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		
14MDE 11	Applied Mathematics	4	2	3	50	100	150	4
14MCM 12	Automation and Computer Integrated Manufacturing	4	2	3	50	100	150	4
14MCM 13	Computer Aided Design	4	2	3	50	100	150	4
14MAR 14	Automation in Manufacturing Systems	4	2	3	50	100	150	4
	Elective – I	4	2	3	50	100	150	4
14MCM16	Manufacturing Engineering Lab I	--	3	--	25	50	75	2
14MCM17	Seminar	--	3	--	25	--	25	1
	Total	**20**	**13**	**15**	**300**	**550**	**850**	**23**

ELECTIVE-I

14MCM151	Finite Element Method	14MCM154	Agile Manufacturing
14MCM152	Artificial Intelligence and Expert Systems	14MAR155	Modeling of Management Information Systems
14MCM153	Rapid Prototyping	14MAR156	Modern Control Engineering

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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		
14MAR21	Robotics for Industrial Automation	4	2	3	50	100	150	4
14MCM22	Flexible Manufacturing Systems	4	2	3	50	100	150	4
14MAR23	Computer Control of Manufacturing Systems	4	2	3	50	100	150	4
14MCM24	Non Traditional Machining	4	2	3	50	100	150	4
	Elective – II	4	2	3	50	100	150	4
14MCM26	Manufacturing Engineering Lab II		3	3	25	50	75	2
14MCM27	SEMINAR	--	3	--	25	--	25	1
	**PROJECT WORK PHASE-I COMMENCEMENT (6 WEEKS DURATION)	--	--	--	--	--	--	--
	Total	**20**	**13**	**15**	**300**	**550**	**850**	**23**

ELECTIVE-II

14MCM251	Advanced Materials Technology	14MCM253	Micro Electro Mechanical Systems
14MCM252	Mechatronics System Design	14MCM254	Microprocessors &Microcontrollers

**** Between the II Semester and III Semester, after availing a vacation of 2 weeks.**

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III SEMESTER : INTERNSHIP **CREDIT BASED**

Course Code	Subject	No. of Hrs./Week		Duration of the Exam in Hours	Marks for		Total Marks	CREDITS
		Lecture	Practical / Field Work		I.A.	Exam		
14MCM31	SEMINAR / PRESENTATION ON INTERNSHIP (AFTER 8 WEEKS FROM THE DATE OF COMMENCEMENT)	-	-	-	25	-	25	20
14MCM32	REPORT ON INTERNSHIP	-	-	-		75	75	
14MCM33	INTERNSHIP EVALUATION AND VIVA-VOCE	-	-	-	–	50	50	
	Total	**-**	**-**	**-**	**25**	**125**	**150**	**20**

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IV SEMESTER **CREDIT BASED**

Subject Code	Subject	No. of Hrs./Week		Duration of Exam in Hours	Marks for		Total Marks	CREDITS
		Lecture	Field Work / Assignment / Tutorials		I.A.	Exam		
14MAR41	Modeling, Simulation and Analysis of Manufacturing Systems	4	--	3	50	100	150	4
	ELECTIVE-III	4	-	3	50	100	150	4
14MCM43	EVALUATION OF PROJECT WORK PHASE-II	-	-	-	25	-	25	1
14MCM44	EVALUATION OF PROJECT WORK PHASE-III	-	-	-	25	-	25	1
14MCM45	EVALUATION OF PROJECT WORK AND VIVA-VOCE	–	-	3	-	100+100	200	18
Total		**12**	**07**	**09**	**150**	**400**	**550**	**28**
Grand Total (I to IV Sem.) : 2400 Marks; 94 Credits								

ELECTIVE-III

14MAR421	Computer Aided Production Operation Management	14MTE154	Tooling for Manufacture in Automation
14MCM422	Dynamics & Mechanism Design	14MAR424	Concurrent Engineering for Manufacturing

NOTE:

1.	Project Phase – I:6 weeks duration shall be carried out between II and III Semesters. Candidates in consultation with the guides shall carryout literature survey / visit to Industries to finalize the topic of dissertation
2.	Project Phase – II:16 weeks duration. 3 days for project work in a week during III Semester. Evaluation shall be taken during the first two weeks of the IV Semester. Total Marks shall be 25.
3.	Project Phase – III :24 weeks duration in IV Semester. Evaluation shall be taken up during the middle of IV Semester. At the end of the Semester Project Work Evaluation and Viva-Voce Examinations shall be conducted. Total Marks shall be 250 (Phase I Evaluation:25 Marks, Phase –II Evaluation: 25 Marks, Project Evaluation marks by Internal Examiner(guide): 50, Project Evaluation marks by External Examiner: 50, marks for external and 100 for viva-voce). Marks of Evaluation of Project: I.A. Marks of Project Phase – II & III shall be sent to the University along with Project Work report at the end of the Semester. During the final viva, students have to submit all the reports.
4.	The Project Valuation and Viva-Voce will be conducted by a committee consisting of the following: a) Head of the Department (Chairman)(b) Guide (c) Two Examiners appointed by the university. (out of two external examiners at least one should be present).

MANUFACTURING:

Computer Integrated Manufacturing (MCM),Industrial Automation and Robotics(MAR),Industrial Automation Engineering(IAE)

I SEMESTER

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

Sub Code	:	14 MDE11	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

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 .**14 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 :	14MCM12	IA Marks :	50
Hrs/ Week:	04	Exam Hours:	03
Total Hrs. :	50	Exam Marks:	100

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. **Comp**
   uter 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. **Funda**
   mentals 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	**:**	**14MCM13**	***IA Marks***	**:**	**50**
Hrs/ Week	**:**	**04**	**Exam Hours**	**:**	**03**
Total Hrs.	**:**	**50**	**Exam Marks**	**:**	**100**

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. **14 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). **06 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	:	14MAR14	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

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. **14 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	:	14MCM 151	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

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	:	14MCM 152	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

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.

14 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.

14 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	:	14MCM153	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

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.

14 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	:	14MCM154	***IA Marks***	:	50
Hrs/ Week	***:***	***04***	***Exam Hours***	***:***	***03***
Total Hrs.	***:***	***50***	***Exam Marks***	***:***	***100***

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	:	14MCM155	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

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	:	14MCM156	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

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.

14 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 : 14MCM16	IA Marks :25
Hrs/ Week : 6	Exam Hours : 03
Total Hrs:84	Exam Marks :50

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.

II Semester

ROBOTICS FOR INDUSTRIAL AUTOMATION
(Common to MCM,MAR,IAE)

Sub Code	:	14MAR21	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

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 and programming of industrial robots.

Course Content:

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

6 Hours

2. **Kinematics of Robot Manipulator**: Introduction, General Description of Robot Manipulator, Mathematical Preliminaries on Vectors & Matrices, Homogenous Representation of Objects, Robotic Manipulator Joint Co-Ordinate System, Euler Angle & Euler Transformations, Roll-Pitch-Yaw(RPY) Transformation, Relative Transformation, Direct & Inverse Kinematics' Solution, D H Representation & Displacement Matrices for Standard Configurations, Geometrical Approach to Inverse Kinematics. Homogeneous Robotic Differential Transformation: Introduction, Jacobian Transformation in Robotic Manipulation.

12Hours

3. **Robotic Workspace & Motion Trajectory:** Introduction, General Structures of Robotic Workspaces, Manipulations with n Revolute Joints, Robotic Workspace Performance Index, Extreme Reaches of Robotic Hands, Robotic Task Description. **Robotic Motion Trajectory Design:** – Introduction, Trajectory Interpolators, Basic Structure of Trajectory Interpolators, Cubic Joint Trajectories. General Design Consideration on Trajectories:-4-3-4 & 3-5-3 Trajectories, Admissible Motion Trajectories.

Dynamics of Robotic Manipulators: Introduction, Bond Graph Modeling of Robotic Manipulators, Examples of Bond Graph Dynamic Modeling of Robotic Manipulator. Brief Discussion on Lagrange–Euler (LE) Dynamic Modeling of Robotic Manipulators: - Preliminary Definitions, Generalized Robotic Coordinates, Dynamic Constraints, Velocity & Acceleration of Moving Frames, Robotic Mass Distribution & Inertia Tensors, Newton's Equation, Euler Equations, The Lagrangian& Lagrange's Equations. Application of Lagrange–Euler (LE) Dynamic Modeling of Robotic Manipulators: - Velocity of Joints, Kinetic Energy T of Arm, Potential Energy V of Robotic Arm, The Lagrange L, Two Link Robotic Dynamics with Distributed Mass, Dynamic Equations of Motion for A General Six Axis Manipulator.

14Hours

4. **Robot Teaching:** Introduction, Various Teaching Methods, Task Programming, Survey of Robot Level Programming Languages, A Robot Program as a Path in Space, Motion Interpolation, WAIT, SIGNAL & DELAY Commands, Branching, Robot Language Structure, various Textual Robot Languages Such as VAL II, RAIL, AML and their Features, Typical Programming Examples such as Palletizing, Loading a Machine Etc,

6 Hours

5. **Robot Sensing & Vision:** Various Sensors and their Classification, Use of Sensors and Sensor Based System in Robotics, Machine Vision System, Description, Sensing, Digitizing, Image Processing and Analysis and Application of Machine Vision System, Robotic Assembly Sensors and Intelligent Sensors.

Industrial Applications: Objectives, Automation in Manufacturing, Robot Application in Industry, Task Programming, Goals of AI Research, AI Techniques, Robot Intelligence and Task Planning, Modern Robots, Future Application and Challenges and Case Studies.

12 Hours

Text 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..

Reference Books:

1. **"Robotics for Engineers"**, YoramKoren, McGraw Hill International, 1985.
2. "**Industrial Robotics",**Groover, Weiss, Nagel, McGraw Hill International, 1986.
3. "**Robot Technology Fundaments**"- Keramas, Thomson Vikas Publication House, 1999.
4. **"Fundamentals of Robotics Analysis and Control**" -Schilling, PHI, 1990
5. **"Introduction to Robotics"**-Niku, Pearson Education, 2011.
6. **"Foundation of Robotics"**-Yoshikawa, PHI (EEE), 1990.
7. **"Robotic Engineering"** - An Integrated approach, Klafter, Chmielewski and Negin, PHI, 1989.
8. "Robot Vision and Sensor Controls"- Rooks B, Vol-3 North Holland.

Course Outcome:

Students will be able to

1. decide various parameters to be considered in designing manipulators and analyzing them
2. Know basic programming language of industrial robot.

FLEXIBLE MANUFACTURING SYSTEMS

(Common to MCM,MAR,IAE)

Sub Code	:	14MCM22	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

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
4. Concepts of group technology and cellular manufacturing.

Course Content:

1. Definition of an FMS – Types & configurations concepts – Types of flexibility & performance measures. Function of FMS host computer, FMS host and area controller function distribution.

Development and implementation of an FMS: Planning phase, Integration, System configuration, FMS layouts, Simulation, FMS Project development steps. Project management, Equipment development, Host system development, planning, Hardware & Software development.

12 Hours

2.Automated Material Handling Systems: Functions, Types, Analysis of material handling equipments, Design of Conveyor & AGV systems. Benefits of Automated material handling systems.Problems.

Automated Storages Systems: Storage system performance, AS/RS, Carousel storage system, WIP storage system, Interfacing handling storage with manufacturing, Problems.

12 Hours

3. Modelling And Analysis Of FMS: Need for FMS modeling, Analytical, Heuristics, Queuing simulation and Petrinet modeling techniques-scope applicability and limitations.

Group Technology and Cellular Manufacturing: Introduction,Part families, parts classification and coding, production flow analysis, Machine cell design, Benefits of Group Technology.

12 Hours

4. 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,

7 Hours

5. FMS Relational: Economic and technological justification for FMS, JIT: Operation and evaluation, Personnel and Infrastructural aspects, Typical case, Future prospects.

7 Hours

TEXT BOOKS:

1. **Flexible manufacturing -** Parrish D J, Butter Worth – Heinemann, Ltd Oxford, 1993.
2. **Production Systems and Computer Integrated Manufacturing -** GROOVER M P, Automation, Prentice Hall India (P) Ltd, 1989.
3. **Intelligent Manufacturing Systems** - Kusiak A, Prentice Hall, EnglewoodClitts, NJ, 1990.
4. **Flexible Manufacturing Cells & Systems -** William W. Luggen –Prentice hall, NJ.

REFERENCE BOOKS:

1. **Standard Handbook of Industrial Automation -** CONSIDINE D M, and CONSIDINE G D, Chopman and Hall, London, 1986.
2. **Performance Modeling of Automated Manufacturing Systems -** Viswanatham N &Narahari Y, Prentice Hall of India (P) Ltd, 1992.
3. **The design and Operation of FMS -** Ranky P G, IFS Pub. Uk, 1988.

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
3. They will be able to solve the sequencing problems for different cases and tool management.

COMPUTER CONTROL OF MANUFACTURING SYSTEMS

(Common to MCM,MAR,IAE,MTE)

Sub Code	:	14MCM23	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

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:

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,

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, Digital to analog converters. **12 Hours**

2. **Interpolations:** DDA integrators, simple and symmetrical DD reference word CNC interpolators. **Control loops for N C Systems:** Introduction-control loops for point and counting systems.

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: Principles of Operation, Machining Centres, Tooling for CNC machines.

12 Hours

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, Adaptive control machining systems. Adaptive control optimization system, adaptive control constraint system, applications to machining processes, Benefits of Adaptive control machining. **14 Hours**

4. **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, robot programming and programming languages. **6 Hours**

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. **6 Hours**

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

Course Outcome:

Students will get clear understanding

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

NON-TRADITIONAL MACHINING

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

Sub Code	:	14MCM24	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

Course learning 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 analyse 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:

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.
Water Jet Machining: Principle, Equipment, Operation, Application, Advantages and limitations of water Jet machinery.

12 Hours

2. 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.

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 ECMprocess, polarization, Tool Design, advantages and disadvantages-applications.Electro Chemical grinding, Electro Chemical honning, Electrochemical deburring.

14 Hours

3. Chemical Machining: Introduction, fundamental principle types of chemical machining, Maskants, Etchants, Advantages and disadvantages, applications, chemical blanking, chemical milling (contour machining), Hydrogen embrittlement.

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.

12 Hours

4. 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. CO_2 Laser: Principle, Equipment, Applications.
Ion Beam Machining: principle, equipment, working, sputtering rate, applications.

6 Hours

5. 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.

6 Hours

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

Course Outcomes:

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

Elective-II

ADVANCED MATERIALS TECHNOLOGY
(Common to MCM,MAR,IAE,MCS,MTE)

Sub Code	:	14MCM251	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

Course Objectives:
Students get an orientation into Newer Materials, Processing of Composites and analysis of composites, Nano Technology and Powder Metallurgy.

Course Content:

1 STRUCTURE-PROPERTY RELATIONS Introduction, Atomic structure, atomic bonds, secondary bonds, crystal structure, Miller indices, packing efficiency, crystal defects, grain structure, elastic and plastic deformation in single crystals, dislocation theory, strain /work hardening, plastic deformation in polycrystalline metals, fracture of metals, cold working, re crystallization and hot working, grain growth.

NEWER MATERIALS: Introduction, plastics, molecular structure, isomers, polymerization, thermosetting and thermoplastic materials, properties and applications of plastics. Ceramics, nature and structure, fine ceramics, properties and applications of ceramics. Composite materials – classification, matrix and reinforcement materials, properties, rule of mixtures, longitudinal strength and modulus (iso strain model), transverse strength and modulus (iso stress model), applications of composites. **13 Hours**

2. PROCESSING OF COMPOSITES: Liquid-state process, solid state process and in situ processes of MMC's. Slurry infiltration process, combined hot pressing and reaction bonding method, melt infiltration process, direct oxidation, isothermal chemical impregnation process and Sol-Gel and polymer pyrolysis of CMC's. Hand layup process, filament winding process, pultrusion process, pressure bag moulding, vacuum-bag moulding, autoclave moulding, injection moulding process and thermoforming process of PMC's.

METHODS OF ANALYSIS OF COMPOSITES: Micromechanics-Mechanics of material approach, elasticity approach to determine material properties. Macromechanics- Stress-strain relations with respect to natural axis, arbitrary axis and determination of material properties.Experimental characterization of laminates and particulate composites.
13 Hours

3.FAILURE ANALYSIS AND DESIGN OF COMPOSITES: Failure criterion for particulate and laminate composites. Design of laminated and particulate composites. Other mechanical design issues-Long term environmental effects, inter laminar stresses, impact resistance, fracture resistance and fatigue resistance.

NANO TECHNOLOGY: Introduction, concept of nanotechnology , nano science, nanomaterials (one, two and three dimensional), top down and bottom up constructions,

fabrication of carbon nano tubes (CNT), nano material characterization – scanning probe microscopy, atomic force microscopy, scanning tunneling microscopy, applications of nano technology. **13 Hours**

4. SURFACE TREATMENT: Introduction, Surface Engineering, Surface quality & integrity concepts, Mechanical treatment, Thermal spraying processes and applications, Vapour depositions processes and applications, Ion-treatment.

5 Hours

5. POWDER METALLURGY: Introduction, Steps in powder metallurgy, Production of Powder, Characterization & Testing of Powders, Powder Conditioning, Powder Compaction, Sintering, Finishing operations, Applications of PM components.

6 Hours

TEXT BOOKS:

1. E.PaulDegarmo, J.T.Black, Ronald A Kohser. , **Materials and Processing in Manufacturing** 8th Edition – Prentice Hall India.
2. K.K.Chawla, **Composite materials** – Science &Engineering,.Springer.
3. A.K. Sinha, **Powder Metallurgy** 2nd Edition –. DhanpatRai Publications.
4. Dr. H.K.Shivanand, **Composite Materials** by. Asian Publication.
5. AUTAR K.KAW ,**Mechanics of composite materials**,Taylor and Francis group.

Reference Books:

1. **Composite Materials, Science &Engg-** Krishan K. Chawla, 2nd edition, Springer publicat1on.
2. **ASM Handbook on Metal Casting** - Vol .15, 9th edition, ASM publication
3. **ASM Handbook on Powder Metallurgy -**Vol 17, ASM publications
4. **Nanotechnology – Basic Science and Emerging Technologies**, -Mick Wilson, KamaliKannangara, Overseas Press India Private Limited, First Indian Edition 2005.
5. V.S.R Murthy, A.K.Jena, K.P.Gupta, G.S.Murthy**Structure and Properties of Engineering Materials**, , Tata McGraw Hill.
6. M.M.Schwartz, **Composite Materials Hand book** –, McGraw Hill.
7. RakeshRath, **Nanotechnology**, S.Chand and company.

Course Outcomes:

Students will be able decide the application of various newer materials to engineering applications satisfying requirement of machinability,strength and weight requirements.

MECHATRONICS SYSTEM DESIGN
(Common to MCM,MAR,IAE)

Sub Code	:	14MCM252	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

Course Objectives

The course gives exposure to mechatronics system design and knowledge of MEMS and Microsystems

Course Content:

1. **Introduction:**Definition and Introduction to Mechatronic Systems, Measurement Systems, Control Systems, Microprocessors Based Controllers and Applications
Study of Actuation Systems: Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actuation Systems.

12 Hours

2. **Modeling for mechatronics system design :** Introduction, System, Mechanical System, Electrical System, Fluid system, Thermal System, Engineering system, Translational mechanical system with spring, damper and mass, Rotational mechanical system with spring, damper and mass , Modeling of electric motor, Chamber filled with fluid, Pneumatic actuator.

10 Hours

MEMS and Microsystems:

3. **Introduction** –Over view of MEMS and Microsystems. Working Principles of Microsystems Micro sensors, Micro actuation , MEMS With Micro actuators.
Materials for MEMS and Microsystems: Substrate and wafers, Active substrate material, Silicon, Silicon compound, Silicon Pezoresisters, Gallium Arsenide, Quartz, Piezoelectric crystals, Polymers.

10 Hours

4. **Micro System Fabrication Process:** Photolithography, Ion Implantation, Diffusion, Oxidation, CVD, PVD, Epitaxy, Etching.
Overview of Micro Manufacturing: Bulk Micro Manufacturing, Surface, Micromachining, The LIGA Process**.**

10 Hours

5. **Fault Finding :**Fault–Detection Techniques, Watch Dog Timer, Parity and Error Coding Checks, Common Hardware Faults, Microprocessor Systems, Emulation and Simulation, PLC Systems.

8 Hours

Text Books:

1. **Mechatronics** - W. Bolton, Pearson Edition
2. **MEMS and Microsystems design and manufacture**. HSU, TMH

Reference Books:

1. **Mechatronics System Design -** Shetty and Kolk, Thomson.
2. **Mechatronics -**Mahalik, TMH.
3. **Mechatronics -** HMT, TMH.
4. **Understanding Electro-Mechanical Engineering:** An Introduction to Mechatronics - Kamm, PHI.

Course Outcome:
Students are able to acquaint themselves with the application of mechatronics systems in various engineering applications.

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

Sub Code	:	14MCM253	IA Marks	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

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

Course Content:

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.

Microfabrication and Micromachining: Integrated Circuit Processes, Bulk Micromachining: Isotropic Etching and Anisotropic Etching, Wafer Bonding, High Aspect-Ratio Processes (LIGA) **12 Hours**

2. 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; ShearmodePiezoactuator; Gripping Piezoactuator; Inchworm Technology. **08 Hours**

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. **08 Hours**

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.

MEMS: Design and Analysis: Basic concepts of design of MEMS devices and processes, Design for fabrication, Other design considerations, Analysis of MEMS devices, FEM and Multiphysics analysis, Modelling and simulation.
14 Hours

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). **8 Hours**

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” Taylor & Francis Group, 2002.
4.Gregory Kovacs, “Micromachined Transducers Sourcebook” 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,November 2000.

Course Outcome:

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

MICROPROCESSORS AND MICRO CONTROLLERS
(Common to MCM,MAR,IAE)

Sub Code	:	14MAR254	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

Course Objective:
The course aims at providing insight into working and application of Microprocessors and Micro Controllers.

Course Content:
1. **Introduction To Microprocessors**: Introduction to Microprocessors, Microprocessor based Computer Systems, evolution of microprocessors, discussion on recent processors, comparison of microprocessors and microcontrollers, discussion on use of microprocessors and microcontrollers in automation.

Register Organisation, Architecture, Signal description, physical memory organization and I/O addressing Capability of 8086 processor: Pin Outs and Pin Functions, functional block diagram, General purpose registers, segment registers, pointers and index registers, flag register. Bus interface unit, Execution unit, Memory segmentation. Minimum and Maximum mode configuration. Signals with common functions in both modes, signal definitions for minimum and maximum mode.

12 Hours

2. **Instruction Set and Assembler Directives of 8086 Processor:** Addressing modes for accessing immediate and register data, addressing modes for accessing data in memory, addressing modes for accessing I/O ports, relative addressing mode, implied addressing mode. Data Transfer Instructions, Arithmetic Instructions.

Bit manipulation Instructions(Logical Instructions), shift instructions, Rotate Instructions, Program Execution Transfer instructions, iteration control instructions, processor control instructions, Interrupt Instructions, String Instructions.

12 Hours

3. **Interrupt Systems, Memory and I/O Interfacing In 8086 Microprocessor:** Introduction to Interrupts, Interrupt related Instructions, Interrupt Processing, Memory Devices, Address Decoding, 8/16-Bit Memory Interfacing, DRAM Memory Systems.

Introduction to I/O Interfacing. Memory Mapped and I/O Mapped I/O Application examples related to Stepper Motor, Temperature Control and Robot Control.

10 Hours

4. **Introduction to Micro Controllers:** Introduction, Comparing Microprocessors and Micro Controllers, Z-80, 8051, PIC Micro Controllers, PIC Development Tools. The Micro Controller Survey, 4Bit, 8Bit, 16Bit And 32 Bit Micro Controllers. Develop Systems for Micro Controllers.

8 Hours

5. **Micro Controllers Architecture:** 8051 Architecture, PIC Architecture, 8051 Micro Controller Hardware, Input/Output Pins, Ports and Circuits, External Memory, Counter And Timers, Serial Data Input/Output, Interrupts.

8 Hours

Text Books:

1. **Advanced Microprocessors and IBM PC -** TMH K. Udaya Kumar & B.S. Umashankar.
2. **Design with PIC and Micro controllers -** John B Peatman, Pearson Education.

Reference Books:

1. **The Intel Microprocessors -** Barry .B.Brey, Fourth Edition, PHI.
2. **Microprocessors and Interfacing -** Douglas V.Hall, McGraw Hill.
3. **Computer Organization and ALP -** Michael Throne, Addison. Wesley.
4. **Essentials of ALP -** Rajaraman, Radhakrishna, PHI.
5. The 8051 Micro Controller Architecture, Programming, and applications - Kenneth J. Ayala, Penram International.

Course Output:

Students will be able to demonstrate their knowledge of working and application of microprocessors and microcontrollers.

Manufacturing Engineering Lab 2

Sub Code : 14MCM26	IA Marks :25
Hrs/ Week : 6	Exam Hours : 03
Total Hrs:84	Exam Marks :50

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.

IV Sem

MODELING, SIMULATION AND ANALYSIS OF MANUFACTURING SYSTEMS
(Common to MCM,MAR,IAE)

Sub Code	**:**	**14MAR41**	***IA Marks***	**:**	**50**
Hrs/ Week	**:**	**04**	**Exam Hours**	**:**	**03**
Total Hrs.	**:**	**50**	**Exam Marks**	**:**	**100**

Course Objectives

- To present basic knowledge about modeling, simulation and analysis of a manufacturing system using various techniques.
- To absorb various case studies on MONTE CARLO principle.

Course Content:

1. **Principles of Modeling & Simulation:** Basic Simulation Modeling, Limitation of Simulation, Monte - Carlo Simulation, Areas of Applications, Discrete and Continuous Systems.

10 Hours

2. **Modeling Approaches:** Modeling Complex Systems, Simulation Software, Basics Probability and Statistics, Building Valid and Credible Simulation Models.

10 Hours

3. **Random Number and Variable Generation:** Selecting Input Probability Distributions, Random Number Generators, Generating Random Variants, and Output Data Analysis for a Single System.

10 Hours

4. **Statistical Techniques:** Comparison of Alternative Systems, Variance Reduction Techniques.

10 Hours

5. **Simulation Studies:** Discrete Event Simulation, Simulation of Inventory Problems, Experimental Design and Optimization, Simulation of Manufacturing Systems, Case Studies.

10 Hours

Text Books:

1. **Simulation**, Modeling and Analysis –Averill Law & David M.Kelton, TMH 3rd Edition.
2. **Discrete event and Simulation Systems** – Banks & Carson, Prentice Hall Inc.

Reference Books:

1. **"System Simulation"**- Gordon, PHI.
2. **"System Simulation with Digital computer"** – Deo, PHI
3. **"Computer Simulation And Modeling"**– Francis Neelamkovil, John Wiley & Sons.

Course Outcome:

Students will be able to

1. Know about various techniques of simulation and modeling used to analyze manufacturing system.
2. Undergo various case studies using real time simulation.

Elective-III

COMPUTER AIDED PRODUCTION AND OPERATION MANAGEMENT
(Common to MCM,MAR,IAE)

Sub Code	:	14MAR421	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

COURSE OBJECTIVES

- Toimpartknowledgeonoperationalresearchtechniquesusedinanalyzingamanufacturingsystem

COURSE CONTENT:

1. Management of Production Systems: Linear Programming, Transportation and Assignment models.
Manufacturing and Service Strategies:, Forecasting, Capacity Analysis.

12 Hours

2. Facility Location and Layout: Balancing of Assembly Lines.
Basic Inventory Systems: Inventory Control, Inventory Systems under Risks, Aggregate and Distribution Inventory Management, Dynamic inventory models.

10 Hours

3. Master Production Schedule: Materials Requirement Planning, Production Scheduling and Sequencing.

8 Hours

4. Capacity Planning and Control, High -Volume Production Activity Control and JIT Systems, Control of Quality, Total Quality Management, Project Management Techniques.
Lean TPM, bench marking, lean six sigma and some modern tools of TQM.

12 Hours

5. System Simulation, Supply Chain Management, Speed to Market, Technological Innovation in Manufacturing and Factory of Future.

8 Hours

Text Books:

1. **Computer Aided Production Management -** P.B. Mahapatra, PHI.
2. **Production Planning and Inventory Control -**Narsimhan, McLeavey and Billington, PHI (EEE).

Reference Books:

1. **Operations Management -** Norman Gaither & Greg Frazier, Thomson South-Western, ISE.
2. **Production/Operations Management -** Elwood S Buffa, Wiley Eastern.
3. **Production and Operations Management: Concepts, Models and Behavior -** Adam & Ebert, PHI.
4. **Production and Operations Analysis -** Steven Nahmias and Robert Bulfin, TMH.
5. **Factory Physics -** Hopp and Spearman, TMH.
6. **Production Planning, Control and Integration -** Sipper and Bulfin, TMH.
7. **Production and Operations Management: 6th Edition -**Muhlemann, Oakland, Lockyer, Sudhir and Katyayani, Pearson Education.

Course Outcome:
Students are able to grasp the knowledge on manufacturing and operation management strategies.

DYNAMICS AND MECHANISM DESIGN

(Common to MDE,MEA,MMD,CAE,MAR)

Sub Code : 14MCM422	IA Marks :50
Hrs/ Week : 04	Exam Hours : 03
Total Hrs: 50	Exam Marks :100

Course Objective:

To include dynamics considerations in the design of mechanisms for engineering applications is the objective of this course.

Course Content:

1) Geometry of Motion: Introduction, analysis and synthesis, Mechanism terminology, planar, Spherical and spatial mechanisms, mobility, Grashoffs law, Equivalent mechanisms, Unique mechanisms, Kinematic analysis of plane mechanisms: Auxiliary point method using rotated velocity vector, Hall - Ault auxiliary point method, Goodman's indirect method. **6 Hours**

2) Generalized Principles of Dynamics: Fundamental laws of motion, Generalized coordinates, Configuration space, Constraints, Virtual work, principle of virtual work, Energy and momentum, Work and kinetic energy, Equilibrium and stability, Kinetic energy of a system, Angular momentum, Generalized momentum. Lagrange's Equation: Lagrange's equation from D'Alembert's principles, Examples, Hamiltons equations, Hamiltons principle, Lagrange's, equation from Hamiltons principle, Derivation of Hamiltons equations, Examples. **13 Hours**

3) System Dynamics: Gyroscopic action in machines, Euler's equation of motion, Phase Plane representation, Phase plane Analysis, Response of Linear Systems to transient disturbances. Synthesis of Linkages: Type, number, and dimensional synthesis, Function generation, Path generation and Body guidance, Precision positions, Structural error, Chebychev spacing, Two position synthesis of slider crank mechanisms, Crank-rocker mechanisms with optimum transmission angle Motion Generation: Poles and relative poles, Location of poles and relative poles, polode, Curvature, Inflection circle. **13 Hours**

4) Graphical Methods of Dimensional Synthesis: Two position synthesis of crank and rocker mechanisms, Three position synthesis, Four position synthesis (point precision reduction) Overlay method, Coupler curve synthesis, Cognate linkages. Ana1ytical Methods of Dimensional Synthesis: Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis, Analytical synthesis using complex algebra. **12 Hours**

5) Spatial Mechanisms: Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles. **6 Hours**

Text Books:

1) K.J.Waldron&G.L.Kinzel , “Kinematics, Dynamics and Design of Machinery”, Wiley India, 2007.
2) Greenwood , “Classical Dynamics”, Prentice Hall of India, 1988.

References Books:

1) J E Shigley, “Theory of Machines and Mechanism” -McGraw-Hill, 1995
2) A.G.Ambekar , “Mechanism and Machine Theory”, PHI, 2007.
3) Ghosh and Mallick , “Theory of Mechanism and Mechanism”, East West press 2007.
4) David H. Myszka , “Machines and Mechanisms”, Pearson Education, 2005.

Course Outcome:

The knowledge of dynamics considerations in mechanism design is essential to use commercial multi body dynamics software in mechanical engineering design

TOOLING FOR MANUFACTURE IN AUTOMATION

(Common to MCM,MAR,IAE,MTE)

Sub Code	:	14MTE 154	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

Course Objective:

Students are introduced to metal cutting principles, cutting tool materials, types of cutting tools and its nomenclature. Students get orientation into clamping methods and jigs used in automated environment.

Course Content:

1. **Mechanics of metal cutting:** Introduction, measurement of cutting forces and chip thickness, force components, chip formation and primary plastic deformation, shear plane and slip line theories for continuous chip formation.

Modern Cutting tool materials: Material properties, HSS related materials, sintered tungsten carbide, cermets, ceramics, polycrystalline tools, tool coatings, coating methods, conventional coating materials, diamonds and CBN

Cutting tools: Basic types of cutting tools, turning tools, indexable inserts, groove geometry, edge preparation, wiper geometry, insert clamping methods, tool angles, threading tools, grooving and cut off tools, milling tools, types of milling cutters, milling inserts and edge clamping methods. Selection and application ofSingle point cutting tool and multipoint cutting tools. **12 Hours**

2. **Optimization:** Machining cost and production rate verses cutting speed, role of computerized optimization system, economic considerations, optimization of machining system, machining conditions, constraints, depth of cut feed and speed.

Tooling Requirements for CNC Machines: Tool holding systems modular and quick change tool holding system, tool holder spindle connection, cutting tool clamping systems, milling cutter driver, side lock type chuck, collet chucks, hydraulic chucks, milling chucks. Tool magazines, Automatic Tool Changers, robotized tool assembly, tool management system. Tool monitoring, presetting and offsets, wear and radius compensation **12 Hours**

3. **Location and Clamping Methods:** Basic principles of locating, locating methods & devices, Basic principles of clamping, clamping methods.

Fixtures: Definitions, General considerations, Machine considerations, Process considerations, Product considerations, Types of fixtures, Vise fixtures, Milling fixtures, Boring fixtures, Broaching fixtures, Lathe fixtures, Grinding fixtures, Steps involved in designing a fixture.

12 **Hours**

4. **Fixtures for Automation**: Work holders for CNC, Fixturing in FMS: Part holding on Pallets, standard fixtures, pallet changers, pallet pool, flexible fixturing – principles and methodologies, modular fixturing system: Tslot based, dowel pin based, fixturing components, computer aided fixture design – locating and clamping, use of GT in fixture design, fixture database. **8 Hours**

5. **Plastics for tooling materials:** Introduction, Commonly used plastics for tooling, Epoxy plastics tools, Construction methods, Urethane dies, Force calculation for Urethane pressure pads. **6 Hours**

Textbooks:

1. Cyrol Donaldson, **Tool Design -**, Tata McGraw Hill, India.
2. Edward G Hoffman, **Fundamentals of Tool Design** -, SME, USA.
3. Joshi, **P.H., Jigs & Fixtures**, Second Edition, Tata McGraw-Hill Publishing Company Limited,New, Delhi 2004
4. Hiram E Grant, **Jigs and Fixture** Tata McGraw-Hill, New Delhi, 2003

Reference Books:

1. William E Boyes, **Handbook of Jigs & Fixtures Design -**, SME, USA.
2. G.R. Nagpal, **Tool Engineering & Design** -, Khanna publications.
3. David A.Stephenson, John S. Agapiou, **Metal cutting theory and practice,** , Second edition CRC taylor and Francis publishers.
4. Dr. B.J. Ranganath, **Metal cutting and tool design**, Vikas publishing house
5. ASTME**; Die Design Hand book**; McGraw Hill.
6. **Metal cutting applications Engineering course material** – by Kennametal.

Course Outcome:

Students are able to decide a type of tool appropriate for machining a material, decide on nomenclature parameters and be able to design a clamping method.

CONCURRENT ENGINEERING FOR MANUFACTURING
(Common to MCM,MAR,IAE)

Sub Code	:	14MAR424	***IA Marks***	:	50
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	Exam Marks	:	100

Course Objectives:

- To present historical review of industrial revolution from Ford to present days.
- To present basic knowledge of life-cycle management, process reengineering.

1. **Introduction:** Introduction. Review of Historical Events. Push and Pull for New Paradigms. Areas of Manufacturing Competitiveness. Product and Services. Process and Methodologies. Performance Indicators, Manufacturing Competitiveness.
   Life-Cycle Management: Shrinking Life Cycle. Life-Cycle Management. New Product Introduction. Strategic Technology Insertions. Managing Continuity. Managing Revision Changes. Life-Cycle Cost Drivers. Life-Cycle Management Tools. Sequential Versus Concurrent Engineering. Life-Cycle Management.

   12 Hours
2. **Process Reengineering:** Understanding and Managing Change, Reengineering Approaches. Tenents of Process Improvement. Work Flow Mapping. Information Flow-Charting. Enterprise Models. Process Improvement Methodology. Change Management Methodology. Concurrent Process Reengineering.

   8 Hours
3. **Concurrent Engineering Definitions:** Introduction, CE Definitions. Basic Principles of CE. Components Of CE. Concurrency And Simultaneity. Modes of Concurrency. Modes of Cooperation. Benefits Of Concurrent Engineering.

   8 Hours
4. **System Engineering :**Introduction. An Automobile Manufacturing Process. System Engineering. Systems Thinking. Approaches to System Complexity. Sharing and Collaboration in CE 300. System Integration. Agile Virtual Company.

   8 Hours

5. **Information Modeling :**Information Modeling. Modeling Methodology. Foundation of Information Modeling. Concurrent Engineering Process Invariant. Enterprise Model-Class. Specification Model-Class. Product Model-Class. Process Model- Class. Cognitive Models. Merits and Demerits.
   Survey of CE Success: key toJapanese success, Future concurrent engineering

   14 Hours

Text Books:

1. **"Concurrent Engineering Fundamentals-Integrated product and process organization**"- Vol I & II, Prasad.B, PHI..
2. **"Concurrent Engineering"-**Shortening lead times, Raising Quality and Lowering Costs, Johan.R. Hartely, Productivity press, Portland, Oregon 1992.

Reference Books :

1. **"Concurrent Engineering"**-The Product Development Environment for the 1990's, Carter DE and Baker BS, Addison Wesley Publishing Company.

2. **“Concurrent Engineering in Product Design and Development”-** Editor-Imad Moustapha,Reprint-2006, New Age International Publishers

Course Outcome:

Students will be able to

1. Know about what concurrent engineering means
2. Know about play of concurrent engineering in industries.
3. Know about life cycle management of a product.