SCHEME OF EXAMINATION

&

DETAILED SYLLABUS

FOR

MASTER OF TECHNOLOGY
[Robotics and Automation]

REGULAR PROGRAMME

Offered by MAE Dept.

Indira Gandhi Delhi Technical University for Women
(Established by Govt. of Delhi vide Act 09 of 2012)
(Formerly Indira Gandhi Institute of Technology)
Kashmere Gate Delhi-110006

M.Tech (Robotics and Automation)

FIRST SEMESTER

Paper Code	Paper Title	L	T/P	Credit
THEORY				
MRA - 501	Robotics Engineering	4	-	4
MRA - 503	Automation in Manufacturing	4	-	4
MRA - 505	Mechatronics Systems and Applications	4	-	4
MRA -507	Computer Aided Modeling and Design	4	-	4
MRA -509	Optimization for Engineering	4	-	4
PRACTICALS				
MRA -511	Robotics Engineering Lab	-	2	1
MRA -513	Mechatronics Systems and Applications Lab	-	2	1
MRA -515	Computer Aided Modeling and Design Lab	-	2	1
MRA -517	Technical Report Writing*	-	2	2
	TOTAL	**20**	**8**	**25**

SECOND SEMESTER

Paper Code	Paper Title	L	T/P	Credit
THEORY				
MRA - 502	Modeling and Simulation	4	-	4
MRA - 504	Advanced Manufacturing System	4	-	4
MRA ï 506	Microcontrollers and Applications	4	-	4
ELECTIVES (Choose any two) **				
MRA ï 508	Pneumatic and Hydraulic Control	4	-	4
MRA --510	Machine Vision	4	-	4
MRA-512	Wireless Sensor Networks	4	-	4
MMC-504	Embedded System Design	4	-	4
MMC ï 512	Advanced Digital Signal Processing	4	-	4
MIS-520	Digital Image Processing and stegnography	4	-	4
MVD ï 522	MEMs & Microsystems	4	-	4
PRACTICALS				
MRA -514	Modeling and Simulation Lab	-	2	1
MRA -516	Microcontrollers and Applications lab	-	2	1
MRA -518	Lab based on elective(s)	-	2	1
MRA -520	Term Paper*	-	2	2
	TOTAL	**20**	**8**	**25**

*NUES (Non University Examination System)

**Any of the subjects may be chosen in distance learning mode such as Massive Open Online Course (MOOCs etc) and supervised by internal faculty-in-charge.

THIRD SEMESTER

Paper Code	Paper Title	L	T/P	Credit
THEORY				
MRA -601	Advanced Robotics	4	-	4
MRA -603	Computer Integrated Manufacturing	4	-	4
ELECTIVES(Choose any one) **				
MRA -605	Multi body Dynamics	4	-	4
MRA-607	Modern Control Theory	4	-	4
MRA- 609	Artificial Intelligence	4	-	4
MRA - 611	Neural Network and Fuzzy Logic	4	-	4
PRACTICALS				
MRA -613	Advanced Robotics Lab	-	2	1
MRA -615	Computer Integrated Manufacturing Lab	-	2	1
MRA -617	Minor Project	-	8	12
	TOTAL	**12**	**8**	**26**

FOURTH SEMESTER

Paper Code	Paper Title	L	T/P	Credit
MRA-602	Dissertation	-	30	24
MRA -604	Seminar and Progress Report*	-	04	04
	TOTAL		**34**	**28**

*NUES (Non University Examination System)
**Any of the subjects may be chosen in distance learning mode such as Massive Open Online Course (MOOCs etc) and supervised by internal faculty-in-charge.

1. The total number of credits of the M. Tech Programme. = 104.
2. Each student shall be required to appear for examination in all courses. However, for the award of the degree a student shall be required to earn a minimum of 100.

Paper Code: MRA-501	**L**	**T**	**C**
Paper Title: Robotics Engineering	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks: 60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

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

(10 Hrs)

UNIT 2

Kinematics of Robots: Transformation Matrices, Inverse transformation matrices, Forward and Inverse kinematic equation for position and orientation, Denavit-Hartenberg representation of robot, inverse kinematic solution for articulated robot, Numericals.

Differential Motions and velocities: Jacobian, Differential motions of a frame, Differential motion between frames, Calculation of the Jacobian, Inverse Jacobian, Numericals.

(10 Hrs)

UNIT 3

Dynamic analysis of Force: Lagrangian and Newtonian mechanics, Dynamic equations for multiple ï DOF Robots, Static force analysis of Robots, Transformation of forces and moments between coordinate frames, Numericals.

Trajectory Planning: Basics of Trajectory planning, Joint space trajectory planning, Cartesian Space trajectories, Numericals.

(10 Hrs)

UNIT 4

Robot Programming languages & systems: Introduction, the three levels of robot programming, requirements of a robot programming language, problems peculiar to robot programming languages.

Off-line programming systems: Introduction, central issues in on-line and off-line programming. Programming examples

(10 Hrs)

References:

1. Saha S K, ñIntroduction to Roboticsò, TMH Publication, 2008
2. Nagrath and Mittal, ñRobotics and Controlò, Tata McGraw-Hill, 2003.
3. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, ñRobotics, control, sensing, Vision and Intelligenceò, McGraw Hill International, 1987
4. Saeed B. Niku, ñIntroduction to Robotics analysis, Systems & Applicationsò, Pearson Education Singapore P. Ltd., 2002.
5. Spong and Vidhyasagar, ñRobot Dynamics and Controlò, John Wiley and sons, 2008.
6. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thurn, ñPrinciples of Robot Motion: Theory, Algorithms, and Implementationsò, Prentice Hall of India, 2005.

Paper Code: MRA-503	**L**	**T**	**C**
Paper Title: Automation in Manufacturing	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks: 60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

Introduction: Definition of automation, Types of production, Functions of Manufacturing, Organization and Information Processing in Manufacturing, Production concepts and Mathematical Models, Automation Strategies.

Fixed Automation: Automated Flow lines, Methods of Workpart Transport, Transfer Mechanism - Continuous transfer, intermittent transfer, Indexing mechanism, Operator-Paced Free Transfer Machine, Buffer Storage, Control Functions, Automation for Machining Operations, Design and Fabrication Considerations.

Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines without Storage, Partial Automation, Automated Flow Lines with Storage Buffers.

(10 Hrs)

UNIT 2

Assembly Systems and Line Balancing: The Assembly Process, Assembly Systems, Manual Assembly Lines, The Line Balancing Problem, Methods of Line Balancing, Computerized Line Balancing Methods, Other ways to improve the Line Balancing, Flexible Manual Assembly Lines.

Automated Assembly Systems: Design for Automated Assembly, Types of Automated Assembly Systems, Vibratory bowl feeder and Non vibratory bowl feeder, Part Orienting Systems, Feed tracks, Escapements and part placing mechanism, Analysis of Multi-station Assembly Machines, Analysis of a Single Station Assembly Machine

(10 Hrs)

UNIT 3

Automated Materials Handling: The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems.

Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Carousel Storage Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing.

(10 Hrs)

UNIT 4

Automated Inspection and Testing: Inspection and testing, Statistical Quality Control, Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods.

Modeling Automated Manufacturing Systems: Role of Performance Modeling, Performance Measures, Performance Modeling Tools: Simulation Models, Analytical Models.

The Future Automated Factory: Trends in Manufacturing, The Future Automated Factory, Human Workers in the Future Automated Factory, The social impact.

(10 Hrs)

References:

1. Mikell P.Grover, ñAutomation, Production Systems and Computer Integrated Manufacturingò, Pearson Education Asia, 2001.
2. C.Ray Asfahl, ñRobots and manufacturing Automationò, John Wiley and Sons New York, 1992.
3. N.Viswanadham and Y.Narahari, ñPerformance Modeling of Automated Manufacturing Syetmsò, Prentice Hall India Pvt. Ltd, 1992.
4. Stephen J. Derby, ñDesign of Automatic Machineryò, Special Indian Edition, Marcel Decker, New York, Yesdee publishing Pvt. Ltd, Chennai, 2004.

Paper Code: MRA-505	**L**	**T**	**C**
Paper Title: Mechatronics Systems and Applications	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS **Maximum Marks : 60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks.**

UNIT 1

Introduction: What is Mechatronics? Measurement System; Control Systems, Mechatronics Approach.

Sensors and Transducers: Performance Terminology; Photoelectric Transducers, Flow Transducers, Optical Sensors & Transducers, Semiconductor Lasers, Selection of Sensors, Mechanical / Electrical switches, Inputting data by switches.

(10 Hrs)

UNIT 2

Actuators and Mechanisms: Actuation Systems; Pneumatic and Hydraulic Systems; Process Control Valves; Rotary Actuators; Mechanical Actuation Systems; Electrical Actuation Systems;

Signal Conditioning: Signal Conditioning; Filtering Digital Signal; Multiplexers; Data Acquisition; Digital Signal Processing; Pulse Modulation; Data Presentation Systems.

(10 Hrs)

UNIT 3

Microprocessors and Microcontrollers: Microcomputer Structure; Microcontrollers; Applications.

Programmable Logic Controllers: PLC Structure, Input / Output Processing, Programming, Language (Ladder Diagram), Logic Functions, Latching, Sequencing, Timers, Internal Relays and Counters, Shift Registers, Master and Jump Controls, Jumps, Data Movement, Code Conversion, Ladder Circuits.

Input/output Systems: Interfacing, I/O addressing, Serial communications interface, Examples of interfacing.

(10 Hrs)

UNIT 4

Modeling & System Response: Mathematical Models; Mechanical, Electrical, Hydraulic and Thermal Systems; Modeling of dynamic systems.

Mechatronic Systems: Mechatronic designs, Consumer Mechatronic Products, Surgical Equipment, Industrial Robot, Autonomous Guided Vehicle, Mechatronic Case studies.

(10 Hrs)

References:

1. Bolton W, ñMechatronicsò, Pearson Education Ltd., 2008.
2. David G. Alciatore & Michael B. Histrand, ñIntroduction to Mechatronicsò, Tata McGraw Hill, 2007.
3. Shetty, Dedas, Kolk and Richard, ñMecharonics System Designò, PWS Pub, 1997.
4. Mahalik, ñMechatronics Principles, Concept and Applicationsò, Tata McGaw Hill, 2003.
5. Bishop, Ropert H., ñMechatronics Handbookò, CRC Press, 2002.
6. Mahalik, ñMehatronicsò, TMH, 2003.

Paper Code: MRA-507	**L**	**T**	**C**
Paper Title: Computer Aided Modeling and Design	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks: 60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

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

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

(10 Hrs)

UNIT 2

Surface Modeling: Surface entities, Surface Representation. Analytic Surface ï Plane Surface, Ruled Surface, Surface of Revolution, Tabulated Cyliner. Synthetic Surface-Cubic, Bezier, B-spline, Coons.

(10 Hrs)

UNIT 3

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

(10 Hrs)

UNIT 4

Advanced Modeling Concepts: Feature Based Modeling, Assembling Modeling, Behavioural Modeling, Conceptual Design & Top Down Design. Capabilities of Modeling & Analysis Packages such as solid works, Unigraphics, Ansys, Hypermesh. Computer Aided Design of mechanical parts and Interference Detection by Motion analysis.

(10 Hrs)

References:

1. Ibrahim Zeid, ñCAD/CAM, Theory and Practiceò, McGraw Hill, 1998.
2. Foley, Van Dam, Feiner and Hughes, ñComputer Graphics Principles and Practiceò, Addison ï Wesley, 2000.
3. Martenson, E. Micheal, ñGeometric Modellingò, John Wiley & Sons, 1995.
4. Hill Jr, F.S., ñComputer Graphics using open GLò, Pearson Education, 2003.

Paper Code: MRA-509	**L**	**T**	**C**
Paper Title: Optimization for Engineering	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks: 60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

Mathematical Background: Historical Development; Engineering applications of Optimization; Objective function; Constraints and Constraint surface; Formulation of design problems as mathematical programming problems; Classification of optimization problems based on nature of constraints, objective functions; Optimization techniques ï classical and advanced techniques.

Convex sets and Convex cones - Introduction and preliminary definition - Convex sets and properties - Convex Hulls - Extreme point - Separation and support of convex sets - Convex Polytopes and Polyhedra - Convex cones - Convex and concave functions - Basic properties- Differentiable convex functions - Generalization of convex functions Hessian matrix formulation; Eigen values; Kuhn-Tucker Conditions; Examples

(10 Hrs)

UNIT 2

Dynamic Programming: Sequential optimization; Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality; Recursive equations ï Forward and backward recursions; Computational procedure in dynamic programming (DP); Discrete versus continuous dynamic programming; Multiple state variables; curse of dimensionality in DP.

Integer linear programming: Concept of cutting plane method; Mixed integer programming; Solution algorithms; Examples.

(10 Hrs)

UNIT 3

Nonlinear Programming: Minimization and maximization of convex functions - Local & Global optimum ï Convergence -Speed of convergence unconstrained optimization: One dimensional minimization - - Gradient methods - Steepest descent method

Geometric Programming: Introduction, Unconstrained minimization problems, solution of unconstrained problem from arithmetic-geometric inequality point of view, Generalized polynomial optimization, Applications of geometric problems

(10 Hrs)

UNIT 4

Novel methods for Optimization: Introduction to simulated annealing, selection of simulated annealing parameters, simulated annealing algorithm; Genetic Algorithm (GA), Design of GA, Key concepts of GA, Examples of simulated algorithm, genetic annealing and Neural Network method.

(10 Hrs)

References:

1. David G Luenberger, ñLinear and Non Linear Programmingò, 2nd Ed, Addison-Wesley, 2008.
2. S.S.Rao, ñEngineering Optimization; Theory and Practiceò; Revised 3rd Edition, New Age International Publishers, New Delhi, 2009.
3. S.M. Sinha, ñMathematical programming: Theory and Methodsò, Elsevier, 2006.
4. Hillier and Lieberman, ñIntroduction to Operations Researchò, McGraw-Hill, 8th edition, 2005.
5. Saul I Gass, ñLinear programmingò, McGraw-Hill, 5th edition, 2005.
6. Bazarra M.S., Sherali H.D. & Shetty C.M., ñNonlinear Programming Theory and Algorithmsò, John Wiley, New York, 1979.
7. Kalyanmoy Deb, ñOptimization for Engineering: Design-Algorithms and Examplesò, PHI, 2012.

Paper Code: MRA ï 511	**L**	**P**	**C**
Paper Title: Robotics Engineering Lab	**0**	**2**	**1**

Experiments will be based on theory course of Robotics Engineering.

Paper Code: MRA - 513	**L**	**P**	**C**
Paper Title: Mechatronics Systems and Applications Lab	**0**	**2**	**1**

Experiments will be based on theory course of Mechatronics Systems and Applications.

Paper Code: MRA - 515	**L**	**P**	**C**
Paper Title: Computer Aided Modeling and Design Lab	**0**	**2**	**1**

Experiments will be based on theory course of Computer Aided Modeling and Design.

Paper Code: MRA - 517	**L**	**P**	**C**
Paper Title: Technical Report Writing*	**0**	**2**	**2**

* Technical reports describe the progress or results of scientific or technical research and development. The purpose of a technical report is to completely and clearly describe technical work, why it was done, results obtained and implications of those results. Technical report presents facts and conclusions about your design and other projects. Typically, a technical report includes research about technical concepts as well as graphical depictions of designs and data. For guidelines of technical report writing, following website may be referred.
www.theiet.org/students/resources/technicalreport.cfm

Paper Code: MRA-502	**L**	**T**	**C**
Paper Title: Modeling and Simulation	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks:**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

System Modeling: Concept of System and environment, Stochastic activities, Continuous and discrete systems, Types of Models, Principles of modeling, System studies and analysis, Advantages and disadvantages of simulation, Decision making with simulation, Numericals.

(10 Hrs)

UNIT 2

System Simulation: Techniques of simulation, Monte Carlo method, Experimental nature of simulation, Numerical computation techniques, Distributed lag models, Cobweb models Continuous system models, Analog and Hybrid simulation, Feedback systems, Computers in simulation studies, Simulation software packages.

System Dynamics: Exponential Growth and Decay models, Logistic curves, System dynamics diagrams, Time delay representation, Examples.

(10 Hrs)

UNIT 3

Probability Concepts in Simulation: Stochastic variables, discrete and continuous probability functions, Random numbers, Methods of generation of Random numbers, Queuing disciplines, Measures of queues, Mathematical solutions of queuing problems, server utilization and Grade of service.

Simulation software: Comparison of simulation packages with programming languages, classification of simulation software, Description of a general purpose simulation package-Design of scenario and modules, dialog box, database, animation, plots and output, interfacing with other software, summary of results. Examples with MATLAB/ AWESIM / ARENA.

(10 Hrs)

UNIT 4

Analysis of Simulation output: Importance of the variance of the sample mean, Procedure for estimating mean and variance, Subinterval method, Replication Method, Regenerative method; Variance reduction techniques, Start up policies, Stopping rules, Statistical inferences, Design of experiments.

Simulation of Manufacturing Systems: Objective of Simulation in Manufacturing, Modeling system randomness, A simulation case study of manufacturing system.

(10 Hrs)

References:

1. Geoffrey Gordon, ñSystem Simulationò, Prentice Hall India, 1969.
2. Robert E. Shannon, ñSystem Simulation: The Art and Scienceò, Prentice Hall India, 1975.
3. Charles M Close and Dean K. Frederick Houghton Mifflin, ñModelling and Analysis of Dynamic Systems:, TMH, 1993.
4. Allan Carrie, ñSimulation of manufacturingò, John Wiley & Sons, 1988.

Paper Code: MRA-504	**L**	**T**	**C**
Paper Title: Advanced Manufacturing System	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks:**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

Flexible Manufacturing System(FMS): Types of FMS, FMS Components like pallets, fixtures, machines, AS/RS, Work handling equipments, and system layout; Control of FMS, FMS applications and benefits, Planning and implementation of FMS, Analysis of FMS through Bottleneck model.

(10 Hrs)

UNIT 2

Automated process planning: General methodology of group technology - code structures variant and generative process planning methods - AI in process planning - process planning software.

CNC technology: principle of numerical control - types of CNC machines - features of CNC systems - programming techniques - capabilities of a typical NC CAM software - integration of CNC machines in CIM environment - DNC - flexible manufacturing systems.

(10 Hrs)

UNIT 3

Reverse Engineering: Need & Techniques, Data collection, Point-Cloud of data

Rapid Prototyping: Process chain in RP in integrated CAD-CAM environment, Advantages of RP; Utility of Rapid Prototyping in Reverse Engineering. Classifications of different RP techniques ï based on raw material, layering technique (2D or 3D) and energy sources; Comparative study of: - Stereo-lithography (SL) with photo-polymerization, SL with liquid thermal polymerization,

Process Technology: Solid foil polymerization, Selective laser sintering, Selective powder binding, Ballistic particle manufacturing ï both 2D and 3D, Fused Deposition Modelling, Shape Melting, Laminated Object Manufacturing, Solid Ground Curing, Repetitive Masking and deposition.

(12 Hrs)

UNIT 4

Data communications and technology management - technology issues - configuration management - database systems - management of technology

Green and Agile manufacturing ï introduction ï agility through group technology, concept of failure mode effect analysis - JIT,SMED,KANBAN,KAIZEN,FMEA,SCM

(8 Hrs)

References:

1. David Bedworth et al., ñComputer Integrated Design and Manufacturingò, McGraw Hill Book Co., 1991.
2. Radhakrishnan P., ñComputer Integrated Manufacturingò, PSG College of Technology, 2008
3. Eric Teicholz & Joel Orr, ñComputer Integrated Manufacturing Handbookò, McGraw Hill Book Co., 1987.
4. Ranky P.G., ñComputer Integrated Manufacturingò, Prentice Hall of India, 1996.
5. Mikell.P.Groover, ñAutomation, Production systems and Computer Integrated Manufacturingò, Pearson Education, 2008.
6. Gibson P, Green Halgh G, Kerr. R., ñManufacturing managementò Chapman & Hall, 1995.
7. Jack M Wacker, ñHand book of Manufacturing engineeringò, Marcel Deeker Inc, USA 1992.

Paper Code: MRA -506	**L**	**T**	**C**
Paper Title: Micro-Controllers and Applications	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks: 60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

Binary data representation: decimal system, binary system, octal system, hexadecimal system, binary coded decimal system, decimal conversion, decimal to Hexadecimal, binary addition and subtraction, binary multiplication and division, binary coded decimal addition, signed numbers, twos complement arithmetic, hexadecimal arithmetic, digital logic gates, MCS51 Micro controller ï difference between micro controller and microprocessor, criteria for choosing a microcontroller, internal architecture of MCS51 microcontroller and its family.

(10 Hrs)

UNIT 2

8051 assembly language programming: instruction set-arithmetic, logical, data transfer branching and Flag manipulation Instructions, addressing modes, 8051 timer/counter, serial communication programming, interrupts structure, interrupt programming, usage of C programming to 8051 family.

(10 Hrs)

UNIT 3

Real word interfacing: Analog to Digital converter, Digital to Analog converter, Mechanical switches, keypads, LEDs, seven segment display, LCDs, keyboard, DC motor, stepper motor, PWM, External Memory Interface.

(10 Hrs)

UNIT 4

Microcontroller Applications: C programming of Podium timer, microcontroller based menu card, chimney sentinel, counting cars, anonymous voting, efficient lighting using microcontroller, I^2 C interface with serial EPROM, reading a PWM waveform using microcontroller, 8051 based pick and place robot.

(10 Hrs)

References:

1. Mazidi, ñThe 8051 micro controller and embedded systemò, Pearson education , 2002
2. Han-way Huang, ñUsing the MCS-51 microcontrollerò, Oxford University Press, 2009.
3. Ajay V Deshmukh, ñMicrocontrollers (Tuning and applications)ò, The McGraw Hill publications, 2007.
4. Parab, Shekale, Kamat & Naik, ñExploring C for Micro controllers: A hands on approachò, Springer Verlag Publications, 2007.
5. Kenneth Hintz and Daniel Tabak, ñMicrocontrollers architecture, Implementation and programmingò, TMH, 2005
6. A. K. Stiffler, ñDesign with microprocessors for Mechanical Engineersò, McGraw Hill, 1992

Paper Code: MRA-508	**L**	**T**	**C**
Paper Title: Pneumatic and Hydraulic Control	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks: 60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

Advantages and Disadvantages of Fluid control, Types of Hydraulic Fluids, physical, chemical and thermal properties of hydraulic fluids, selection of hydraulic fluid, fluid flow fundamentals

Hydraulic Pumps and Motors: Basic Types and constructions, ideal pump and motor analysis, Performance curves and parameters,

(10 Hrs)

UNIT 2

Hydraulic Control Valves: Valve configurations, general valve analysis, critical centre, open centre, three way spool valve analysis and Flapper valve analysis, pressure control valves, single and two stage pressure control valves, flow control valves, introduction to electro hydraulic valves.

Hydraulic Power Elements: Valve controlled motor, valve controlled piston, three way valve controlled piston, and pump controlled motor, pressure transients in power elements.

(10 Hrs)

UNIT 3

Characteristics of Pneumatics, Applications of Pneumatics, Basic Pneumatic elements, Steady flow of Ideal gases, orifice and nozzle calculations, capillary flow, flow of real gases, linear flow equations in Orifices and Nozzles.

Steady state analysis of pneumatic components: Multiple restriction and volume calculations, sensing chambers, valves, Single acting actuators.

(10 Hrs)

UNIT 4

Transients in elementary pneumatic systems: Linear dynamics-linear pneumatic spring rate, linear dynamics of a variable volume of gas, Pneumatic transmission lines, linear dynamics in single acting actuators. Applications in industrial process controls: On-Off pneumatic feedback systems, feedback control of proportional gain, derivative action, integral action, Design of a Pneumatic Pressure Regulator.

(10 Hrs)

References:

1. Herbert E. Merritt, ñHydraulic Control Systemsò, John Wiley & Sons, 2005.
2. B.W. Anderson, ñThe Analysis and Design of Pneumatic Systemsò, Wiley, 1980.
3. A.B. Goodwin, ñFluid Power Systemsò, Macmillan, 1989.
4. Anthony Esposito, ñFluid power with applicationsò, Prentice Hall, 7th Edition, 2002.
5. Arthur Akers, Max Gassman, Richard Smith, ñHydraulic Power System Analysisò, Taylor and Francis Group, 2006.
6. John Pippenger & Tyler Hicks, ñIndustrial Hydraulicsò, 3rd edition McGraw Hill, 1980.

Paper Code: MRA-510	**L**	**T**	**C**
Paper Title: Machine Vision	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks: 60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

Introduction to machine vision, Fundamental concept: Digital image, Elements of a machine vision system, Parts of machine vision system, Forming an image, Illumination Techniques, Camera Image model: perspective geometry, image function, Camera Calibration: Intrinsic and extrinsic parameters, Current and future applications

(10 Hrs)

UNIT 2

Images and basic image processing**,** Different types of images (spectral, colour, gray-level, binary), Operating on gray level images, Image gray-level histogram, Efficiency considerations in image processing, Thresholding (a) Problem definition and trivial solution (b) Adaptive thresholding, Edge detection, Image segmentation

(10 Hrs)

UNIT 3

High level Segmentation**,** Tessellation and connectivity**,** Connected component labelling**,** Crack and border following, Image Enhancement: Gray Scale Modification**,** Histogram Modification**,** Image restoration: Laplacian operator**,** Image filtering operations: sharpening, smoothing, averaging, median filtering

(10 Hrs)

UNIT 4

From segmentation to object analysis: Shape as a simple description of objects**,** Representing shapes (binary and boundary pattern shape descriptors)**,** from shapes to features (different features and invariance), Morphological Image Processing: Binary erosion/dilation, opening/closing, hit-or-miss transforms, Gray-scale morphology, Recognition: Hough transform techniques, Geometric constraints, Matching

(10 Hrs)

References:

1. González, Rafael C. and Woods, Richard Eugene, ñDigital Image Processingò, Prentice Hall, 3rd Edition, 2008.
2. Ballard, D.H. and Brown, C.M., ñComputer Visionò, Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1992.
3. Davies, E.R., ñMachine Vision: Theory, Algorithms, Practicalitiesò, Academic Press, London, 2012.
4. Dougherty, E.R., ñAn Introduction to Morphological Image Processing, SPIE Optical Engineering Pressò, Bellingham, Washington, 1992.
5. Grimson, W.E.L., ñObject Recognition by Computer: The Role of Geometric Constraintsò, The MIT Press, Cambridge, Massachusetts, 1990.
6. Haralick, R.M. and Shapiro, L.G., ñComputer and Robot Vision (Volumes I and II)ò, Addison-Wesley, Reading Massachusetts, 1990.
7. Rosenfeld, A. and Kak, A.C., ñDigital Picture Processing (Volumes I and II)ò, 2nd Edition, Academic Press, Orlando, Florida, 1992.

Paper Code: MRA-512	**L**	**T**	**C**
Paper Title: Wireless Sensor Networks	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks:60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

Overview: Introduction, Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks.

Architectures: Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture, Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.

(10 Hrs)

UNIT 2

Networking: Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts, S-MAC, The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing and Major Routing Protocols.

(10 Hrs)

UNIT 3

Infrastructure Establishment: Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.

(10 Hrs)

UNIT 4

Sensor Network Platforms And Tools: Sensor Node Hardware ï Berkeley Motes, Deployment, Programming Challenges, Node-level software platforms, Embedded Operating System, Node-level Simulators, State-centric programming.

(10 Hrs)

References:

1. Holger Karl & Andreas Willig, ñProtocols And Architectures for Wireless Sensor Networks" , John Wiley2005.
2. Feng Zhao & Leonidas J. Guibas, ñWireless Sensor Networks- An Information Processing Approachò, TMH, 2004.
3. Elsevier B.W. Anderson, ñThe Analysis and Design of Pneumatic Systemsò, Wiley, 1995.
4. Kazem Sohraby, Daniel Minoli, & Taieb Znati, ñWireless Sensor Networks-Technology, Protocols, And Applicationsò, John Wiley, 2007.
5. Anna Hac, ñWireless Sensor Network Designsò, John Wiley, 2003.
6. Feng Zhao and Leonidas Guibas, ñWireless Sensor Networksò, Morgan Kaufman Publishers,2007.
7. Robert Faludi, ñBuilding Wireless Sensor Networksò, Oôreily Publications. John Pippenger & Tyler Hicks, ñIndustrial Hydraulicsò, 3rd edition McGraw Hill, 2010.

Paper Code: MMC - 504	**L**	**T**	**C**
Paper Title: Embedded System Design	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks:60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 10 marks**

UNIT I

Fundamental design aspects: Embedded design life cycle-Product Specification- Hardware Software Partitioning-Design and Integration-Selection Process-Performance Selections and Evaluation of development Tools-Benchmarking- RTOS, Hardware Software co design, Pre-Design and - Memory organization, interfacing.

(10 Hrs)

UNIT II

Embedded controllers: Processor Selection for embedded systems and its issues. Overview of 8051 architecture, Atmel AVR controllers, Atom architecture in terms of architecture, programming, interfacing and applications.

(10 Hrs)

UNIT III

Introduction to ARM Architectures and Its Programming: Interrupt Service Routines-Watchdog timers-Flash memory-Basic toolset-Host based debugging-Remote debugging-ROM emulators-Logic Analyzer-Caches-Computer Optimization- Statistical profiling-In circuit emulators-Buffer control-Real-Time trace-Hardware break points-Overlay memory-Timing Constraints-Usage Issues-Triggers. Comparison between ARM and Atom processors

(10 Hrs)

UNIT IV

Interfacing and Application Development: Cortex M4/A0/Atom (E6xx) Architecture and Programming by using Atmel SAM4 L Starter Kit/ NXP LPC11U24 (mbed)/, Tools, remote compilation, debugging and testing. Interfacing of displays, keyboard, and sensors.

(10 Hrs)

Text Books:

1. Andrew Sloss, Dominic Symes, Chris Wright, ñARM System Developer's Guide: Designing and Optimizing System Softwareò, The Morgan Kaufmann Series an imprint of Elsevier, 2009.
2. William Hohl, ñARM Assembly Language: Fundamentals and Techniquesò, CRC Press, 2012

Reference Books:

1. Arnold S. Berger ñEmbedded System Designò CMP Books USA 2002
2. David.E.Simon ñAn Embedded Software PrimeròPearson Education 2001
3. Frank Vahid and Tony Gwargie ñEmbedded System Design ñJohn Wiley & Sons 2002
4. Steve Heath ñEmbedded System Designò Elserian Second Edition 2004 Petter Barry
5. Peter Barry, Patrick Crowley ñModern Embedded Computingò2012.

Paper Code: MMC- 512	**L**	**T**	**C**
Paper Title: Advanced Digital Signal Processing	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks:60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

Review DSP: Discrete Fourier Transform, linear filtering method based on the DFT, FFT at radix2. Digital filter design FIR and IIR (Butterworth and Chebyshev). Introduction - Decimation, Interpolation Sampling rate conversion by rational factor

(10 Hrs)

UNIT 2

Linear Prediction and Optimum Linear Filters: Representation of a stationary random process, forward and backward linear prediction, solution of normal equations (levinson-durbin)**,** lattice structure**,** Wiener ï Hopf equation for filtering and prediction

(10 Hrs)

UNIT 3

System Modeling and Identification: Adaptive systems - definitions and characteristics - applications - properties-examples - adaptive linear combiner-input signal and weight vectors - performance function - gradient and minimum mean square error -introduction to filtering- smoothing and prediction - linear optimum filtering -orthogonality - wiener

(10 Hrs)

UNIT 4

Adaptive Filtering Algorithms: Least Mean Squares (LMS) LMS algorithm - convergence of weight vector - properties, and Recursive Least square (RLS) algorithms and their convergence performance, Application of adaptive filters

(10 Hrs)

Text Books:

1. Proakis, Rader, Ling, Nikias, ñAdvanced Digital Signal Processingò, Macmillan Publishing House, 1992.
2. Alexander ñAdaptive Signal Processing Theory and Applicationsò Springer Verlag, 1986.

Reference Books:

1. Widrow, Stearns ñAdaptive Signal Processingò, Pearson Education, 1985.
2. Vaseghi, ñAdvanced Digital Signal Processing and Noise Reductionò, Wiley, 2000.

Paper Code: MIS-520	**L**	**T**	**C**
Paper Title: Digital Image Processing and stegnography	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks: 60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

Light, Brightness adaption and discrimination, Pixels, coordinate conventions, Imaging Geometry, Perspective Projection, Spatial Domain Filtering, sampling and quantization.
Intensity transformations, contrast stretching, histogram equalization, Correlation and convolution, Smoothing filters, sharpening filters, gradient and Laplacian. Hotelling Transform, Fourier Transforms and properties, FFT (Decimation in Frequency and Decimation in Time Techniques), Convolution, Correlation, 2-D sampling, Discrete Cosine Transform, Frequency domain filtering.

(10 Hrs)

UNIT 2

Basic Framework, Interactive Restoration, Image deformation and geometric transformations, image morphing, Restoration techniques, Noise characterization, Noise restoration filters, Adaptive filters, Linear, Position invariant degradations, Estimation of Degradation functions, Restoration from projections. Encoder-Decoder model, Types of redundancies, Lossy and Lossless compression, Entropy of an information source, Shannon's 1st Theorem, Huffman Coding, Arithmetic Coding, Golomb Coding, LZW coding.

(10 Hrs)

UNIT 3

Transform Coding, Sub-image size selection, blocking artifacts, DCT implementation using FFT, Run length coding, FAX compression (CCITT Group-3 and Group-4), Symbol-based coding, JBIG-2, Bit-plane encoding, Bit-allocation, Zonal Coding, Threshold Coding, JPEG, Lossless predictive coding, Lossy predictive coding, Motion Compensation, Expansion of functions, Multi-resolution analysis, Scaling functions, MRA refinement equation, Wavelet series expansion, Discrete Wavelet Transform (DWT), Continuous Wavelet Transform, Fast Wavelet Transform, 2-D wavelet Transform, JPEG-2000 encoding, Digital Image Watermarking.

(10 Hrs)

UNIT 4

Basics, SE, Erosion, Dilation, Opening, Closing, Hit-or-Miss Transform, Boundary Detection, Hole filling, Connected components, convex hull, thinning, thickening, skeletons, pruning, Geodesic Dilation, Erosion, Reconstruction by dilation and erosion. Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresholding, Iterative thresholding, Otsu's method, Moving averages, Multivariable thresholding, Region-based segmentation, Watershed algorithm, Use of motion in segmentation

(10 Hrs)

References:

1. Rafael C Gonzalez and Richard E Woods, ñDigital Image Processingò, Pearson, 2008.
2. Anil K Jain, ñFundamentals of Digital Image Processingò, PHI, 2002.
3. Rafael C Gonzalez, ñDigital Image Processing using MATLABò, TMH, 2007.

Paper Code: MVD-522	**L**	**T**	**C**
Paper Title: MEMS & Microsystems	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks: 60**

3. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
4. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

Introduction to MEMS & Microsystems, Introduction to Micro sensors, Evaluation of MEMS, Micro sensors, Market survey, application of MEMS, MEMS Materials, MEMS materials properties, microelectronic technology for MEMS, micromachining technology for MEMS

(10 Hrs)

UNIT 2

Micromachining process, Etch stop techniques and microstructure, surface and quartz Micromachining, Fabrication of micro machined microstructure, Micro stereolithography MEMS micro sensors, thermal micro machined micro sensors, Mechanical MEMS, Pressure and flow sensor, Micro machined flow sensors, MEMS inertial sensors

(10 Hrs)

UNIT 3

Micro machined micro accelerometers for MEMS, MEMS accelerometers for avionics, Temperature drift and damping analysis, Piezoresistive accelerometer technology, MEMS capacitive accelerometer, MEMS capacitive accelerometer process

(10 Hrs)

UNIT 4

MEMS gyro sensor, MEMS for space application, Polymer MEMS & carbon nano tubes (CNT), Wafer bonding & packaging of MEMS, Interface electronics for MEMS, MEMS for biomedical applications (Bio-MEMS)

(10 Hrs)

References:

1. Tai-Ran Hsu, ñMEMS and Microsystems: Design and Manufactureò, McGraw-Hill, 2002.
2. Ghodssi, Reza; Lin, Pinyen (Eds.), ñMEMS Materials and Processes Handbookò, Springer, 2011.
3. Mohamed Gad-el-Hak, ñMEMS: Introduction and Fundamentalsò, Taylor and Francis, 2005.
4. Jan Korvink and Oliver Paul, ñMEMS: A Practical Guide to Design, Analysis and Applicationsò, 2005.

Paper Code: MRA ï 514	**L**	**T**	**C**
Paper Title: Modelling and Simulation Lab	**0**	**2**	**1**

Experiments will be based on theory course of Modelling and Simulation

Paper Code: MRA ï 516	**L**	**P**	**C**
Paper Title: Microcontrollers and Applications Lab	**0**	**2**	**1**

Experiments will be based on theory course of Microcontrollers and Applications

Paper Code: MRA - 518	**L**	**P**	**C**
Paper Title: Lab Based on Electives	**0**	**2**	**1**

Experiments will be based on theory course of Electives

Paper Code: MRA - 520	**L**	**P**	**C**
Paper Title: Term Paper*	**0**	**2**	**2**

*Term papers are generally intended to describe an event, a concept or argue a point. The topic for the term paper may be based on the recent trends in technology/ industry or Academia research outcomes. The guidelines for writing are same as that for technical report writing.

Paper Code: MRA-601	**L**	**T**	**C**
Paper Title: Advanced Robotics	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks:60

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

Review of serial, parallel robotic manipulators: Kinematic chain; Degrees of freedom; Forward and Inverse Kinematics; Dynamics

Different types of wheeled mobile robots and walking machines: Number of wheels; Type of wheels (e.g., Omni directional, torus, etc.); legged robots (Biped, Quadruped, etc.).

(10 Hrs)

UNIT 2

Algorithmic issues for inverse and forward kinematics of robotic systems: Efficiency (Computational Count); Accuracy in numerical calculations; Numerical stability (tolerances in numerical solutions of algebraic and differential equations).

Kinematic design of serial and parallel robots based on singularity and workspace: Definition of workspace; How to calculate it? Meaning of singularity; How to calculate it?

(10 Hrs)

UNIT 3

Manipulability and dexterity: Definitions; How to use them?

Dynamic algorithms - Inverse, forward: Formulation of dynamic model (equations of motion); Newton-Euler algorithm; Use of computer-orientated approaches, e.g., Decoupled Natural Orthogonal Complement (DeNOC) based; Inverse dynamics; Forward dynamics; Mechanical design (choice of material, cross-section, etc.)

(10 Hrs)

UNIT 4

Control of robotic systems: Basics of control; PD, PI and PID control; Force control; Adaptive control

Mechanical design of robot links and joints: Design from mechanical failure and stiffness criteria; Consideration of natural frequency in design.

(10 Hrs)

References:

1 Ghosal, A., ñRoboticsò, Oxford, New Delhi, 2006
2 Roland Siegwart, Illah R Nourbakhsh, Davide Scaramuzza, ñAutonomous Mobile Robotsò, PHI, 2011
3 Craig, J.J., ñIntroduction to Robotics: Mechanics and Controlò, Pearson, Delhi, 3rd Edition, 2009
4 Tsai, L, ñRobot Analysisò, John Wiley & Sons, Singapore, 1999
5 Saha, S.K., ñIntroduction to Roboticsò, Tata McGraw Hill, 4th reprint, 2010

Paper Code: MRA-603	**L**	**T**	**C**
Paper Title: Computer Integrated Manufacturing	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks:60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

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

(10 Hrs)

UNIT 2

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

(10 Hrs)

UNIT 3

CIM Technology and Systems Product Design: Needs of the market, Design and Engineering, The design Process, Design for Manufacturability (DFM): Component Design, Design for Assembly. Computer-Aided Process Planning: Basic Steps in developing a process plan, Variant and Generative Process Planning, Feature Recognition in Computer-Aided Process Planning. Material Requirements Planning (MRP), Manufacturing Resource Planning (MRP ï II), Cellular Manufacturing: Design of Cellular Manufacturing Systems, Cell Formation Approaches: Machineï Component Group Analysis, Similarity Coefficients-Based Approaches. Evaluation of Cell Design. Shop-floor Control: Data Logging and Acquisition, Automated Data Collection, Programmable Logic Controllers, Sensor Technology. Flexible Manufacturing Systems: Physical Components of an FMS. Types of Flexibility, Layout Considerations: Linear Single Machine Layout, Circular Machine Layout, Cluster Machine Layout, Loop Layout; Operational Problems of FMS. FMS benefits.

(10 Hrs)

UNIT 4

Enterprise Wide Integration in CIM and CIM Models Introduction to Networking, Principles of Networking, Network Terminology, Types of Networks: LAN, MAN, WAN; Selection of Network Technology: Communication medium, Network Topology, Medium access control Methods, Signalling methods; Network Architectures and Protocols: OSI Model, MAP & TOP,

TCP/IP, Network Interconnection and Devices, Network Performance. Framework for Enterprise-wide Integration. CIM Models: ESPRIT-CIM OSA Model, NIST-AMRF Model, Siemens Model of CIM, Digital Equipment Corporation Model, IBM Concept of CIM.

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

(10 Hrs)

References:

1. S.Kant Vajpayee, ñPrinciples of Computer Integrated Manufacturingò, Prentice-Hall India, 2007.
2. Nanua Singh: ñSystems Approach to Computer Integrated Design and Manufacturingò- John Wiley, 1995.
3. P.Radhakrishnan, S.Subramanyam, ñCAD/CAM/CIMò, New Age International, 2009.
4. Alavudeen, Venkateshwaran, ñComputer Integrated Manufacturingò, Prentice-Hall India, 2008.

Paper Code: MRA - 605	**L**	**T**	**C**
Paper Title: Multi body Dynamics	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks:60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

Overview of kinematic loops, constraints, degrees of freedom: Links and joints; Open and Closed-kinematic chains; Kinematic constraints (Holonomic and non-holonomic); Independent coordinates; Degrees of freedom.

Review of dynamics for open and closed-loop chains: Generalized coordinates; Euler-Lagrange equations of motion; Newtonôs 2nd law; Eulerôs equations for rotational motion

(10 Hrs)

UNIT 2

Computer-based approaches: Kaneôs equations of motion; Partial velocities; Orthogonal complement based approached like using Decoupled Natural Orthogonal Complement matrices.

Dynamic algorithms: Inverse dynamics; Forward dynamics; Recursive algorithms; Use of software like ADAMS, RecurDyn, MATLAB- Sim Mechanics, ReDySim.

(10 Hrs)

UNIT 3

Dynamics of closed-loop systems: Free-body diagrams; Tree-type systems; Cut-loop systems; Lagrange multipliers to represent cut-open joints; Dynamic algorithms for closed-loop systems.

ODE and DAE formulations: Ordinary Differential Equations (ODE); Differential Algebraic Equations; Numerical instability; Stiff and non-stiff systems; Numerical algorithms to solve ODE and DAE equations.

(10 Hrs)

UNIT 4

Kinematic constraints of rigid and flexible systems: Discretization of deformation; Lagrange equations of motion; Inclusion of kinematic constraints due to joints.

Dynamics of flexible multi body systems, dynamic analysis using classical approximation, FEM: Forward dynamics simulation of flexible body systems; Use of Finite Elements to represent deformations; Equations of motion; Use of software, e.g., ADAMS, RecurDyn.

(10 Hrs)

Reference

1. Shabana, A., ñDynamics of Multi body Systemsò, Cambridge University Press, 2005
2. Saha, S.K., ñIntroduction to Roboticsò, TMH, 2008
3. Chaudhary, H., Saha , S. K., ñDynamics and Balancing of Multi body Systemsò, Springer, 2009

Paper Code: MRA- 607	**L**	**T**	**C**
Paper Title: Modern Control Theory	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks:60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT 1

Digital Control System configuration, Basic discrete time signals, time domain models for discrete time systems, transfer function models, stability on z plane, z domain description of continuous time systems, implementation of digital controllers, stepper motor and its control, synchro error detector pair, servo motors and their control, position control systems, z transforms

(10 Hrs)

UNIT 2

Vectors and matrices, state variable representation, conversion of state variable models to transfer function and vice versa, Eigen values and Eigen vectors, solution of state equations: forced and unforced systems, controllability and observe ability, multi variable systems, state variable analysis of digital control systems

(10 Hrs)

UNIT 3

State variable feedback structure, pole placement design using state feedback, state feedback with integral control, observer based state feedback control, digital control using state feedback, optimal control systems, optimal digital control

(10 Hrs)

UNIT 4

Non Linear systems: Linear approximations, common nonlinearities in control systems, describing function method for stability analysis, concepts of phase plane analysis, lyapunov stability analysis, linear quadratic optimal control through lyapunov equation

(10 Hrs)

References:

1. M. Gopal, ñDigital control and state variable methodsò, TMH, 2008.
2. M. Gopal, ñControl systems: Principles and designò, TMH, 2002.
3., K. Ogata, ñControl Theoryò, PHI, 4th Edition, 2009.

Paper Code: MRA-609	**L**	**T**	**C**
Paper Title: Artificial Intelligence	**4**	**0**	**4**

Instructions to paper setters: **Maximum Marks:60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT-1

Scope of AI: Robotics, Machine Learning, Intelligent Machines, Expert Systems, Games theorem proving, natural language processing, vision and speech processing, expert system, AI techniques-search knowledge, abstraction. Intelligent Agents: Autonomy ,Properties, Environments , Taxonomy, Mobile Agents, Architectures- Reactive , Hybrid & Mobile Architecture. Robotics: Taxonomy, Hard & Soft Robots, Natural Sensing Control, Perception with sensors, Actuation with Effectors, Movement Planning, Robot Programming Languages.

(10 Hrs)

UNIT-2

Machine Learning: Machine Learning Algorithms, Supervised learning, unsupervised learning, Markov Model, Nearest Neighbour classification-kNN, Knowledge Representation: Predicate Logic: Unification, Modus Ponens, Modus Tolens, , Resolution in Predicate Logic, Conflict Resolution Forward Chaining, Backward chaining, Declarative and Procedural Representation, Rule based Systems.

(10 Hrs)

UNIT-3

Rule Based Systems , Inference Systems, Problem Solving (Blind): State Space search; production system, depth-first, breadth-first search. Heuristic search, Hill climbing, best-first search, branch and bound, Problem reduction, Constraint Satisfaction End,

(10 Hrs)

UNIT-4

Expert System: Need and justification for expert System, Knowledge acquisition, , Architecture of Expert Systems. Case Studies: Intelligent Air Condition, Sugar Mill Boiler, Salmon Cutting Machine.

(10 Hrs)

References:

1. Jones M. T ñArtificial Intelligence ï A systems Approachò, Firewall Media, Infinity Science Press, 2008.
2. Luger G.F. ñArtificial Intelligence ï Structures and Stratgies for Complex Problem Solvingò, Pearson Education, 5th Edition, 2010.
3. Russel S. & Norvig P. ñArtificial Intelligence ï A Modern Approachò, Second Edition 2013.
4. Schalkoff R., ñIntelligent Systems - Principles, Paradigms & Pragmaticsò Jones & Bartlet Learning, First Indian Edition 2011.

Paper Code: MRA-611	**L**	**T**	**C**
Paper Title: Neural Network and Fuzzy Logic	**4**	**0**	**4**

Instructions to paper setters: **Maximum marks:60**

1. **Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 20 marks.**
2. **Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 10 marks**

UNIT-1

Network: History, Overview Of Biological Neuro-System, Mathematical Models Of Neurons, ANN architecture, Learning Rules, Learning Paradigms-Supervised, Unsupervised and Reinforcement Learning, ANN training Algorithms-perceptions, Training rules, , Back Propagation Algorithm, K Means clustering, Probabilistic Neural Network, Multilayer Perception Model, Hopfield Networks, Associative Memories, Applications of Artificial Neural Networks.

(10 Hrs)

UNIT-2

FUZZY LOGIC: Introduction to fuzzy logic, Classical and fuzzy sets: Overview of Classical Sets, Membership Function and Fuzzy rule Generation. **Operation on Fuzzy Sets:** Compliment, Intersection, Unions, Combinations of Operations, Aggregation Operations **Fuzzy Airthmetic:** Fuzzy numbers, Linguistic variables, arithmetic operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations.

(10 Hrs)

UNIT-3

Fuzzy Logic: Classical Logic, Multivalued logics, Fuzzy Propositions, Fuzzy Qualifires, Linguistic Hedges. **Uncertainty based Information:** Information & Uncertainty, Nonspecificity of Fuzzy & Crisp Sets, Fuzziness of Fuzzy Sets.

(10 Hrs)

UNIT-4

Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks. Application of Fuzzy Logic & Neural Networks in Intelligent Machine Design.

(10 Hrs)

References:

(1) Lee H.H., ñFirst Course on Fuzzy Theory & Applicationò, Springer Publications, 2005.
(2) Yen J. & Langari R., ñFuzzy Logicð Intelligence Control & Informationò, Pearson Education Asia, 1999.
(3) Ross T.J., ñFuzzy Logic with Engineering Applicationsò, Wiley India, 2011
(4) Haykins S., ñNeural Networksò, Pearson Education, 2009
(5) Kumar S., ñNeural Networksò, Tata Mc GrawHill Publications, 2004.

Paper Code: MRA ï 613	**L**	**P**	**C**
Paper Title: Advanced Robotics Lab	**0**	**2**	**1**

Experiments will be based on theory course of Advanced Robotics

Paper Code: MRA ï 615	**L**	**P**	**C**
Paper Title: Computers Integrated Manufacturing Lab	**0**	**2**	**1**

Experiments will be based on theory course of Computers Integrated Manufacturing

Paper Code: MRA - 617	**L**	**P**	**C**
Paper Title: Minor Project	**0**	**8**	**12**

Paper Code: MRA - 602	**L**	**P**	**C**
Paper Title: Dissertation	**0**	**8**	**12**

Paper Code: MRA - 604	**L**	**P**	**C**
Paper Title: Seminar and Progress Report	**0**	**8**	**12**