Master of Technology
(Robotics and Automation)

First Semester

Code No.	Paper	L	T/P	Credits
Theory papers				
MERA-601	Computational Mathematics	4	-	4
MERA-603	Robotics Engineering	4	-	4
MERA-605 or MERA-607	Introduction to Manufacturing Systems *(For CSE/IT/ECE/ICE background students)* or Introduction to Electrical and Electronics Systems *(For MAE/Mechanical/Production/Industrial Engg background students)*	4	-	4
	Electives (Choose any two)	4	-	4
MERA-609	Control System	4	-	4
MERA-611	Robotics Based Industrial Automation	4	-	4
MERA-613	Computer Aided Modeling and Design	4	-	4
MERA-615	Introduction to Wireless Networks	4	-	4
MERA-617	Digital System Design	4	-	4
MERA-619	Mechatronics Systems and Applications	4	-	4
MERA-621	Signal Processing	4	-	4
Practical				
MERA-651	Lab -I (Computational Lab)	-	2	1
MERA-653	Lab-II (Robotics Engineering Lab)	-	2	1
MERA-655	Lab-III (Lab based on Elective)	-	2	1
MERA-657*	Term Paper-I			2
	Total	20	6	25

* Non-University Examination System

Master of Technology
(Robotics and Automation)

Second Semester

Code No.	Paper	L	T/P	Credit
Theory Papers				
MERA-602	Mobile Robots	4	-	4
MERA-604	Embedded Systems Design	4	-	4
MERA-606	Artificial Intelligence	4	-	4
	Elective-I & II (Choose any two)	4	-	4
MERA-608	Image Processing	4	-	4
MERA-610	CAD/CAM	4	-	4
MERA-612	Instrumentation and Sensors	4	-	4
MERA-614	Pneumatic and Hydraulic Control	4	-	4
MERA-616	Programming and Data Structure	4	-	4
MERA-618	Optimization Techniques	4	-	4
MERA-620	Advanced Manufacturing Systems	4	-	4
Practical				
MERA-652	Lab-IV (Embedded Systems Lab)	-	2	1
MERA-654	Lab-V (Artificial Intelligence Lab)	-	2	1
MERA-656	Lab-VI (Elective Lab)	-	2	1
MERA-658*	Term Paper-II	-	-	2
	Total	20	6	25

* Non-University Examination System

Master of Technology
(Robotics and Automation)

Third Semester

Code No.	Paper	L	T/P	Credit
MERA-701	Computer Integrated Manufacturing	4	-	4
MERA-703	Computer Vision	4	-	4
	Elective-III& IV (Choose any three)			
MERA-705	Robot Programming	4	-	4
MERA-707	Digital control	4	-	4
MERA-709	Advanced Control System	4	-	4
MERA-711	Global Optimization techniques	4	-	4
MERA-713	Soft Computing	4	-	4
MERA-715	Rapid Prototyping	4	-	4
MERA-717	MEMS and Microsystems	4	-	4
MERA-719	Simulation and Modeling	4	-	4
MERA-721	Machine learning	4	-	4
	LABS			
MERA-751	Lab-VII (Simulation and Modeling Lab)	-	2	1
MERA-753	Lab- VIII (Elective lab)	-	2	1
MERA-755*	Term Paper-III	-	-	2
MERA-757	Minor Project		4	4
	Total	**20**	8	28

* Non-University Examination System

Master of Technology
(Robotics and Automation)

Forth Semester

S.N.	Subject Code	Subject Name	L/P	Credit
1.	MERA-752	Dissertation	-	24
2.	MERA-754*	Seminar and Progress Report	-	4
3.	MERA-756*	Term Paper-IV	-	2
		Total		30

* Non-University Examination System

NOTE:

1. The total number of credits of the Programme M. Tech. = 108.
2. Each student shall be required to appear for examination in all courses, But for the award of the degree a student shall be required to earn the minimum of 100 credits out of 108. However only Elective Courses and Term papers may be dropped towards counting for total credits of 100 to award M. Tech. Degree.

MERA- 601	Computational Mathematics	L	T/P	C
		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

Fourier Series and Transform (continuous time): Definition, properties, solution of differential equation.
Laplace Transform (continuous time): Definition, properties, solution of differential equation.
Discrete Fourier Transform: Definition, properties, solution of difference equations. Fast fourier transform.
z-Transform:Definition, properties, solution of difference equations. [T1, R1]

UNIT-II

Interpolation and Numerical Differentiation: Interpolating Polynomial, Lagrange Form, Newton Form, Nested Form, Inverse Interpolation, Estimating Derivatives and Richardson Extrapolation.
Approximation by Spline Function: 1st and 2nd Degree Splines, Natural Cubic Splines, B Splines, Interpolation and Approximation. [T2]

UNIT-III

Numerical Integration: Definite Integral, Riemann – Integrable Functions, Trapezoid Rule, Romberg Algorithm, Simpson's Scheme, Gaussian Quadrature Rule.
Differential Equations: Euler method, Taylor series method of higher orders, Runge – Kutta method of order 2 and 4, Solution of Parabolic, Hyperbolic and Elliptic PDEs. [T2, R2]

UNIT-IV

Location of Roots of functions and their minimization: Bisection method (convergence analysis and implementation), Newton Method (convergence analysis and implementation), Secant Method (convergence analysis and implementation). Unconstrained one variable function minimization by Fibonnaci search, Golden Section Search and Newton's method. Multivariate function minimization by the method of steepest descent.
Linear System of Equations: Conditioning, Gauss Elimination, Pivoting, Cholesky Factorization, Iterative Methods, Power Method. [T2, R1]

Text Books:

[T1] S. Haykin and B. V. Veen, "Signal and Systems", John Wiley and Sons, 1999.
[T2] D. Kincaid and W. Cheney, "Numerical Analysis: Mathematics of Scientific Computing", Thomson/Brooks-Cole., 1991.

Reference Books:

[R1] B. P. Lathi, "Signal Processing and Linear System", Berkeley Cambridge Press, 1998.
[R2] H. M. Antia, "Numerical Methods for Scientists & Engineers", Hindustan Book Agency,2002.
[R3] W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, "Numerical Recipes in C", CUP, 2002.

MERA-603	Robotics Engineering	L	T/P	C
		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-Introduction

History of robots, Classification of robots, Present status and future trends. Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Mechanisms and transmission, End effectors, Grippers-different methods of gripping, Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, Cam type gripper, Magnetic grippers, Vacuum grippers, Air operated grippers; Specifications of robot. [T1, T2, R1, R2, R7]

UNIT II- Drive systems and Sensors

Drive system- hydraulic, pneumatic and electric systems

Sensors in robot – Touch sensors, Tactile sensor, Proximity and range sensors, Robotic vision sensor, Force sensor, Light sensors, Pressure sensors. [T1, T2, R1, R2, R6, R7]

UNIT II- Kinematics and Dynamics of Robots

2D, 3D Transformation, Scaling, Rotation, Translation, Homogeneous coordinates, multiple transformation, Simple problems.

Matrix representation, Forward and Reverse Kinematics Of Three Degree of Freedom, Homogeneious Transformations, Inverse kinematics of Robot,Robot Arm dynamics, D-H representationof robots, Basics of Trajectory Planning. [T1, T2, R1, R2, R5]

UNIT IV-Robot Control, Programming and Applications

Robot controls-Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT,Motion Interpolations, Adaptive control.

Introduction to Robotic Programming, On-line and off-line programming, programming examples.

Robot applications-Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting. [T1, T2, R6, R7]

Text Books:

[T1] Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.

[T2] Craig. J. J. "Introduction to Robotics- mechanics and control", Addison- Wesley, 1999.

Reference Books:

[R1] S.R. Deb, "Robotics Technology and flexible automation", Tata McGraw-Hill Education., 2009.

[R2] Richard D. Klafter, Thomas .A, ChriElewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning., 2009.

[R3] Francis N. Nagy, Andras Siegler, "Engineering foundation of Robotics", Prentice Hall Inc., 1987.

[R4] P.A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing company Ltd., 1995.

[R5] Carl D. Crane and Joseph Duffy, "Kinematic Analysis of Robot manipulators", Cambridge University press, 2008.

[R6] Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics control, sensing, vision and intelligence", McGraw Hill Book co, 1987

[R7] Ray Asfahl. C., "Robots and Manufacturing Automation", John Wiley & Sons Inc.,1985

MERA-605	Introduction to Manufacturing Systems (for CSE/IT/ECE/ICE/EE background students)	L	T/P	C
		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

Definition of manufacturing, Overview of manufacturing processes.

Welding Processes- Definition of welding, Gas Welding, Electric Arc Welding- Principle of arc, arc welding equipment, manual metal arc welding. Resistance welding- Principle, Resistance spot welding, Resistance seam welding. Electron beam welding, Laser beam welding, Brazing, Soldering. [T2, R1]

UNIT-II

Metal Removal Processes- Introduction of metal removal processes, Concept of chip formation, Orthogonal and oblique cutting, Classification of machine tools, Generation and forming, methods of generating surfaces, Basic elements of machine tools. Introduction to centre lathe, Operations performed on centre lathe.

Reciprocating Machine Tools- Shaper, Planer, Slotter. [T1, T2, R1, R2]

UNIT-III

Milling- Introduction, Types of milling machines.

Hole Making Operations- Introduction to Drilling, Boring, Reaming, Tapping.

Grinding- Introduction, Grinding wheel-abrasive type, grain size; Types of grinding machines - cylindrical grinding, surface grinding, centre less grinding, Honing, Lapping.

Introduction to Gear cutting operations.

Unconventional Machining Processes- Working principles of EDM, ECM, USM, LBM. [T1, T2, R1, R2]

UNIT-IV:

Process Planning- Concept of process planning, Product cycle in manufacturing, Product Quality, Accuracy of machining, Accuracy of assembly.

Metrology- Tolerance, Limits and Fits, Hole basis system, Linear measurement, Slip gauges, comparators, Angular measurement.

Numeric Control of Machine Tools- Numeric control, NC machine tools, Introduction to CNC and DNC. [T2,T3, R1, R2]

Text Books:

[T1] P.N.Rao, "Manufacturing Technology-Metal Cutting and Machine Tools", TMH.

[T2] M.P.Groover, "Fundamentals of Modern Manufacturing", Wiley India Pvt., Ltd.

[T3] M.P.Groover, "Automation, Production Systems and Computer Integrated Manufacturing", PHI

Reference Books:

[R1] Serope Kalpakjian and Steven R. Schimid, "Manufacturing Processes", Pearson.

[R2] Gerling Heinrich, “All about Machine Tools”, New Age Publication, 2003.

MERA-607	Introduction to Electrical and Electronics Systems (for MAE/ME/Production/Industrial Engg background students)	L	T/P	C
		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

Review of DC and AC circuits.

Introduction of DC Circuit parameters and energy sources (Dependent and Independent), Mesh and Nodal Analysis, Superposition, Thevenin's, Norton's, Reciprocity, Maximum Power Transfer and Millman's Theorems. [T1]

UNIT-II

Introduction to DC and Induction motors (both three phase and single phase), Stepper Motor and Permanent Magnet Brushless DC Motor. Speed and Torque Equation of D.C. motors, Characteristics of D.C. series, shunt and compound motors and their applications, Starting and speed control of D.C. motors, Braking of D.C. motors, Efficiency and testing of D.C. Machines, Introduction of D.C. servo motor and permanent magnet / brushless D.C. motors. [T2]

UNIT-III

Review of p-n junction diode.

Introduction to BJT and MOSFETS, hybrid model for transistor at low frequencies.

Digital and analog signals, number systems, Boolean algebra, Switching Theory: - Boolean Algebra-Postulates and Theorems, De' Morgan's Theorem, Switching Functions- Canonical Forms- logic gates with simple applications, logic gates, Simplification of Switching Functions- Karnaugh Map and Quine Mc-Clusky Methods. [T3]

UNIT-IV

Number Systems and Codes:- Decimal, Binary, Octal and Hexadecimal Number systems, Codes- BCD, Gray Code, Excess-3 Code, ASCII, EBCDIC, Conversion between various Codes.

Combinational Logic Circuits:- Review of basic gates- Universal gates, Adder, Subtractor ,Serial Adder, Parallel Adder- Carry Propagate Adder, Carry Look-ahead Adder, Carry Save Adder, Comparators, Parity Generators, Decoder and Encoder, Multiplexer and De-multiplexer, ALU, PLA and PAL. [T4]

Text Books:

[T1] S.N Singh, "Basic Electrical Engineering" PHI India Ed 2012.
[T2] Chakrabarti, Chanda,Nath "Basic Electrical Engineering" TMH India", Ed 2012.
[T3] R.P. Jain, "Modern Digital Electronics", TMH, 2nd Ed.
[T4] Morris Mano, Digital Logic and Computer Design", Pearson.

Reference Books:

[R1] ZyiKohavi, "Switching & Finite Automata Theory", TMH, 2nd Edition.
[R2] S.Salivahanan, A. Vallavaraj, C. Gnanapriya, "Digital Signal Processing", Tata McGraw Hill International/TMH, 2007.

MERA-609	Control System	L	T/P	C
		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

Introduction to control and Feedback Control: Basic principles, Elements of the feedback Loop, Block Diagram, Control Performance, Measures for Common Input Changes, Selection of Variables for Control Approach to Process Control.

Factors in Controller Tuning, Determining Tuning Constants for Good Control Performance, Correlations for tuning Constants, Fine Tuning of the controller tuning Constants. The performance of feedback Systems, Practical Application of Feedback Control: Equipment Specification, Input Processing, Feedback Control Algorithm, Output Processing. [T1,T2]

UNIT-II

Multi Loop & Nonlinear Systems: Cascade control, Feed forward control, feedback-feed forward control, Ratio control, Selective Control , Split range control- Basic principles, Design Criteria , Performance, Controller Algorithm and Tuning, Implementation issues, Examples and any special features of the individual loop and industrial applications. Nonlinear Elements in Loop: Limiters, Dead Zones, Backlash, Dead Band Velocity Limiting, Negative Resistance, Improvement in nonlinear process performance through: Deterministic Control Loop Calculations, Calculations of the measured variable, final control element selection, cascade control design, Real time implementation issues. [T1,T2, R1]

UNIT-III

Multivariable Control: Concept of Multivariable Control: Interactions and it's effects, Modelling and transfer functions, Influence of Interaction o the possibility of feedback control, important effects on Multivariable system behavior Relative Gain Array, effect of Interaction on stability and Multiloop Control system. Multiloop control Performance through: Loop Paring, tuning, Enhancement through Decoupling, Single Loop Enhancements. [T1,T2]

UNII-IV

Intelligent Controllers: Step analysis method for finding first, second and multiple time constants and deadtime. Model Based controllers: Internal Model control, Smith predictor, optimal controller, Model Predictive controller, Dynamic matrix controller (DMC). Self Tunning Controller. Fuzzy logic systems and Fuzzy controllers, Introduction, Basic Concepts of Fuzzy Logic, Fuzzy Sets, Fuzzy Relation, Fuzzy Graphs, and Fuzzy Arithmetic, Fuzzy If-Then Rules, Fuzzy Logic Applications, Neuro-Fuzzy Artificial Neural networks and ANN controller. [T1, T2, R5, R6]

Text Books:

[T1] K. Ogata, "Modern control engineering", Pearson 2002.
[T2] Nagraath Gopal "Control Systems Engineering -Principles and Design" New Age Publishers

Reference Books:

[R1] Donald Eckman, "Automatic Process Control", Wiley Eastern Limited.
[R2] Thomas E Marlin "Process Control- Designing processes and Control Systems for Dynamic Performance", McGraw-Hill International Editions.
[R3] F.G.Shinskey, "Process control Systems", TMH.
[R4] Krishna Kant, "Computer Based Industrial Control", PHI .
[R5] Chi-Tsong Chen, "Linear System Theory and Design", Oxford University Press.
[R6] B. C. Kuo, "Automatic Control System", Prentice Hall of India, 7th edition 2001.

MERA-611	**Robotics Based Industrial Automation**	L	T/P	C
		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

Introduction: Definition, automation principles and strategies, scope of automation, socio-economic consideration, low cost automation, basic elements of advanced functions, Information processing in manufacturing industry, Production concepts and automation strategies.

Fixed Automation: Automated Flow lines, Methods of Work part 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. [T1]

UNIT II

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. [T1, R1]

UNIT III

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. [T1, T2]

UNIT IV

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, PerformanceModeling Tools: Simulation Models, Analytical Models. [T2, R1, R2]

Text Books:

[T1] Mikell P.Grover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education Asia, 2001.

[T2] C.RayAsfahl, "Robots and manufacturing Automation", John Wiley and Sons New York, 1992.

Reference Books:

[R1] N.Viswanadham and Y.Narahari, "Performance Modeling of Automated Manufacturing Systems", Prentice Hall India Pvt. Ltd, 1992.

[R2] Stephen J. Derby, "Design of Automatic Machinery", Special Indian Edition, Marcel Decker, New York, Yesdee publishing Pvt. Ltd, Chennai, 2004.

MERA-613	Computer aided Modelling and Design	L	T/P	C
		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 1

Introduction: 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, Synthetic curves-Bezier, B-Spline, NURBS. [T1,T2]

UNIT 2

Surface Modeling: Surface representations, surface generation methods, Analytic Surface – Plane Surface, Ruled Surface, Surface of Revolution, Synthetic Surface-Cubic, Bezier, B-spline, Blending of surfaces, surface rendering. [T1,T2]

UNIT 3

Solid Modeling Techniques: Graph Based Model, Boolean Models, Instances, Cell Decomposition & Spatial – Occupancy Enumeration, Boundary Representation (B-rep) & Constructive Solid Geometry (CSG). [T1,T2]

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. [T1]

Text Books:

[T1] Ibrahim Zeid, "CAD/CAM, Theory and Practice", McGraw Hill, 1998.

[T2] Foley, Van Dam, Feiner and Hughes, "Computer Graphics Principles and Practice", Addison – Wesley, 2000.

Reference Books:

[R1] Martenson, E. Micheal, "Geometric Modelling", John Wiley & Sons, 1995.

[R2] Hill Jr, F.S., "Computer Graphics using open GL", Pearson Education, 2003.

[R3] Hearn & Baker, "Computer Graphics", PHI.

MERA-615	Introduction to Wireless Networks	L	T/P	C
		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

Introduction To Wireless Communication Systems: Evolution of mobile radio communications; examples of wireless comm. systems; paging systems; Cordless telephone systems; overview of generations of cellular systems, comparison of various wireless systems.

Introduction to Personal Communication Services (PCS): PCS architecture, Mobility management, Networks signaling. A basic cellular system, multiple access techniques: FDMA, TDMA, CDMA.

Introduction to Wireless Channels and Diversity: Fast Fading Wireless Channel Modeling, Rayleigh/Ricean Fading Channels, BER Performance in Fading Channels, Introduction to Diversity modeling for Wireless Communications. [T1, T2]

UNIT - II

2G Networks: Second generation, digital, wireless systems: GSM, IS_136 (D-AMPS), IS-95 CDMA. Global system for Mobile Communication (GSM) system overview: GSM Architecture, Mobility Management, Network signaling, mobile management, voice signal processing and coding. Spread Spectrum Systems-Cellular code Division Access Systems-Principle, Power Control, effects of multipath propagation on code division multiple access. [T1, T2]

UNIT - III

2.5G Mobile Data Networks: Introduction to Mobile Data Networks, General Packet Radio Services (GPRS): GPRS architecture, GPRS Network nodes, EDGE,Wireless LANs, (IEEE 802.11), Mobile IP.

Third Generation (3G) Mobile Services: Introduction to International Mobile Telecommunications 2000 (IMT 2000) vision, Wideband Code Division Multiple Access (W-CDMA), and CDMA 2000, Quality of services in 3G, Introduction to 4G. [T1, T2]

UNIT – IV

Wireless Local Loop (WLL): Introduction to WLL architecture, WLL technologies. Wireless personal area networks (WPAN): Blue tooth, IEEE 802.15, architecture, protocol stack. Wi-Max, introduction to Mobile Adhoc Networks.

Global Mobile Satellite Systems, Case studies of IRIDIUM and GLOBALSTAR systems. [T1, T2]

Text Books:

[T1] Raj Pandya, "Mobile & Personnel communication Systems and Services", Prentice Hall India, 2001.

[T2] Theodore S. Rappaport, "Wireless Communication- Principles and practices," 2nd Ed., Pearson Education Pvt. Ltd, 5th Edition, 2008.

Reference Books:

[R1] T.L.Singhal "Wireless Communication", Tata McGraw Hill Publication.

[R2] Jochen Schiller, "Mobile communications," Pearson Education Pvt. Ltd., 2002.

[R3] Yi –Bing Lin &ImrichChlamatac, "Wireless and Mobile Networks Architecture," John Wiley & Sons, 2001.

[R4] Lee, W.C.Y., "Mobile Cellular Telecommunication", 2nd Edition, McGraw Hill,1998.

[R5] Smith & Collins, "3G Wireless Networks," TMH, 2007.

[R6] Schiller, Jochen, "Mobile Communications", 2nd Edition, Addison Wesley.

MERA-617	Digital System Design	L	T/P	C
		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

Gajski's 'Y' Chart, Behavioral Modeling, Data flow modeling, Structural modeling, Hardware Description Language, Specification of combinational systems using VHDL, Introduction to VHDL, Basic language, element of VHDL, Design of Adder, Subtractor, Decoder, Encoder, and Multiplexor circuit, Generic, Component and Package description with example. [T1, R4]

UNIT – II

Description and design of sequential circuits using VHDL, Description of Process, Functions, Packages and loop statement using example, Design of shift Register, Design of Counter and Memory using VHDL. [T1, R2]

UNIT – III

Register- transfer level systems, Systems, Analysis of RTL Systems, Design of RTL Systems. Data Subsystems, Storage Modules, Functional Modules, Datapaths, Control Subsystems. Basics of State Machine, Design of a Serial Adder with Accumulator, State Graph for Control Network, design of a Binary Multiplier. [T2, R1]

UNIT – IV

Programmable Devices: Architecture of Programmable Array Logic and PLA, Architecture description of Field Programmable Gate Array and Complex Programmable Logic Devices, Case studies of robotic application using FPGA/CPLD. [T2, R1]

Text Books:

[T1] V.Padroni, "Digital System Design". Pearson.

[T2] M. Ercegovac, T. Lang and L.J. Moreno, "Introduction to Digital Systems", Wiley,2000

Reference Books:

[R1] C. H. Roth, "Digital System Design using VHDL", Jaico Publishing, 2001

[R2] J. Bhaskar, " A VHDL Primer", Addison Wesley, 1999.

[R3] Douglas L. Perry , "VHDL Programming by Examples", TMH, 2000

[R4] Sumit Ghose, "Hardware Description Languages" PHI, 2000

[R5] P.J. Ashendern , "The Designer Guide to VHDL", Kaufmann Pub. 2000

[R6] Mark Zwolinski , "Digital System Design with VHDL" Prentice Hall Pub. 1999

[R7] Zeidman , "Designing with FPGA & CPLDs", CMP Pub. 1999

[R8] Douglas J. Smith , "HDL Chip Design", Doone Pub. 2001

MERA-619	Mechatronics Systems and applications	L	T/P	C
		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

Introduction: Introduction to Mechatronics System, mechatronics in manufacturing, product and design, Measurement Systems, Control System, comparison between traditional and mechatronics approach.

Sensors and Transducers: Introduction, Performance terminology, Displacement, Position and Proximity, Velocity and motion, Fluid pressure, Temperature sensors, Light sensors, Selection of sensors. [T1, T2]

UNIT-II

Mechanical Actuation System: Cams, Gear trains, Ratchet and Pawl, Belt and chain drives, Bearings.

Hydraulic and Pneumatic Actuation System: Introduction to Hydraulic and Pneumatic Systems, Directional Control valves, Flow control valves.

Electrical Actuation System: Electrical systems, Solid State Switches, Solenoids, D.C. motors, A.C. motors, Stepper motors. [T1, T2]

UNIT-III Processors/Controllers

Microprocessors: Microprocessor systems, Microcontrollers, applications.

Programmable Logic Controllers: Basic PLC structure, Input/output processing, ladder programming, latching and internal relays, Sequencing, Timers and counters, Shift registers, Master and jump controls, Code conversion, Data handling, selection of PLC. [T1, T2]

UNIT-IV

System Models: Mathematical models, Mechanical, Electrical, hydraulic and Thermal Systems, Modelling of dynamic systems.

Design of Mechatronics systems: Stages in designing mechatronics system, Traditional and Mechatronic design.

Case studies of Mechatronics system: Pick and place robots, automated guided vehicle, Automatic car park barrier, Engine management system. [T1, T2]

Text Books:

[T1] W.Bolton, "Mechatronics" , Pearson education, second edition, fifth Indian Reprint, 2003.

[T2] A. Smaili and F. Mrad, "Mechatronics- integrated technologies for intelligent machines", Oxford university press, 2008.

Reference Books:

[R1] R.K Rajput, A textbook of mechatronics, S. Chand & Co, 2007.

[R2] Michael B. Histand and David G. Alciatore, " Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 2000.

[R3] D. A. Bradley, Dawson D., Buru N.C. and. Loader A.J, "Mechatronics", Chapman and Hall, 1993.

[R4] Dan Necsulesu, "Mechatronics", Pearson Education Asia, 2002 (Indian Reprint).

[R5] Lawrence J. Kamm, "Understanding Electro – Mechanical Engineering", An Introduction to Mechatronics, Prentice – Hall of India Pvt., Ltd., 2000.

[R6] Nitaigour Premchand Mahadik, "Mechatronics", Tata McGraw-Hill publishing Company Ltd, 2003.

MERA-621	Signal Processing	L	T/P	C
		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

Signals and signal Processing: Characterization & classification of signals, typical Signal Processing operations, example of typical signals, typical Signals Processing applications.

Time Domain Representation of Signals & Systems: Discrete Time Signals,
Operations on Sequences, the sampling process, Discrete-Time systems, Time Domain characterization of LTI Discrete-Time systems. [T1, T2, R1, R2]

UNIT-II

Transform-Domain Representation of Signals: Discrete Fourier Transform (DFT), DFT properties, computation of the DFT of real sequences, Linear Convolution using the DFT. Z-transforms, Inverse z-transform, properties of z-transform. [T1, T2, R1, R2]

UNIT-III

Computation of the Discrete Fourier Transform: Computational complexity of the direct computation of the DFT, different approaches for reducing the computations, Decimation-in-Time FFT algorithms, Decimation-in-frequency FFT algorithms. [T1, T2, R1, R2]

UNIT-IV

Digital Filter Structure: Block Diagram representation, Signal Flow Graph Representation, Signal Flow Graph Representation, FIR Digital Filter Structure, IIR Filter Structures, Parallel all pass realization of IIR Filter design based on Frequency Sampling approach. [T1, T2, R1, R2]

Text Books:

[T1] A. Y. Oppenhein and R. W. Schater, "Digital Signal Processing", PHI 1975.
[T2] Sanjit K. Mitra, "Digital Signal Processing: A Computer based approach",TMH, 2005.

Reference Books:

[R1] J. G. Proakis and D.G. Manolakis, "Digital Signal Processing, Principals, Algorithms, and Applications", Pearson Education, 4th ed., 2007.
[R2] A. Y. Oppenhein, R. W. Schater and J. R. Buck, "Discrete Time Signal Processing", PHI 1999.

Lab-I (Computational Lab): Experiments based on Computational Mathematics.

Lab-II (Robotics Engg Lab): Experiments based on Robotics Engineering.

Lab-III: Based on elective.

MERA-602	Mobile Robots	L	T/P	C
		4	0	4

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

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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

Introduction of Mobile Robotics, Mechanics and Locomotion: A brief history of mobile robotics, applications and market. Recent advances in the mobile robotics for RISE (Risky Intervention and Surveillance Environment) applications, Locomotion, Key issues in locomotion, legged, wheeled and aerial mobile robots.

Mobile Robot Kinematics: Introduction, kinematic models and constrains, mobile robot workspace, beyond basic kinematics, motion control (kinematic control). [T1, T2, T3]

UNIT-II

Perception, robotics Architectures and Robot Learning: Sensors Classification, sensor characterization, wheel/motor encoders, heading/orientation sensors, ground based beacons, active ranging, motion/speed sensors, vision based sensors. Low level control, Control architectures, software frameworks, Robot Learning, case studies of learning robots. [T1, T2, T3]

UNIT-III

Mobile Robot Localization: Introduction, the challenge of localization: Noise and aliasing, to localize or not to localize: localization based navigation versus programmed solutions, map representation, probabilistic map, map based localization, autonomous map building.

Planning and navigation: Planning and reaction, obstacle avoidance, D* algorithm, Navigation architecture, case studies. [T1, T2, T3, R2]

UNIT-IV

Introduction to image processing: Introduction to computer vision, Image processing: Point operators, Linear Filters, More neighborhood operators, Fourier transforms, Pyramids and wavelets, Geometric transformations.

Camera Systems in Machine : Camera Technology, History in Brief, Machine Vision versus closed Circuit Television (CCTV), Sensor Technologies, spatial Differentiation: 1D and 2D, CCD Technology, Full Frame Principle, Frame Transfer Principle, Interline Tranfer, Interlaced Scan Interline Transfer, Frame Readout. [T1, T2, T3, R1]

Text Books:

[T1] Roland Siegwart & Illah R. Nourbakhsh, “Introduction to autonomous mobile robots”, Prentice Hall of India, 2004.

[T2] George A. Bekey “Autonomous Robots” MIT Press.

[T3] Howie Choset, Kevin M. Lynch, Seth Hutchinson, George A. Kantor, Wolfram Burgard, Lydia E. Kavrakiand Sebastian Thrun, "Principles of Robot motion: Theory, Algorithm and Implementations", MIT Press.

Reference Books:

[R1] Richard Szeliski: “Computer Vision : Algorithms and Applications”, 2010 Springer.

[R2] Alexander Hornberg: “Handbook of Machine Vision”, Wiley-VCH.

MERA-604	Embedded System Design	L	T/P	C
		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 10 marks**

UNIT -I

Introduction to Embedded System Design, Categories of ES, Overview of Embedded System Architecture, Recent Trends in Embedded Systems, Hardware Architecture of Embedded System, Real-time Embedded Systems and Robots, Robots and Robotics, Microprocessors and Microcontrollers, Microcontroller or Embedded Controller [T1, R2]

UNIT - II

Robotics: Classification of Robots, Degree of freedom, Kinematics; Multidisciplinary approach: Motors-DC motors, Stepper Motors, Servo Motors; Power Transmission-Type of Gears, Gear Assembly, CAM follower, Sensors, Open-loop and Closed-loop Controls, Artificial Intelligence, Architecture of 8051 Microcontroller-Assembly language programming (data types, directives, flag bits, PSW, register banks and Stacks) [T1, R1]

UNIT- III

Jump, Loop and Call instruction, Time delay for various 9051 chip, I/O programming and I/O bit manipulation , Interface of LED module, Key Scanning

Case studies to design sensor (LDR), Motor Driver (H-bridge) module [T1, R1]

UNIT-IV

Case studies of Closed-loop control and a learning robot- Hardware requirement, Locomotion and obstruction sensing, Learning process, Picking another set of points

Addressing Modes of 8051,Power Management of 8051, Timer Interrupts, Multiplexed displays

Case studies to Design an Intelligent Clock. [T1, R1]

Text Books:

[T1] Subrata Ghoshal, "Embedded Systems & Robots", Cengage Learning

Reference Books:

[R1] M.A. Mazidi, J.G. Mazidi, R.D. Mckinlay, "8051 Microcontroller and Embedded Systems", Pearson.

[R2] Dr. K.V.K. Prasad, "Embedded/Real-Time Systems: Concepts Design & Programming", Dreamtech.

MERA-606	Artificial Intelligence	L	T/P	C
		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

Introduction:

Introduction to artificial intelligence and intelligent agents, categorization of AI

Problem solving:

Production systems and rules for some AI problems: water jug problem, missionaries-cannibals problem etc.

Solving problems by searching : state space formulation, depth first and breadth first search, iterative deepening. [T1, T2]

Unit-II

Intelligent search methods:

A* and its memory restricted variants

Heuristic search:

Hill climbing, best-first search, problem reduction, constraint satisfaction.

Game Playing:

Minimax, alpha-beta pruning. [T1, T2, R1]

Unit-III

Knowledge and reasoning:

Propositional and first order logic, semantic networks, building a knowledge base, inference in first order logic, logical reasoning systems

Planning:

Components of a planning system, goal stack planning, non-linear planning strategies, probabilistic reasoning systems, Baysian networks. [T1, T2]

Unit-IV

Learning:

Overview of different forms of learning, Inductive learning, learning decision trees, computational learning theory,

Artificial neural networks.

Evolutionary computation: Genetic algorithms, swarm intelligence, particle swarm optimization.

Applications:

Robotics, Natural language processing etc. [T1, T2, R2]

Text Books:

[T1] Rich and Knight, "Artificial Intelligence", 3rd Edition, Tata McGraw Hill, 2014.

[T2] Saroj Kaushik, "Artificial Intelligence", Cengage Learning, 2011.

Reference Books:

[R1] Deepak Khemani, "A First Course in Artificial Intelligence", Tata McGraw Hill, 2013.

[R2] S. Russel and P.Norvig,"AI: A modern approach", 3rd Edition, Pearson Education, 2009.

MERA-608	Image Processing	L	T/P	C
		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

Introduction & Digital Image Fundamentals: Fundamentals Steps in Digital Image Processing, Components of Digital Image Processing Systems, Applications of Digital Image Processing, Image Sampling and Quantization, Some basic relationships like Neighborhood, Connectivity, Distance Measures between pixels, Linear and Non Linear Operations, stereo imaging and camera calibration. [T1]

UNIT II

Image Enhancement in the Spatial Domain: Some basic Gray Level Transformations, Histogram Equalization, Enhancement Using Arithmetic and Logic operations, Basics of Spatial Filters, Smoothening and Sharpening Spatial Filters, Combining Spatial Enhancement Method, Image Negation.

Image Enhancement in the Frequency Domain:

Introduction to Fourier Transform and its properties, Fast Fourier Transform, Smoothing and Sharpening Frequency Domain Filters, Homomorphic Filtering. [T1,R1]

UNIT III

Image Restoration: Model of the Image Degradation / Restoration Process, Noise Models, Restoration in the presence of Noise Only Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear Position-Invariant Degradations, Estimation of Degradation Function, Inverse filtering, Wiener filtering, Constrained Least Square Filtering, Geometric Mean Filter, Geometric Transformations.

Image Compression:

Coding, Inter-pixel and Psycho-visual Redundancy, Image Compression models, Elements of Information Theory, Error free compression, Lossy compression, Image compression standards, Introduction to Video Coding. [T1, R2]

UNIT IV

Image Segmentation: Detection of Discontinuities - point, lines and edge segmentation, Edge linking and boundary detection, Thresholding, Region Oriented Segmentation.

Representation and Description:

Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description,

Morphological Image Processing: Erosion and dilation, Some basic Morphological Algorithms.

[T1, R2, R3]

Text Books:

[T1] Rafael C. Gonzalez & Richard E. Woods, “Digital Image Processing”, 3rd Edition, Pearson Education, 2009.

Reference Books:

[R1] A.K. Jain, “Fundamental of Digital Image Processing”, PHI, 2003.
[R2] William K. Pratt, “Digital Image Processing”, Wiley, 2007.
[R3] Milan Sonka,VaclavHlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision" 3rd Edition, Cengage Learning, 2008.

MERA-610	CAD/CAM	L	T/P	C
		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

Introduction to CAD/CAM, Basic concepts of CAD - CAD workstation - principles of computer graphics - graphics programming - mechanical drafting package, CAD/CAM data base development and data base management systems, principles of computer aided engineering. [T1]

UNIT II

Advanced modeling techniques - surface modeling - solid modeling, rendering methods. Graphics and data exchange standards, Principles of optimum design - CAD optimization techniques, design for manufacture and assembly, application of CAD, concurrent engineering. [T1]

UNIT III

Computer aided manufacturing, programming and interface hardware – computer aided process monitoring - adaptive control, on-line search strategies, computer-aided process planning. [T2]

UNIT IV

Production systems at the operation level - computer generated time standards - machinability data systems - cutting conditions optimization - production planning - capacity planning - shop floor control - computer integrated manufacturing systems, application. [T2]

Text Books:

[T1] Ibrahim Zeid, "CAD/CAM, Theory and Practice", McGraw Hill, 1998.

[T2] M P Groover, "Automation, Production System and Computer Aided Manufacture", Prentice Hall, 1984.

Reference Books:

[R1] P. Radhakrishnan& C.P. Kothandaraman, "Computer Graphics and Design", Dhanpat Rai & Sons, 1990.

[R2] William M Newman & Robert Sproul, "Principle of Interactice Computer Graphics", Mc Graw Hill, 1984.

MERA-612	Instrumentation and Sensors	L	T/P	C
		4	0	4

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

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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

Measurement and Characteristics: Elements of a Measurement System; Classification of Instruments; Static Performance Parameters; Loading and Impedance Matching; Errors and Uncertainties in Measurement; Process and Standards of Calibration; Dynamic Characteristics- Transfer Function Representation of a Measurement System, Impulse and Step Responses of First and Second Order Systems, Frequency Response of First and Second Order Systems. [T1, R2]

UNIT II

Error Analysis: Types of errors, Methods of error analysis, uncertainty analysis, statistical analysis, Gaussian error distribution, chi- square test, correlation coefficient , students T – test , method of least square , curve fitting, graphical analysis.

Electrical Measurement: DC measurements, DC voltmeter, Ammeter ohmmeter, digital type voltmeter, Ammeter ohmmeter, AC measurement, Ammeter, ohmmeter, AC voltmeter using rectifier, true RMS voltmeter, Digital VOM meter. [T1, T2]

UNIT III

Transducers: Principles and classification of transducers, guidelines for selection and application of transducers, basic requirements of transducers. Different types of transducers.

Display Devices and Recorders: Telemetry & Remote sensing, GIS (Geographical information System), various display devices and Recorder, CRO (basic block diagram, deflection sensitivity, application: voltage, current, frequency and phase angle measurement). Digital R-L-C meters, digital frequency Meter and Universal Counter. [T1,T2,R1]

UNIT IV

Sensors: Classification, characteristics and calibration of different sensors, position sensors, motion sensors, force sensors, torque sensors, strain gauge sensors, pressure flow sensors, temperature sensors, smart sensors, tactile and proximity sensors, opto-electrical sensor, Principles and structures of modern micro sensors. [T3]

Text Books:

[T1] D.V.S. Murthy, "Transducers and Instrumentation", PHI 2003.

[T2] Albert D Helfrick and William D Cooper, "Modern Electronic Instrumentation and Measurement Techniques" 2004, PHI.

[T3] Nakra and Chaudhry, "Instrumentation, Measurement and Analysis",Tata McGraw-Hill.

Reference Books:

[R1] C.S. Rangan, G.R. Sarma, and V.S.V. Mani, "Instrumentation Devices and Systems", Tata McGraw-Hill.

[R2] S.K. Singh, "Industrial Instrumentation and Control" Tata Mcgrow-Hill (Third Edition).

[R3] K. Krishnaswamy and S. Vijaychitra, "Industrial Instrumentation", New Age International Publishers, Second Edition.

[R4] Doeblin and Ernest, "Measurement Systems Application and Design", Tata McGraw-Hill 2004.

[R5] D. P. Eckman, "Industrial Instrumentation", CBS Publishers and Distributer.

MERA-614	Hydraulic and Pneumatic control	L	T/P	C
		4	0	4

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

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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-Introduction

Fluid properties, Concepts of fluid dynamics, Hydraulic systems and their components, Pneumatic systems and their components, Use of fluid power, Properties of Hydraulic fluids, fluid flow fundamentals, Comparison of hydraulic and pneumatic systems, Safety considerations. [T1, T2, R4]

UNIT II- Hydraulic System

Hydraulic power transmission- Fluid power system design, Hydrostatic pumps and motors- Introduction, selection of pumps and motors, Types of motors and pumps, Some general considerations, comparison of motor performance characteristics.

Hydraulic actuators and motors- Introduction, linear actuators, principal features, Actuator selection.

Flow control valves- Valve configurations, symbolic representation, Valve analysis, three way spool valve analysis, flapper valve analysis, single and two stage pressure control valves, introduction to electro-hydraulic valves.

[T1, R3, R5]

UNIT III-Pneumatic System

Pneumatic fundamentals, symbols, Pneumatic elements, Steady flow of ideal gases, orifice and nozzle calculations, capillary flow, flow of real gases, linear flow equations in orifices and nozzles.

Multiple restrictions and volume calculations, Single acting pneumatic actuators and their applications. [T2, R4]

UNIT IV- Hydraulic and Pneumatic control elements

Control of single and double acting hydraulic cylinder, regenerative circuit, pump unloading circuit, Counter valve application, Hydraulic cylinder sequencing control, speed control of hydraulic cylinder.

Simple pneumatic control- direct and indirect actuation pneumatic cylinders, memory valves. Flow control valves and speed control of cylinders- supply air throttling and exhaust air throttling, use of quick exhaust valve.

[T1, T2, R3, R5]

Text Books:

[T1] Herbert E. Merritt, “Hydraulic Control Systems”, John Wiley & Sons.

[T2] B.W. Anderson, “The Analysis and Design of Pneumatic Systems”, Wiley.

Reference Books:

[R1] A.B. Goodwin, “Fluid Power Systems”, Macmillan.

[R2] Anthony Esposito, “Fluid power with applications”, Prentice Hall, 7th Edition.

[R3] Arthur Akers, Max Gassman, Richard Smith, “Hydraulic Power System Analysis”, Taylor and Francis Group.

[R4] Andrew Parr, "Pneumatic & Hydraulic", PHI.

[R5] John Pippenger & Tyler Hicks, “Industrial Hydraulics”, 3rd edition McGraw Hill.

MERA-616	Programming and Data Structure	L	T/P	C
		4	0	4

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

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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

C program structures, Variables, Data Types, Declarations, Operators (Arithmetic, Relational,Logical), increment and decrement operators, Assignment operators and expressions, Arithmeticexpressions, statements, symbolic constants, conditional expressions, Bitwise operators, precedenceand order of evaluations, input-output functions.

Statements and Blocks, branching statements (if, switch), Loops (while, for, do-while, repeat-until), Break and continue, go to and labels.

Functions, external variables, scope rules, header files, static variables, initialization, parameter passing (call-by-value, call-by-reference), recursion, C preprocessor. [T1, R1]

UNIT – II

Pointers and addresses, pointers and function arguments, pointer and arrays, address arithmetic, character pointers and functions, pointer arrays, multidimensional arrays, initialization of pointer arrays, pointers and multidimensional arrays, command line arguments, memory management.

Structures: Defining and processing, passing to a function, Unions.

Files: Standard input and output, formatted output, formatted input, file access, miscellaneous functions. [T1, R1]

UNIT – III

Data Structures: Arrays : representation and basic operations.

Linked list : Singly, Doubly, Circular and Doubly circular, definition, representation and their basic operations.

Stacks and queues : insertion, deletion. [T2, R2, R3]

UNIT – IV

Trees : insertion, deletion, traversal (inorder, preorder and postorder), binary trees, AVL trees, Btrees, B+-trees. [T2, R2, R3]

Text Books:

[T1] Kernighan and Ritche, “The C programming Language”, PHI. 1999.

[T2] Horowitz, E. and Sahni, S., “Fundamentals of Data Structures”, Galgotia Publications. 2002

Reference Books:

[R1] Gottfried, “Schaum’s Outline series in C Programming”, McGraw Hill 2003.

[R2] Lipschultz, “Schaum’s Outline series in Data Structures”, McGraw Hill 2001.

[R3] Tanenbaum: “Data Structures using C”, Pearson/PHI.

MERA-618	Optimization Techniques	L	T/P	C
		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

Statement of the Optimization Problem, Basic Definitions, Optimality Criteria for Unconstrained Optimization, Optimality Criteria for Constrained Optimization, Engineering Application of Optimization, Overview of optimization technique, Interdisciplinary nature. [T1, T2]

UNIT- II

Formulation, Simplex method, Primal to Dual, Dual Simplex method, Sensitivity Analysis.
Gomory's cutting plane method, Branch & Bound Technique. [T1, T2]

UNIT-III

Lagrangian method & Kuhn tucker method.
Interpolation method (Quadratic, Cubic & Direct root method). Direct search method – Random search, Pattern search and Rosen Brock's hill climbing method. [T1, T2]

UNIT-IV:

Gradient descent, Newton's method, Marquardt's method, Quasi Newton method.
Response Surface, the Least-Squares Methods, Two-Level Factorial Design, Central Composite Design (CCD), Sequential Nature of RSM. [T1, T2]

Text Books:

[T1] S.S. Rao, "Engineering Optimization - Theory and Practice", John Wiley and Sons Inc.
[T2] Pierre D.A., "Optimization, Theory with Application", John Wiley & sons.

Reference Books:

[R1] Pablo Pedregal, "Introduction to Optimization", Springer.
[R2] L.C. Jhamb, "Quantitative Techniques Vol. 1 and 2", Everest Pub. House.
[R3] Ranjan Ganguli, "Engineering Optimization-A modern approach", University Press.

ITRA- MERA-620	Advanced Manufacturing Systems	L	T/P	C
		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

Introduction- Advanced manufacturing systems- definition, concept, industrial requirement, types of AMS.

CNC technology: principle of numerical control - types of CNC machines - features of CNC systems - programming techniques - capabilities of a typical NC, DNC. [T1, T2, R1]

UNIT-II

Flexible Manufacturing System(FMS): Types of FMS, FMS Components like pallets, fixtures, machines, AS/RS, Work handling equipmentsand system layout; Control of FMS, FMS applications and benefits.

Group Technology and Cellular Manufacturing: Part families, part classification and coding, cellular manufacturing, applications and quantitative analysis. [T1, T2]

UNIT-III

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

Reverse Engineering: Need & Techniques, Data collection. [T1, T2, R2, R6]

UNIT-IV

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

Rapid Prototyping: Process chain in RP in integrated CAD-CAM environment, Advantages of RP, Utility of Rapid Prototyping in Reverse Engineering.

Integrated Manufacturing System: Concept, features, components of integrated manufacturing system. [T1, T2, R1, R2, R5]

Text Books:

[T1] Mikell.P.Groover, "Automation, Production systems and Computer Integrated Manufacturing", Pearson Education.

[T2] P.N.Rao, N.K. Tewari & T.K. Kundra, "*Computer Aided Manufacturing*", Tata McGraw Hill, 2001.

Reference Books:

[R1] Tien-Chien Chang, Richard A. Wysk & Hsu-Pin Wang, " Computer-Aided Manufacturing", Pearson.

[R2] Andrew Kusiak, "Intelligent Manufacturing Systems", Prentice Hall.

[R3] P. Radhakrishnan, "Computer Integrated Manufacturing", PSG College of Technology, 2008

[R4] Eric Teicholz& Joel Orr, "Computer Integrated Manufacturing Handbook", McGraw Hill Book Co., 1987.

[R5] P.G. Ranky, "Computer Integrated Manufacturing", Prentice Hall of India, 1996.

[R6] P.Gibson, G. Green Halgh, R. Kerr, "Manufacturing management" Chapman & Hall, 1995.

MERA-652: Lab-IV (Embedded Systems Lab): Experiments based on Embedded System Design.

MERA-654: Lab-V (Artificial Intelligence Lab): Experiments based on Artificial Intelligence.

MERA-656: Lab-VI: Experiments based on Elective.

MERA-658: Term Paper-II.

MERA-701	Computer Integrated Manufacturing	L	T/P	C
		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

Introduction to CIM

Manufacturing - Types, Manufacturing Systems, CIM Definition, CIM wheel, CIM components, Evolution of CIM, needs of CIM, Benefits of CIM, basic components of NC system, NC motion control system, applications of NC, advantages and disadvantages of NC, computer Numerical control, advantages of CNC, functions of CNC, Direct Numerical Control, components of a DNC system, functions of DNC, advantages of DNC.

Development of computers, CIM Hardware & Software, Data-Manufacturing data, types, sources, Structure of data models, Introduction to DBMS. [T1, T2, T3, R6]

UNIT II

Computer Aided Design - benefits, Graphic Standards, Interfaces, CAD software, Integration of CAD/CAM/CIM.

Group Technology- Part families, Parts classification and coding, Production flow analysis, Machine Cell Design, Benefits of Group Technology. [T1, T2, T3, R1]

UNIT III

Flexible Manufacturing Systems

FMS concept, Components of FMS, FMS Layouts, FMS planning and implementation, . Tool Management systems-Tool monitoring, Work holding devices- Modular fixturing, flexible fixturing, flexibility, quantitative analysis of flexibility, application and benefits of FMS, automated material handling system –AGVs, Guidance methods, AS/RS. [T1, T2, T3]

UNIT IV

Automated Process Planning

Structure of a Process Planning, Process Planning function,CAPP - Methods of CAPP, CAD based Process Planning, Inventory management - Materials requirements planning - basics of JIT

Monitoring and Quality Control

Types of production monitoring system, process control & strategies, Direct digital control - Supervisory computer control - computer aided quality control - objectives of CAQC, QC and CIM, contact, non-contact inspection methods, CMM and Flexible Inspection Systems; Integration of CAQC with CIM. [T1, T2, T3]

Text Books:

[T1] Mikell P. Groover, " Automation, Production System and CIM", Prentice-Hall of India,2001.
[T2] Mikell P. Groover, “Computer Aided Design and Manufacturing”, Prentice Hall of India, 1987.
[T3] S. Kant Vajpayee, “Principles of Computer Integrated Manufacturing”, Prentice Hall of India, 1999.

Reference Books:

[R1] Radhakrishnan.P, Subramanyan. S, “CAD/CAM/CIM”, New Age International publishers.
[R2] David Bedworth, "Computer Integrated Design and Manufacturing", TMH, New Delhi, I Edition1999.
[R3] Scheer.A.W., “CIM- Towards the factory of the future” Springer - Verlag, 1994.
[R4] Daniel Hunt.V., “Computer Integrated Manufacturing Hand Book”, Chapman & Hall, 1989.
[R5] YoremKoren, “Computer Control of Manufacturing System”, McGraw Hill, 1986.
[R6] Paul. G Ranky., “Computer Integrated Manufacturing”, Prentice Hall International, 1986.

MERA-703	Computer Vision	L	T/P	C
		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

Introduction: Image Formation, Image Geometry, Radiometry, Digitization

Recognition Methodology: Conditioning, Labelling, Grouping, Extracting, Matching.

Morphological Image Processing: Introduction, Dilation, Erosion, Opening, Closing, Morphological algorithm operations on binary images, Morphological algorithm operations on gray-scale images, Thinning, Thickening, Region growing, region shrinking.

Image Representation and Description: Representation schemes, Boundary descriptors, Region descriptors. [T1, R2]

UNIT II

Binary Image Analysis and Segmentation: Thresholding, Segmentation, Connected component labelling, Hierarchal segmentation, Spatial clustering, Split & merge, Rule-based Segmentation, Motion-based segmentation.

Area Extraction: Data-structures, Edge, Line-Linking, Hough transform, Line fitting, Curve fitting. Region Analysis: Region properties, External points, Spatial moments, Mixed spatial gray-level moments, Boundary analysis: Signature properties, Shape numbers.

Facet Model Recognition: Labelling lines, Understanding line drawings, Classification of shapes by labelling of edges, Recognition of shapes, Consisting labelling problem, Back-tracking Algorithm. [T1, T2, R2]

UNIT III

Perspective Projective geometry, Inverse perspective Projection, Photogrammetry - from 2D to 3D, Image matching : Intensity matching of 1D signals, Matching of 2D image, Hierarchical image matching.

Object Models And Matching: 2D representation, Global vs. Local features, General Frame Works For Matching: Distance relational approa

ch, Ordered structural matching, View class matching, Models database organization. [T1, T2, R2]

UNIT IV

Knowledge Based Vision: Knowledge representation, Control strategies, Information Integration.

Object Recognition: Model-based methods, Appearance-based methods, Invariants.

Applications: Image based rendering, constructing 3-D models from image sequences, light fields. [T1, T2, R1]

Text Books:

[T1] David A. Forsyth, Jean Ponce, "Computer Vision: A Modern Approach", Prentice Hall, 2003.

[T2] Milan Sonka,VaclavHlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision" 3rd Edition, Cengage Learning, 2008.

Reference Books:

[R1] Robert Haralick and Linda Shapiro, "Computer and Robot Vision", Vol I, II, Addison-Wesley, 1993.

[R2] Rafael C. Gonzalez & Richard E. Woods, “Digital Image Processing”, 3rd Edition, Pearson Education, 2009.

MERA-705	Robot Programming	L	T/P	C

	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-Introduction to Robot Programming

Robot programming-Introduction-Types- Flex Pendant- Lead through programming, Coordinate systems of Robot, Robot controller- major components, functions-Wrist Mechanism-Interpolation-Interlock commands-Operating mode of robot, Jogging-Types, Robot specifications- Motion commands, end effectors and sensors commands. [T1, T2, T3]

UNIT II-VAL Language

Robot Languages-Classifications, Structures- VAL language commands motion control, hand control, program control, pick and place applications, palletizing applications using VAL, Robot welding application using VAL program-WAIT, SIGNAL and DELAY command for communications using simple applications.

VAL-II programming-basic commands, applications- Simple problem using conditional statements-Simple pick and place applications-Production rate calculations using robot. [T1, T2, T3]

UNIT III- RAPID Language and AML

RAPID language basic commands- Motion Instructions-Pick and place operation using Industrial robot- manual mode, automatic mode, subroutine command based programming. Move master command language-Introduction, syntax, simple problems.

AML Language-General description, elements and functions, Statements, constants and variables-Program control statements-Operating systems, Motion, Sensor commands-Data processing. [T1, T2, T3]

UNIT IV- Practical Study of Virtual Robot

Robot cycle time analysis-Multiple robot and machine Interference-Process chart-Simple problems-Virtual robotics, Robot studio online software- Introduction, Jogging, components, work planning, program modules, input and output signals-Singularities-Collision detection-Repeatabilitymeasurement of robot-Robot economics.

AML Language-General description, elements andfunctions, Statements, constants and variables-Program control statements-Operating systems, Motion, Sensor commands-Data processing. [T1, T2, T3]

Text Books:

[T1] S. R.Deb, "Robotics technology and flexible automation", Tata McGraw Hill publishing company limited, 1994.

[T2] Mikell. P. Groover, "Industrial Robotics Technology", Programming and Applications, McGraw Hill Co, 1995.

[T3] Robotcs Lab manual, 2007.

Reference Books:

[R1] Klafter. R.D, Chmielewski.T.A. and Noggin's., "Robot Engineering : An Integrated Approach", Prentice Hall of India Pvt. Ltd.,1994.

[R2] Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics control, sensing, vision and intelligence", McGraw Hill Book co, 1987.

[R3] Craig. J. J. "Introduction to Robotics mechanics and control", Addison-Wesley, 1999.

MERA-707	Digital Control	L	T/P	C
		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:

Introduction: Advantages of Digital control systems ,Practical aspects of the choice of sampling rate and multirate sampling, Basic discrete time signals, Quantization, Sampling theorem, Data conversion and Quantization, Sampling process, Mathematical modeling, Data reconstruction and filtering of sampled signals.

z - transform and inverse z - transform, Relationship between s - plane and z - plane – Difference equation - Solution by recursion and z - transform - pulse transfer functions of the zero - order Hold and relationship between G(s) and G(z)– Bilinear transformation . [T1, T2]

UNIT II:

Digital control systems - Pulse transfer function - z transform analysis of open loop, closed loop systems - Modified z Transform - transfer function - Stability of linear digital control systems - Stability tests. Root loci - Frequency domain analysis - Bode plots - Gain margin and phase margin - Design of Digital Control Systems based on Root Locus Technique. [T1, T2]

UNIT III:

Cascade and feedback compensation by continuous data controllers - Digital controllers - Design using bilinear transformation - Realization of Digital PID controllers.

State equations of discrete data systems, solution of discrete state equations, State transition Matrix: z - transform method. Relation between state equations and transfer functions. [T1, T2]

UNIT IV

Concepts on Controllability and Observability - Digital state observer: Design of the full order and reduced order state observer - Pole placement design by state feedback.

Design of Dead beat Controller - some case studies - Stability analysis of discrete time systems based on Lyapunov approach. [T1, T2]

Text Books:

[T1] K. Ogata, “Modern control engineering”, Pearson 2002.

[T2] B.C Kuo, "Digital Control Systems", 2nd Edition, Oxford Univ Press, Inc., 1992.

Reference Books:

[R1] F. Franklin, J.D. Powell, and M.L. Workman, "Digital control of Dynamic Systems", Addison - Wesley Longman, Inc., Menlo Park, CA , 1998.

[R2] Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill, India, 1997.

[R3] C. H. Houpis and G.B. Lamont, Digital Control Systems, McGraw Hill, 1985.

[R4] John S. Baey, "Fundamentals of Linear State Space Systems", Mc. Graw – Hill, 1st edition.

[R5] Bernard Fried Land, "Control System Design", Mc. Graw – Hill, 1st edition

[R6] Dorsay, "Continuous and Discrete Control Systems", McGraw - Hill.

MERA-709	Advanced Control System	L	T/P	C
		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 10 marks**

UNIT- I

Introductory matrix algebra and linear vector space. State space representation of systems. Linearization of a nonlinear System. Solution of state equations. Evaluation of State Transition Matrix (STM), Similarity transformation and invariance of system properties, Minimal realization of SISO, SIMO, MISO transfer functions, Discretization of a continuous time state space model. Conversion of state space model to transfer function model using Fadeeva algorithm. [T1, T2]

UNIT-II

Fundamental theorem of feedback control - Controllability and Controllable canonical form – Pole assignment by state feedback using Ackermann's formula – Eigen structure assignment problem. Linear Quadratic Regulator (LQR) problem and solution of algebraic Riccati equation using eigenvalue and eigen vector methods, iterative method. Controller design using output feedback. [T1, T2]

UNIT- III

Observability and observable canonical form - Design of full order observer using Ackermann's formula - Bass Gura algorithm. Duality between controllability and observability - Full order Observer based controller design. Reduced order observer design. [T1, T2]

UNIT-IV

Internal stability of a system. Stability in the sense of Lyapunov, asymptotic stability of linear time invariant continuous and discrete time systems. Solution of Lyapunov type equation.
Model decomposition and decoupling by state feedback. Disturbance rejection, sensitivity and complementary sensitivity functions. [T1, T2]

Text Books:

[T1] K. Ogata, "Modern control engineering", Pearson 2002.
[T2] Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", 11th Edition, Pearson Edu, India, 2009.

Reference Books:

[R1] T. Kailath, "Linear Systems", Perntice Hall, Englewood Cliffs, NJ, 1980.
[R2] N. K. Sinha , "Control Systems", New Age International, 3rd edition, 2005.
[R3] Panos J Antsaklis, and Anthony N. Michel, "Linear Systems", New-age international (P) LTD Publishers, 2009.
[R4] John J D'Azzo and C. H. Houpis , "Linear Control System Analysis and Design Conventional and Modern", McGraw - Hill Book Company, 1988.
[R5] B.N. Dutta, "Numerical Methods for linear Control Systems" , Elsevier Publication, 2007.
[R6] C.T.Chen, "Linear System Theory and Design", PHI, India.

MERA-711	Global Optimization Techniques	L	T/P	C
		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- Introduction to Optimization Algorithms

Introduction - Classification of Optimization Algorithms, Structure of Optimization, Formae and Search Space/Operator Design.

Evolutionary Algorithms – Introduction, The Basic Principles from Nature, Basic Cycle of Evolutionary Algorithms, Basic Evolutionary Algorithm Scheme, Classification of Evolutionary Algorithms, Configuration Parameters of evolutionary algorithms, Fitness Assignment, Tournament Selection, Ranking Selection, VEGA Selection, Simple Convergence Prevention. [T1]

UNIT II-Genetic Algorithms and Genetic Programming

Genetic Algorithms, Areas of Application, Genomes, Fixed-Length String Chromosomes, Variable-Length String Chromosomes, Schema Theorem, The Messy Genetic Algorithm, Genotype-Phenotype Mappings and Artificial Embryogeny. Genetic Programming, Tree Genomes, Genotype-Phenotype Mappings, Grammars in Genetic Programming, Linear Genetic Programming, Artificial Life and Artificial Chemistry- Correctness of the Evolved Algorithms. [T1]

UNIT III-Modern Optimization techniques

Ant Colony Optimization, Particle Swarm Optimization, Hill Climbing, Multi-Objective Hill Climbing, Raindrop Method, Random Optimization, Simulated Annealing, Temperature Scheduling, Multi-Objective Simulated Annealing, Downhill Simplex (Nelder and Mead). [T1, R4]

UNIT V-Search and Hybrid algorithms.

State Space Search, Uninformed Search, Breadth-First Search, Depth-First Search, Depth-limited Search, Iterative Deepening Depth-First Search, Random Walks Informed Search, Greedy Search, A* search, AdaptiveWalks.

Memetic and Hybrid Algorithms, some problems. [T1, R3]

Text Books:

[T1] Thomas Weise, "Global Optimization Algorithms – Theory and Application", 2009.

Reference Books:

[R1] Kalyanmoy Deb "Optimization for Engineering Design: Algorithms and Examples", PHI.
[R2] Hans Paul Schwefel., "Evolution and Optimum Seeking", Wiley-Interscience, 1995.
[R3] S.S. Rao, "Optimization – Theory and Applications", Wiley Eastern,New Delhi, 2009.

MERA-713	Soft Computing	L	T/P	C
		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

Introduction: Introduction to Soft Computing Concepts.

Neural Networks: Overview of biological Neuro-system, Mathematical Models of Neurons, ANN Architecture, Learning rules, Learning Paradigms-Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms-Perceptron learning rule, Delta, Back-Propagation Algorithm, Multilayer Perceptron Model, Hopfield Networks, Associative Memories, Applications of Artificial Neural Networks. [T1, R1,R2, R6]

UNIT II

Introduction to Fuzzy Sets: Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation.

Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations.

Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. [T1, R3, R4]

UNIT III

Fuzzy Logic: Classical Logic, Multivalued Logics, Fuzzy Propositions, Fuzzy Qualifiers, Linguistic Hedges.

Uncertainty based Information: Information & Uncertainty, Nonspecificity of Fuzzy & Crisp Sets, Fuzziness of Fuzzy Sets, Defuzzyfication.

Evolutionary Computation: Genetic Algorithms and Genetic Programming, Evolutionary Programming, Evolutionary Strategies and Differential Evolution Coevolution, Different operators of Genetic Algorithms, Analysis of Selection Operations, Convergence of Genetic Algorithms [T1, R3, R5]

UNIT IV

Hybrid Systems: Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks.Fuzzy Logic bases Neural Networks, Genetic Algorithm for Neural Network Design and Learning, Fuzzy Logic and Genetic Algorithm for Optimization,

Applications of soft computing techniques. [T1, R5]

Text Book:

[T1] S. Rajasekaran and G.A.VijaylakshmiPai.. Neural Networks Fuzzy Logic, and Genetic Algorithms, PHI, 2003.

Reference Books:

[R1] Simon Haykin, “Neural Networks and Learning Machines”, PHI, 2013.
[R2] M. T. Hagan, H. B. Demuth, & M. Beale, “Neural Network Design”, Cengage Learning, 1996.
[R3] G.J. Klir& B. Yuan, “Fuzzy Sets & Fuzzy Logic”, PHI, 1995.
[R4] G.J. Klir& B. Yuan, “Fuzzy Sets & Fuzzy Logic”, PHI, 1995.
[R5] Melanie Mitchell, “An Introduction to Genetic Algorithm”, PHI, 1998.
[R6] Freeman J.A. & D.M. Skapura. “Neural Networks: Algorithms, Applications and Programming Techniques”, Addison Wesley, Reading, Mass, (1992).

MERA-715	Rapid Prototyping	L	T/P	C
		4	0	4

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

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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- Introduction

Definition, Types, Evolution, History. Product design and rapid productdevelopment. Feasibility of RPT, detail designing, prototyping, manufacturing and product release. Fundamentals of RPT technologies, RPT andits role in modern manufacturing mechanical design.

Role of CAD in RPT, 3D solid modelling software and their role in RPT. Creation of STL or SLA file from a 3D solid model. [T1, T2]

UNIT II-Liquid and Powder Based RP Processes

Liquid based process: Principles of STL and typical processes such as SLA process, solid ground curing and others.

Powder based process: Principles and typical processes such as selective laser sintering and 3D-printing processes. [T1, T2]

UNIT III- Solid based Processes

Principles and typical processes such as fused deposition modeling, laminated object modeling and others. [T1, T2]

UNIT IV

Rapid Tooling-Indirect Rapid tooling -Silicon rubber tooling —Aluminum filled epoxytooling Spray metal tooling, Cast kirksite, 3D keltool, Direct Rapid Tooling — Direct,AIM, Quick cast process, Copper polyamide, DMILS, ProMetal ,Sand castingtooling,Laminate tooling, soft Tooling vs. hard tooling.

Software for RPT-Stl files, Overview of Solid view, magics, magic communicator,Internet based software, Collaboration tools. [T1, T2]

Text Books:

[T1] C.K. Chua, “Rapid Prototyping”, Wiley, 1997.

[T2] Peter D. Hilton, Hilton Jacobs, Paul F.Jacobs, "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000

Reference Books:

[R1] Paul F. Jacobs: “Stereo 1ithography and other RP & M Technologies”-SME NY,1996.

[R2] D.T Flham & S.S. Dinjoy “Rapid Manufacturing”- Verlog London 2001.

[R3] Terry Wohler’s “Wohler’s Report 2000”- Wohler’s Association 2000.

[R4] M.Burns, “Automated Fabrication”, PHI, 1993.

[R5] P.D.Hilton et all, “Rapid Tooling”, Marcel, Dekker 2000.

[R6] J.J. Beaman et all, “Solid freeform fabrication”, Kluwer, 1997.

MERA-717	MEMS and Microsytems	L	T/P	C
		4	0	4

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

5. **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.**
6. **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:

Overview of MEMS & Microsystems: Evolution of Micro fabrication, Microsystems & Microelectronics, Microsystems & Miniaturization, Applications of MEMS in Industries.

Materials for MEMS and Microsystems – Si as substrate material, mechanical properties of Silicon, Silicon Compounds, Gallium Arsenide, Piezoresistors, Piezoelectric crystals, Polymers, Packaging Materials. [T1, T2]

UNIT II:

MEMS and Miniaturization: Scaling laws in miniaturization: Introduction to Scaling**.**

Thermo Fluid Engineering: Overview of Basics of Fluid Mechanics in Macro and Meso scales, Basic equations in Continuum Fluid dynamics, Overview of Heat conduction in Solids, Heat Conduction in Multilayered Thin Films. [T1,T2]

UNIT III:

Micromachining Processes: Overview of microelectronic fabrication processes used in MEMS, Bulk Micromachining – Isotropic & Anisotropic Etching, Comparison of Wet vs Dry etching, Surface Micromachining – General description, Processing in general, Mechanical Problems associated with Surface Micromachining, Introduction to LIGA process, Introduction to Bonding. Assembly of 3D MEMS - foundry process. [T1, R1]

UNIT IV

Micro machined Micro sensors: Mechanical, Inertial, Biological, Chemical, Acoustic, Microsystems Technology, Integrated Smart Sensors and MEMS, Interface Electronics for MEMS, MEMS Simulators, MEMS for RF Applications, Bonding & Packaging of MEMS, Future Trends Micro sensors: bio, chemical, optical and thermal sensors. [T2, R2]

Text Books:

[T1] Tai-Ran Hsu, “MEMS and Microsystems: Design and Manufacture”, McGraw-Hill, 2002.

[T2] Jan Korvink and Oliver Paul, “MEMS: A Practical Guide to Design, Analysis and Applications”, 2005.

Reference Books:

[R1] Ghodssi, Reza; Lin, Pinyen (Eds.), “MEMS Materials and Processes Handbook”, Springer, 2011.

[R2] Mohamed Gad-el-Hak, “MEMS: Introduction and Fundamentals”, Taylor and Francis, 2005.

[R3] RaiChoudhary P., “MEMS and MOEMS technology and applications”, PHI, New Delhi.

[R4] S.M. Sze, Semiconductor Sensors, John Wiley & Sons, INC., 1994.

MERA-719	Simulation and Modelling	L	T/P	C
		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

Introduction: Definition and components of a system, continuous and discrete systems.

Modelling: Concepts of system modelling, types of models, static and dynamic physical models, static and dynamic mathematical models.

Simulation: Basics of simulation, Steps in simulation, Discrete event system simulation, Advantages and disadvantages of simulation, Decision making with simulation. [T1, R2]

UNIT II

Statistical Models: Review of terminology and concepts, Useful statistical models, Discrete distributions, Continuous distributions, Poisson process, Empirical distributions, Random numbers, Techniques for random generation.

Queuing Models: Characteristics of queuing systems; Queuing notation; Long-run measures of performance of queuing systems, Application of models. [T1, R2]

UNIT III

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

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. [T1, R2]

UNIT IV

Analysis after simulation: 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.

Verification and validation of simulated models, optimization via simulation.

Case studies on application of modelling and simulation in manufacturing systems. [T1,R5]

Text Books:

[T1] Averill M. Shaw, "Simulation Modeling and Analysis", Tata McGraw-Hill, 2007.

Reference Books:

[R1] Frank L. Severance, "System Modeling& Simulation-an Introduction", Johm Wiley & Sons, 2001.
[R2] Geoffrey Gordon, "System Simulation", Prentice Hall India, 1969.
[R3] Robert E. Shannon, "System Simulation: The Art and Science", Prentice Hall India, 1975.
[R4] Charles M Close and Dean K. Frederick Houghton Mifflin, "Modelling and Analysis of Dynamic Systems:, TMH, 1993.
[R5] Allan Carrie, "Simulation of manufacturing", John Wiley & Sons, 1988

MERA-721	Machine Learning	L	T/P	C
		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

Introduction: well posed learning problem, designing a learning system: training experience, target function, final design. Issues in machine learning

Concept, Learning and General to specific ordering: concept learning task, concept learning as search, version spaces and candidate elimination, inductive bias. [T1, T2, R2]

UNIT-II

Decision Tree learning (DTL): introduction, decision tree representation, problems for DTL, DTL algorithm, hypothesis space search, inductive bias in DTL, issues in DTL.

Bayesian Learning: Introduction, Bayes Theorem, concept learning, least square hypothesis, predicting probabilities, Bayes optimal classifiers, EM algorithm. [T1, T2]

UNIT-III

Instance Based Learning: introduction, K-nearest neighbor learning, locally weighted regression, case based reasoning.

Learning set of rule: introduction, sequential covering algorithm, learning rule sets, first order rules. [T1, T2, T3, R1]

UNIT-IV

Analytical learning: introduction, perfect domain theory, explanation based learning. Inductive analytical approaches to learning. [T1, T3]

Text Books:

[T1] Tom M. Mitchell , "Machine learning", McGraw Hill 1997.

[T2] Ethem Alpaydin, "Introduction to machine learning", PHI learning, 2008.

[T3] Rajjan Shinghal, "Pattern Recognition", Oxford Press, 2006.

Reference Books:

[R1] Duda, Hart and Stork, "Pattern Classification", 2000.

[R2] Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning", Springer 2001.

MERA-751: Lab-VII (Simulation and Modeling lab): Experiments based on Simulation and Modeling lab.

MERA-753: Lab-VIII (Experiments based on Elective).