, Economic and Social aspects of FMS. **10 Hours**

Module 2.Control structure of FMS: Architecture of typical FMS, Automated work piece flow, Control system architecture – Factory level, Cell level; hierarchical control system for FMS, LANs - characteristics, transmission medium, signaling, network topology, access control methods; Factory networks, Structure and functions of manufacturing cell, Distributed Numerical Control (DNC) **10Hours**

Module 3. Scheduling & Loading Of FMS: Introduction, Scheduling of operations on a single machine, 2 machine flow shop scheduling, 2 machine job shop scheduling, 3 machine flow shop scheduling, scheduling 'n' operations on 'n' machines, Scheduling rules, loading problems , Tool management of FMS, material Handling system schedule. Problems. **10Hours**

Module 4.Tooling in FMS: Modern cutting tools and tool materials, tool holders, modular tooling, tool monitoring, presetting and offsets, wear and radius compensation, tool magazines, automatic tool changers, robotized tool assembly, tool management system **10 Hours**

Module 5.Fixturing in FMS: Part holding on Pallets, standard fixtures, pallet changers, pallet pool, flexible fixturing – principles and methodologies, modular fixturing system: T slot based, dowel pin based, fixturing components, computer aided fixture design – locating and clamping, use of GT in fixture design, fixture database **10Hours**

Course outcome:

1. The students will get a clear idea of importance of an FMS system in present manufacturing world
2. The student will learn the different types of FMS layouts, material handling and retrieval systems ,they will be able to solve the sequencing problems for different cases and tool management

Text Books

1. Groover, Mikell P. (2002), 2/e, **" Automation, Production Systems & Computer Integrated Manufacturing",** Pearson Education or PHI
2. Viswanadhan, N. & Narahari, Y. (1998), **"Performance Modelling of Automated Manufacturing Systems",** PHI
3. Pinedo, Michael & Chao, Xiuly (1999), **"Operations Scheduling with Applications in Manufacturing & Services",** McGraw Hill International Editions (with 2 Floppy Disks of LEKIN Scheduling Software)

Reference Books

1. Kelton, Sadowsky & Sadowsky, "Simulation with ARENA",2/e, McGraw Hill International Editions (with CD of ARENA Simulation Software)
2. Radhakrishnan, Subramanyan, "CAD / CAM / CIM", John Wiley
3. Rao, PN, Tewari NK, Kundra TK, "Computer Aided Manufacturing", TMH
4. Rong, Yeming; "Computer Aided Fixture Design", Marcel Dekker, ISBN 0-8247-9961-5
5. Hobbs, "Lean Manufacturing Implementation", J. Ross Publishing, ISBN 1-932150-14-2
6. Chowdiah, Gargesa & Kumar, "Agile Manufacturing", TMH

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

COMPUTER CONTROL OF MANUFACTURING SYSTEMS
(Common to MCM, MAR, IAE)

Sub Code	: 16MCM23	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objectives:

1. To impart the basic concepts in manufacturing systems and fundamentals of NC & CNC system
2. Knowledge enhancement in design consideration and increasing productivity with NC machine tools, machining centers and tooling for CNC machines
3. To enhance students awareness in system devices that include feedback devices, counters, DAC converters and interpolators

Course Content:

Module 1.Introduction to Computer integrated Manufacturing Systems: Manufacturing Systems, Types of Manufacturing Systems, , Machine Tools and related equipment's, Material Handling Systems, Computer monitoring and control, Manufacturing support systems, The Product Cycle and CAD/ CAM, Functions of computers in CIMS: CIMS Data Files, System Reports, Benefits of Computer integrated Manufacturing Systems,

Fundamentals of Numerical Control: Basic concepts of NC, Classification of NC- Point to Point and contouring, Incremental and absolute system, Open loop and closed loop system, Advantages of NC. **10 Hours**

Module 2. NC/ CNC Machine Tools: General architecture of CNC Machine, Components of the CNC Systems: Machine Control Unit , CNC Driving system components: Hydraulic, Servo Motors, Stepper Motors, Feedback Devices: Encoder, Resolver, Inductosyn, Tachometers, Counting devices.

Constructional Features of CNC Machines: Design considerations of CNC machines for improving machining accuracy, Structural Members, Slide ways, bearings, Re-circulating ball Screws, Spindle drives, Work holding devices and tool holding devices, Automatic tool changers.

10 Hours

Module 3. N.C part programming: Introduction, NC/ CNC programming methods: Manual part programming for turning and milling centers, G codes, M codes, canned cycles, Programming with CAD/CAM integration, CAM packages for CNC part program generation, Practical Exercises on CNC part programming.

Computer Controls in NC: CNC Technology: Functions of CNC Control in Machine Tools, Advantages of CNC, Direct Numerical Control(DNC Systems): Configuration of DNC system, Functions of DNC, Communication between DNC computer & MCU, Advantages of DNC,

10 Hours

Module 4. **Adaptive control**: machining systems. Adaptive control optimization system,

adaptive control constraint system, applications to machining processes, Benefits of Adaptive control Machining.

Industrial Robotics: Robotics technology : Types of Robots, Robot Technology Levels, Robot geometric configurations and Technical Features, basic robot motions, Robot control systems, robot drive systems, Work-cell control and Interlocks, robot sensors, robot safety,
Robot-computer interface, industrial robot applications and benefits.

. **10 Hours**

Module 5: Computerized Manufacturing Planning and Control Systems: Computer aided process planning, Variant and Generative approaches, Computer integrated production planning and control systems, Typical production planning and control system, Material planning systems, Capacity planning, Shop Floor Control, Automatic identification, Automated data collection systems. **10 Hours**

Course Outcome:

1. Students will get clear understanding Of NC/CNC machines
2. Various elements of CNC machines and its uses, Constructional features of CNC machine Tools
3. Knowledge of CNC programming and its implementation.

TEXT BOOKS:

1. GROOVER M P, **Automation, Production Systems and Computer Integrated Manufacturing -**, Prentice Hall India (P) Ltd, 1989.
2. Mikell P. Groover and Emory W. Zimmer, Jr., **CAD/CAM Computer Aided Design and Manufacturing,** Prentice Hall India (P) Ltd, 1992. (unit 1)
3. M. Koren **—Computer Controls of Manufacturing Systems,** McGrawHill, 1983

REFERENCE BOOKS:

1. Martin J. **—Numerical control of machine tools".**
2. P.N. Rao – CAD/CAM **Principles and Applications**McGrawhill 2002
3. Y. Koren&J.Benuri **-"Numerical control of machine tools** -Khanna, 1992
4. Wilson F.M **—Numerical control in manufacturing**- McGraw Hill Newyork
5. Suk-Hwan Suh, Seong-Kyoon Kang, Dea-Hyuk Chung and Ian Stroud, **Theory and Design of CNC Systems**, , Springer, 2008

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

NON-TRADITIONAL MACHINING
(Common to MCM, MAR, IAE)

Sub Code	: 16MCM24	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course objectives:

1. To demonstrate the need for development of newer/ non-traditional machining processes.
2. The student will be able to identify different energy sources like fluid motion, electric current, high speed electrons, high energy radiation, etc.
3. To analyze the concept, mechanism, parameters associated with the processes.
4. To demonstrate the operational principles, advantages applications, limitations of the various non-traditional machining processes.

Course Content:

Module 1. Introduction: Need for non-traditional machining processes, Process selection, classification, comparative study of different processes.
Ultra Sonic Machining: Definition, Mechanism of metal removal, elements of the process, Tool feed mechanisms, Theories of mechanics, effect of parameters, Different types of concentrators, horn design, applications, Limitations **.**
Abrasive Jet Machining: Principle, Process parameters, Influence of process parameters on MRR , applications, advantages and disadvantages. **10 Hours**

Module 2. Water Jet Machining: Principle, Equipment, Operation, Application, Advantages and limitations of water Jet machinery.
Thermal Metal Removal Processes: Electric discharge machining, Principle of operation, mechanism of metal removal, basic EDM circuitry, spark erosion generators, Analysis of relaxation type of circuit, material, removal rate in relaxation circuits, critical resistance parameters in Ro Circuit, Die electric fluids, Electrodes for spark erosion- surface finish, applications. **10 hours**

Module 3. Electro Chemical machining (ECM): Classification of ECM process, Principle of ECM, Chemistry of the ECM process, parameters of the process, 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, Electrochemical deburring.

10 Hours

Module 4. Chemical Machining: Introduction, fundamental principle types of chemical machining, Maskants, Etchants, Advantages and disadvantages, applications
Plasma arc Machining: Introduction, Plasma, Generation of Plasma and equipment, Mechanism of metals removal, PAM parameters, process characteristics, types of torches, applications
Electron beam machining (EBM): Introduction, Equipment for production of Electron beam, Theory of electron beam machining, Thermal & Non thermal type, Process characteristics, applications. **10 Hours**

Module 5 . Laser Beam Machining: Introduction, principles of generation of lasers, Equipment and Machining Procedure, Types of Lasers, Process characteristics, advantages and limitations, applications of laser beam machining.
Ion Beam Machining: principle, equipment, working, sputtering rate, applications.
High Velocity forming processes: Introduction, development of specific process, selection, comparison of conventional and high velocity forming methods.
Types of high velocity forming methods: explosion forming process, electro-hydraulics forming, magnetic pulse forming. Applications, Advantages and limitations. **10Hours**

Course Outcomes:
1. Student will be in a position to appreciate the merits of nontraditional machining and its application in Industries.
2. Justify and demonstrate the benefits of non-traditional machining processes over traditional machining processes. Students will be able to decide a process suitable for a particular material based on the availability of the sources.

Text Books:
1. **Modern Machining Process -** P.C Pandy& H.S Shan Tata McGraw Hill.
2. **Modern Machining Processes -** P.K Mishra
3. **Thermal Metal Cutting Processes**-Dr.B.J.Ranganath,I K International,New Delhi.

Reference Books:

1. **New technology -** Bhattacharya, Institution of Engineers, India
2. **Production technology -** HMT Tata McGraw Hill.
3. **Metals hand book** - ASM Vol-3.
4. **High velocity forming of metals -** F.M Wilson ASTME PreticeHall.
5. **Modern Manufacturing Methods -** Adithan

Scheme of Examination:
Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

Elective II

FLUID POWER AUTOMATION
(Common to MCM, MAR, IAE)

Sub Code	: 16MAR251	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course Objectives

To make the students to learn the basic concepts of hydraulics and pneumatics and their controlling elements in the area of manufacturing process. To train the students in designing the hydraulic and pneumatic circuits using various design procedures.

Module 1. Introduction Need for Automation, Hydraulic & Pneumatic Comparison – ISO symbols for fluid power elements, Hydraulic, pneumatic ,application in different filed , advantage, disadvantage , Selection criteria. **10 Hour**

Module 2. Fluid Power Generating/Utilizing Elements Hydraulic pumps and motor gears, vane, piston pumps-motors-selection and specification-Drive characteristics – Linear actuator – Types, mounting details, cushioning – power packs – construction. Reservoir capacity, heat dissipation, accumulators – standard circuit symbols, circuit (flow) analysis. **10Hour**

Module 3. Control And Regulation Elements Direction flow and pressure control valves-Methods of actuation, types, sizing of ports-pressure and temperature compensation, overlapped and under lapped spool valves-operating characteristics electro hydraulic servo valves-Different types-characteristics and performance. **10Hour**

Module 4. Circuit Design Typical industrial hydraulic circuits-Design methodology – Ladder diagram-cascade, method-truth table-Karnaugh map method-sequencing circuits-combinational and logic circuit. **10Hour**

Module 5. Electro Pneumatics & Electronic Control Of Hydraulic And Pneumatic Circuits Electrical control of pneumatic and hydraulic circuits-use of relays, timers, counters, Ladder diagram. Programmable logic control of Hydraulics Pneumatics circuits, PLC ladder diagram for various circuits, motion controllers, use of field busses in circuits. Electronic drive circuits for various Motors**.** **10Hour**

Course outcome

Student has to gain the knowledge about hydraulics pneumatics, and their application in different filed ,different circuit, adoption of hydraulics pneumatics in automation.

Text book

1. W.Bolton, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering Pearson Education, 2003.
2. Peter Rohner, Fluid Power Logic Circuit Design, Mcmelan Prem, 1994.

References Text Book

1. Antony Esposito, Fluid Power Systems and control Prentice-Hall, 1988

2. E.C.Fitch and J.B.Suryaatmadyn. Introduction to fluid logic, McGraw Hill, 1978

3. Peter Rohner, Fluid Power logic circuit design. The Macmillan Press Ltd.,London, 1979

4. Herbert R. Merritt, Hydraulic control systems, John Wiley & Sons, Newyork, 1967 7. Dudbey. A. Peace, Basic Fluid Power, Prentice Hall Inc, 1967

Scheme of Examination:
Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

Elective II

CONCURRENT ENGINEERING AND PRODUCT LIFE CYCLE MANAGEMENT
(Common to MCM, MAR, IAE,)

Sub Code	: 16MCM252	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course objectives

1. The graduates shall have the ability to understand the importance of product design in leveraging both manufacturing cost and product lifecycle cost.
2. The graduates shall have the ability to plan and implement a product development program.
3. The graduates shall have the ability to participate in multi-discipline Integrated Product Development teams.

Module 1. Introduction: Extensive definition of Concurrent Engineering(CE),CE design methodologies, Review of CE techniques like DFM (Design for manufacture), DFA(Design for assembly),QFD (Quality function deployment), RP (Rapid prototyping), TD (Total design), for integrating these technologies, organizing for CE, CE tool box, Collaborative product development. **10 Hour**

Module 2. Use of Information Technology: IT Support Solid modeling, product data management, Collaborative product commerce, Artificial Intelligence, expert systems, Software hardware component design**.** **10 Hour**

Module 3. Design Stage: Lifecycle design of products, opportunities for manufacturing enterprises, Modality of Concurrent engineering design, Automated analysis idealization control, CE in optimal structural design, Real time constraints**.** **10 Hour**

Module 4. Need for PLM: Importance of PLM, Implementing of PLM, Responsibility for PLM, Benefits to different managers, Components of PLM, Emergence of PLM, Life cycle problems to resolve, Opportunities to seize**.** **10 Hour**

Module 5. Components of PLM: components of PLM, Product lifecycle activities, Product organizational structure, Human resources in product lifecycle, Methods, techniques, practices, Methodologies, Processes, System components in lifecycle, slicing and dicing the systems, Interfaces, Information, Standards. **10 Hour**

Course outcome

1. The graduates shall have the ability to determine customer needs and define product specifications that meet professional ethical standards.
2. The graduates shall have the ability to define product architecture and design products for maximum economic impact.
3. The graduates shall have the ability to design and conduct experiments to ensure that the product design is robust and compatible with the capability of the manufacturing process.

Text Book

1. Integrated Product Development / M.M .Anderson and L.Hein/ IFS Publications
2. Design for Concurrent Engineering/ J Cleetus/ CE Research Centre, Morgantown,
3. Concurrent Engineering Fundamentals/ Prasad / Prentice hall India Integrated Product Development 4. Concurrent Engineering in product Design and Development/ I.Moustapha / New age International

REFERENCE BOOK

1.Product Life Cycle Management/ John Stark/ Springer –Verlag/ UK
2. Product Lifecycle Management/ Michael Grives/ Mc Graw Hill
3. Concurrent Engineering: Automation tools and Technology/Andrew Kusiak/ Wiley Eastern Technology

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

Elective II

ADVANCED MECHATRONICS

(Common to MCM, MAR, IAE)

Sub Code	: 16MCM253	***IA Marks***	: 20
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	Exam Marks	: 80

Course objectives

1. Have a strong foundation in science and focus in mechanical, electronics, control, software, and computer engineering, and a solid command of the newest technologies.
2. Be able to design, analyze, and test "intelligent" products and processes that incorporate appropriate computing tools, sensors, and actuators.

Module 1. Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion , force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors. **10 Hour**

Module 2. Solid state electronic devices, PN junction diode, BJT, FET, DIA and TRIAC. Analog signal conditioning, amplifiers, filtering. Introduction to MEMS & typical applications **10 Hour**

Module 3. Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems: Mechanical actuating systems and electrical actuating systems.**10 Hour**

Module 4.Digital electronics and systems, digital logic control, micro processors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control**.** **10 Hour**

Module 5. System and interfacing and data acquisition, DAQS , SCADA, A to D and D to A conversions; Dynamic models and analogies, System response. Design of mechatronics systems & future trends. **10 Hour**

Course outcome

1. Select and apply the knowledge, techniques, skills and modern tools in mechatronics engineering technology.

2. Apply concepts of circuit analysis, analog and digital electronics, automation and controls, motors, electric drives, power systems, instrumentation, and computers to aid in the design, characterization, analysis, and troubleshooting of mechatronics systems.

Text Book

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran & GK Vijaya Raghavan/WILEY India Edition/2008
2. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005.
3. Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.

REFERENCE BOOK:

1. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
2. Mechatronics System Design / Devdas shetty/Richard/Thomson.
3. Mechatronics/M.D.Singh/J.G.Joshi/PHI.
4. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition, Pearson, 2012 W. Bolton 8. Mechatronics – Principles and Application Godfrey C. Onwubolu, Wlsevier, 2006 Indian print.

Scheme of Examination:
Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

Elective II

MICRO ELECTRO MECHANICAL SYSTEMS
(Common to MCM MAR, IAE)

Sub Code	:	16MAR254	***IA Marks***	:	20
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	80

Course Objective:
Students get exposure to various Micro Electronic Mechanical systems which find extensive usage in Industrial applications

Module 1. Introduction: Micro Electro-Mechanical Systems, Ultra Precision Engineering, Micro-sensors; Micro-actuators; Microelectronics Fabrication; Micromachining; Mechanical MEMS; Thermal MEMS : MOEMS; Magnetic MEMS; RF MEMS; Micro-fluidic Systems; Bio and Chemo – Devices; MEMS Packages and Design Considerations; Micro-Instrumentation.
10 Hours

Module 2. Microfabrication and Micromachining: Integrated Circuit Processes, Bulk Micromachining: Isotropic Etching and Anisotropic Etching, Wafer Bonding, High Aspect-Ratio Processes
Mechanical Sensors and Actuators: Principles of Sensing and Actuation; Beam and Cantilever; Microplates; Capacitive Effects; Piezoelectric material as Sensing and Actuating Elements; Strain Measurement; Pressure measurement; Flow Measurement using Integrated Paddle – Cantilever Structure; Pressure Measurement by Microphone; Shearmode Piezoactuator; Gripping Piezoactuator; Inchworm Technology. **10 Hours**

Module 3.Thermal and Fluidic Micro Sensors and Actuators : Thermal sensors, Electrical Sensors, Chemical and Biosensors Electromagnetic and Thermal microactuation, Mechanical design of microactuators, Microactuator examples, Micro Fluidic systems, Fluid actuation methods, microvalves, micropumps, micromotors-Microactuator systems : Ink-Jet printer heads, Micro-mirror TV Projector. **10 Hours**

Module 4. Surface Micromachining: One or two sacrificial layer processes, Surface micromachining requirements, Polysilicon surface micromachining, Other compatible materials, Silicon Dioxide, Silicon Nitride, Piezoelectric materials, Surface Micromachined Systems: Success Stories, Micromotors, Gear trains, Mechanisms.
10 Hours

Module 5. MEMS: Characterization: Technologies for MEMS characterization, Scanning Probe Microscopy (SPM): Atomic Force Microscopy (AFM), Scanning tunneling microscopy (STM), Magnetic Force Microscopy, Scanning Electron Microscope, Laser Doppler vibrometer, Electronic Speckle Interference Pattern technology (ESPI). **10 Hours**

Course Outcome:
Students will be in a position to demonstrate their knowledge in micro machining and micro electro mechanical systems

Text Books:

1.Rai-Choudhury P. MEMS and MOEMS Technology and Applications, PHI Learning Private Limited, 2009.

2.Stephen D. Senturia, "Microsystem Design" Springer, 2001.

3.MarcMadou, "Fundamentals of Microfabrication" Tay lor & Francis Group, 2002.

4.Gregory Kovacs, "Micromachined Transducers Source book" McGraw Hill 1998.

Reference Books

1.M.H. Bao, "Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes" Handbook, Elsevier.

2.NadimMaluf, An Introduction to Microelectromechanical Systems Engineering, Artech House Publishers, 2000.

3.Stephen D. Senturia, "Microsystems Design" Kluwer Academic Publishers, New York.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

Manufacturing Engineering Lab 2

Sub Code : 16MCM26 IA Marks :20

Hrs/ Week: 3 Exam Hours : 03

Total Hrs: 42 Exam Marks :80

Note:

- The focus is on experimental investigations on one or more topics identified below.
- Physical experiments as well as numerical experiments are welcome.
- Parametric studies and correlation studies are implied.
- Each student must prepare and submit a comprehensive report on the problems investigated and give a presentation on the same for internal evaluation.
- Any one of the exercises done from the following list has to be asked in the Examination for evaluation.

Exercises:

1. Study waviness produced by grinding process and characterize the resulting surface.
2. Develop and implement a program for pick and place of an object by a robot.
3. Modeling and simulation using MATLAB of a vibration control system and to draw time response/ frequency response curves.
4. Kinematic analysis of forward/reverse linkages of robots using MATLAB (Denavit-Hartenberg convention).
5. Trajectory planning of robots using MATLAB.
6. Design and analysis of PID controller for mechanical engineering applications using MATLAB.
7. Reduce MLT using Lean principles that are followed in major industries (using case studies and data from industries and make a proposal for redesigning existing machine shop).
8. To develop a CIM Layout consisting of 3 machining centers, one AGV and 3 material handling robots. Layout developed must indicate complete CIM environment consisting of tool crib, raw material storage and finished product storage area. (using solid edge, Autocad or any other available software).

9. Monitoring of vibrations/noise of a machine tool and to compare it with industry standards. List the causes of variation and suggest remedial measures.
10. Detection, location and characterization of defects in castings / welds/ adhesive bonds.