SYLLABUS

FOR

M.TECH. (Robotics Engineering)

M. Tech.
Robotics Engineering
Teaching and Examination Scheme

1st Year – I Semester

THEORY												
SN	**Category**	**Course**		**Contact hrs/week**			**Marks**				**Cr**
		Code	**Title**	**L**	**T**	**P**	**Exam Hrs**	**IA**	**ETE**	**Total**	
1	PCC	1MEMRE1-01	Industrial Automation	3	-	-	3	20	80	**100**	**3**
		1MEMRE1-02	Robotics : Analysis & Systems	3	-	-	3	20	80	**100**	**3**
		1MEMRE1-03	CAD/CAM	3	-	-	3	20	80	**100**	**3**
4	PEC-I	1MEMRE2-04	Introduction to Mechanical Engineering	3	-	-	3	20	80	**100**	**3**
		1MEMRE2-05	Introduction to Electronics & Electrical Engineering								
		1MEMRE2-06	Mechatronics								
		1MEMRE2-07	Flexible Manufacturing	-	-	-	-	-	-	-	-
5	PEC-II	1MEMRE2-08	Sensors Application in Manufacturing	3	-	-	3	20	80	**100**	**3**
		1MEMRE2-09	Microprocessor & Microcontroller								
		1MEMRE2-10	Robotics & Control								
		1MEMRE2-11	----------	-	-	-	-	-	-	-	-
6	OES	1MEMRE3-12	Human Values and Professional Ethics	2	-	-	3	20	80	**100**	**2**
			Sub Total	17						**600**	**17**
PRACTICAL & SESSIONAL											
7	PCC	1MEMRE1-13	Lab - I	-	-	2	-	60	40	**100**	**2**
8	FW	1MEMRE4-14	Field Work	-	-	2	-	60	40	**100**	**2**
9	AC	1MEMRE5-15	Human Values Practice School	-	-	2	-	30	20		-
			Sub- Total			6				**200**	**4**
			TOTAL OF I SEMESTER	17		6				**800**	**21**

L: *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits* ***ETE:*** *End Term Exam,* ***IA:*** *Internal Assessment*

PCC: Program Core Courses

PEC: Program Elective Courses

Electives Courses (3-4Nos.) should be relevant to the chosen specialization/branch

OES: Other Emerging Subjects: (i) Human Values and Professional Ethics
(ii) Research Methodology

It is decided common for all branches.

FW: Field Work

Student is required to work in the organization/industry concerned with his/her course.

AC: Audit Course

It is mandatory to pass the audit course. However, credit shall not be awarded

M. Tech.
Robotics Engineering
Teaching and Examination Scheme
1st Year – II Semester

SN	Category	Course Code	Course Title	Contact hrs/week L	T	P	Marks Exam Hrs	IA	ETE	Total	Cr
THEORY											
1	PCC	2MEMRE1-01	Drives & Control systemfor	3	-	-	3	20	80	100	3
2		2MEMRE1-02	Advance Computer Concept for	3	-	-	3	20	80	100	3
3		2MEMRE1-03	Simulation, Modeling & Analysis	3	-	-	3	20	80	100	3
4	PEC-I	2MEMRE2-04	Process Control & Automation	3	-	-	3	20	80	100	3
		2MEMRE2-05	Virtual Instrumentation								
		2MEMRE2-06	Artificial Intelligence & Expert System in Automation								
		2MEMRE2-07	Additive Manufacturing & Tooling								
5	PEC-II	2MEMRE2-08	Optimization Techniques& Design of	3	-	-	3	20	80	100	3
		2MEMRE2-09	Pneumatic & Hydraulic Control								
		2MEMRE2-10	Design of Mechanisms and Manipulators								
		2MEMRE2-11	----------								
6	OES	2MEMRE3-12	Research Methodology	2	-	-	3	20	80	100	**2**
			Sub Total	17						600	**17**
PRACTICAL & SESSIONAL											
7	PCC	2MEMTE1-13	Lab –II	-	-	2	-	60	40	100	**2**
8	FW	2MEMTE4-14	Field Work	-	-	2	-	60	40	100	**2**
			Sub- Total			4				200	**4**
			TOTAL OF II SEMESTER	17		4				800	**21**

M. Tech.
Robotics Engineering
Teaching and Examination Scheme

2nd Year – III Semester

PRACTICAL & SESSIONAL											
SN	**Category**	**Course**		**Contact hrs/week**			**Marks**				**Cr**
		Code	**Title**	**L**	**T**	**P**	**Exam Hrs**	**IA**	**ETE**	**Total**	
1	PSD	3MEMRE6-16	Industrial/ Field Project	-	-	28	-	360	240	**600**	**14**
2	PSD	3MEMRE6-17	Seminar	-	-	4	-	60	40	**100**	**2**
		TOTAL OF III SEMESTER				32				**700**	**16**

PSD: Industrial/Field Project, Seminar, Dissertation

M. Tech.
Robotics Engineering
Teaching and Examination Scheme

2nd Year – IVSemester

PRACTICAL & SESSIONAL											
SN	**Category**	**Course**		**Contact hrs/week**			**Marks**				**Cr**
		Code	**Title**	**L**	**T**	**P**	**Exam Hrs**	**IA**	**ETE**	**Total**	
1	PSD	4MEMRE6-18	Dissertation	-	-	32	-	420	280	**700**	**16**
		TOTAL OF IV SEMESTER				32				**700**	**16**

Note: The Dissertation Work for M.Tech consists of Dissertation Work. Students are required to undertake research work related to latest developments in the field of Automation & Robotics with multidisciplinary background and innovative concept. For students desirous of seeking career in industry, may take up industry sponsored projects or application oriented project i. e developing a complex application which does not already exit, or by enhancing some existing application or method to improve its functionality, performance for immediate use of industry, as equivalent to the theoretical research work towards M.Tech dissertation

M. Tech.
Robotics Engineering
Syllabus

YEAR-I, SEMESTER-I

1MEMRE1-01: INDUSTRIAL AUTOMATION 3 Credits

Introduction: Automation in Production System, Principles and Strategies of Automation, BasicElements of an Automated System, Advanced Automation Functions, Levels of Automations. Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break-Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in-process.

Detroit-Type Automation: Automated Flow lines, Methods of Workpart Transport, TransferMechanism, Buffer Storage, Control Functions, and 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, Computer Simulation of Automated Flow Lines.

Material handling and Identification Technologies: The material handling function, Types ofMaterial 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, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing. Product identification system: Barcode, RFID etc. **Automated Assembly Systems**: Design for Automated Assembly, Types of Automated AssemblySystems, Part Feeding Devices, Analysis of Multistation Assembly Machines, Analysis of a Single Station Assembly Machine.

Control Technologies in Automation: Industrial Control Systems, Process Industries VersesDiscrete-Manufacturing Industries, Continuous Verses Discrete Control, Computer Process Control and its Forms. Computer Based Industrial Control: Introduction & Automatic Process Control, Building Blocks of Automation System: LAN, Analog & Digital I/O Modules, SCADA System & RTU.

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

PLC: Introduction, Micro PLC, Programming a PLC, Logic Functions, Input & Output Modules,PLC Processors, PLC Instructions, Documenting a PLC System, Timer & Counter Instructions, Comparison & Data Handling Instructions, Sequencing Instructions, Mask Data Representation, Typical PLC Programming Exercises for Industrial Applications.

Text Books / References:

1. "Automation, Production Systems and Computer Integrated Manufacturing"- M.P.Grover, Pearson Education.
2. "Computer Based Industrial Control" – Krishna Kant, EEE-PHI

3. Principles and Applications of PLC – Webb John, Mcmillan 1992
4. "An Introduction to Automated Process Planning Systems" – Tiess Chiu Chang & Richard A. Wysk
5. "Anatomy of Automation" – Amber G.H & P.S. Amber, PrenticeHall.

1MEMRE1-02 ROBOTICS: ANALYSIS AND SYSTEMS 3 Credits

Introduction. Construction of manipulators, advantages and disadvantages of various kinematic structures. Applications, Nonservo robots, motion planning. Feedback systems, encoders Kinematics, homogeneous coordinates solution of the inverse kinematic problem, multiple solutions, jacobian, work envelopes. Trajectory planning. Joint Interpolated Trajectory, Link joints and their Manipulator dynamics and force control. Sensors: Vision, ranging, laser, acoustic, tactile.

Developments in sensor technology, sensory control. Programming Language: VAL, RAIL, AML. Mobile robots, walking devices. Robot reasoning.

Text Books / References:

1. K.S Fu, R.C. Gonzalez, C.S.G. Lee, Robotics, McGraw Hill, 1987.
2. Y. Koren, Robotics for Engineers, McGraw Hill, 1985
3. J.J. Craig, Robotics, Addison-Wesley, 1986.
4. Saeed B. Niku, " Introduction to Robotics – Analysis, Systems and Application" : PHI 2006
5. Richard D, Klafter, Thomason A ChmielOwski, Michel Nagin "Robotics Engg-an Integrated Approach" PHI 2005
6. R.K. Mittal & I.J. Nagrath, "Robotics & Control" TMH-2007.

1MEMRE1-03 CAD/CAM 3 Credits

Mathematical Elements, CAD, Solid modeling methods, Database structures for CAD, CSG formulation, B-rep and wire frame methods, Intersection surface generation methods, Boundary file generation methods, Feature based modeling systems, Surface modeling, B- splines, Coons and Bezier surfaces, NURBS and surface patches, fitting surfaces for arbitrary digested points, Offset surfaces, Fillet surfaces, Sewn surfaces.
Features recognition from the databases,IGES, STEP, PDES, and DXF data exchange formats, Graphic standards for CAD/CAM such as GKS, PHIGS and VDI.

Concurrent engineering integration of manufacturing principles and analytical principles in design, Manufacturing
information generation from CAD data, Planar sectioning, Penalty functions, cavity milling, Optimization of cutter path, Effect of tool profile geometry, Methods for multi-axis machining, Methods for software design for CAD/CAM system, use of software libraries, Development of software package for a specific problem as part of course using software libraries.

Introduction to automation, CAM/CIM, Part programming, Interpolator & Control.

Books:

1. Computer Graphics D Hearn & M P Baker Prentice Hal
2. CAD/CAM Theory and Practice Ibrahim Zeid& R Sivasubramanian Tata McGraw-Hill
3. Mathematical Elements for Comp. Graphics D F Rogers and J A Adams McGraw-Hill International
4. Computer Aided Engineering & Design Jim Browne New ATC International
5. The Engineering Database D.N. Chorafas and S.J. Legg Butterworths
6. Principles of CAD J Rooney &P Steadman Longman Higher Education
7. CAD/CAM H P Groover and E W Zimmers Prentice Hall
8. Computer Integrated Design and Manufacture D Bedworth, M Henderson & P Wolfe MacGraw Hill Inc.

1MEMRE2-04 INTRODUCTION TO MECHANICAL ENGINEERING 3Credits

Concepts of Stress, Strains and theories of failure. Concepts of Fatigue and Creep. Design principles: strength, rigidity and wear considerations. Design for strength, static and dynamic loadings. Manufacturing consideration, limits, fits and standardization. Design of shafts, keys, splines, springs. Design of riveted, bolted, welded and friction joints. Power screws. Design of sliding and rolling contact bearings. Material selection and design process.

Theory and principles of design of couplings, clutches, brakes, belt and chain drives, spur, helical, bevel and worm gear drives. Lubrication Systems.

Failure – quality loss and robust design. Service failure modes, characterization and interpretation. Deformation modes-yielding and creep. Ductile and Brittle fracture – fatigue and fracture mechanics approach to design. Cumulative damage – life prediction. Wear- modes and control. Systematic approach to failure analysis.

***Text Books / References*:**

1. Shigley, J.E. and Mitchel, L.D., Mechanical Engineering Design, McGraw-Hill International; 1993.
2. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley and Sons, 1994.
3. Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
4. Deutschman, D., Michels, E., Machine Design Theory and Practice, Macmillan, 1992
5. Collens, J.A., "Failure of Materials in Mechanical Design", John Wiley & Sons, 1991.
6. Fuchs H.O., "Metal fatigue in Engineering", John Wiley & Sons, 1991.
7. Dieter G.E, "Mechanical Metallurgy (Sl Edition), McGraw Hill Book Co., 1988

1MEMRE2-05 INTRODUCTION TO ELECTRONICS AND ELECTRICAL ENGINEERING

3 Credits

Basic Electronics-Diode, Transistor Biasing and Introduction to experimental mode of transistor (Low frequency and high frequency analysis), Operation amplifiers-Application of operational amplifier characteristics and equivalent circuits, Power amplifier: Class A, Class B, Class C, Class AB efficiency calculation and heat sinks, Feedback amplifiers-Advantages, disadvantages, Classification (positive and negative feedback), V & I feedback.

Oscillators-PC phase shift, LC Wein bridge & crystal, Digital- Number system, Boolean algebra, Gates, K-map, sequential circuits, Brief introduction of-Transformer, motors AC/DC, Solid state devices- SCR, IGBT, Converters & Invertors, Variable speed drives (AC & DC), Transducers.

Books:

1.	Integrated Electronics	MillmanHalkias	Tata McGraw-Hill
2.	Digital Design	M. Morris Mano	McGraw-Hill
3.	Operational Amplifier-Linear Integrated Circuits	Gayakwad	Prentice Hall India
4.	Power Electronics	Mohammad H. Rasid	Prentice Hall India
5.	Electrical and Electronics Measurement & Instrumentation	A.K. Sawhney	DhanpatRai& Sons

1MEMRE2-06 MECHATRONICS **3 Credits**

Its elements – such as mechanics, electronics, microelectronics, power electronics and information technologies.

Mechanical elements with integrated electronics, suspension systems, vibration dampers, clutches, bearings – mechanical / magnetic, gears etc. Micro-motors dc-micro motors, PCB motors, disc motors, reluctance motors, PM motors(Materials, design &contruction), Brushless motors, stepper motors, universal motors, aerial field motors, Induction motors and synchronous motors.

Applications to Tele-communication technology equipment, computer printers actuators consumer products such as cameras, camcorder, timers, clock, VCR, wipers, fax machines, recorders.

Text Books / References:

1. Bolten, “Mechatronics”
2. V. Athani, “Stepper Motors Fundamentals, Applications and Design” New Edge Intl.
3. T.J.E. Miller, “Switched Reluctance Motors and their control” Oxford 1993
4. J.F. Gieras and M. Wing, “Permanent Magnet Motor Technology” (M.Dieker)1997
5. Y. Dote & S Kinoshika, “Brushless Servo motor fundamentals and applications” Calrendon Press

Oxford

1MEMRE2-08 SENSORS APPLICATIONS IN MANUFACTURING 3Credits

Unit I

Fundamentals of Sensors and Transducers: Performance terminology, static and dynamiccharacteristics of transducers, classification of sensors and transducers, signal processing and signal conditioning. Operational amplifiers, filters, protection devices, analog to digital converter, digital to analog converter.

Unit II

Sensors and their applications: Inductive, capacitive, magnetic, various types of photo sensors, detection methods, through-beam detection, reflex detection & proximity detection, ultrasonic and microwave sensors. Applications and understanding of the above sensors.

Unit III

Advanced Sensor Technologies: Laser production, characteristics of lasers, types of laser sensors, bar code sensors, benefits of bar coding, transponder, RFID (Radio Frequency Identification), electro-magnetic identifier, optical encoders ,.color sensors, sensing principles, color theory, unit color measurement, colour comparator, color sensing algorithm, fuzzy logic color sensor. fuzzy logic for opt-electronic colour sensor in manufacturing.

Sensors in Flexible Manufacturing Systems: Vision sensors, image transformations, robotvisual sensing tasks, detecting partially visible objects, sensors in flexible manufacturing

Unit VI

Networking: Networking of sensors, control of manufacturing process, tracking- the meantime between operations interventions, tracking the yield and mean process time, detection of machining faults, diagnostic systems, resonance vibration analyzer, sensing motor current for signature analysis, temperature sensing.

Unit V

Sensors for Special Applications: A multi objective approach for selection of sensors inmanufacturing, cryogenic manufacturing applications, semiconductor absorption sensors, semiconductor temperature detector using photoluminescence temperature detectors using point-contact, sensors in process manufacturing plants, measurement of high temperature, robot control through sensors, other sensors, collection and generation of process signals in decentralized manufacturing system.

References:

1. Sensor Technology Handbook by Jon S. Wilson
2. N.L.Buck&T.G.Buckwith, Mechanical measurement.
3. Sensors and Transducers by Ian Sinclair

Text Books:

1. Sabnesoloman, sensors & control systems in manufacturing. Mc-Graw Hill book Company Network, 1994.
2. Mechatronics by W,Bolton

1MEMRE2-09 MICROPROCESSORS AND MICRO CONTROLLERS 3 Credits

Evolution of Microprocessors, General architecture of **µ**P, an overview of 8086/88/architecture minimum/maximum mode configuration. Assembly Language programming in 8086, interrupt structure Programmed I/O, parallel I/O (8255-PPI) serial I/O (8251/8250), RS-232, IEEE bus standard, 8157 DMA controller A/D & D/A conversion, 8253/54 PIT/counters.

8087 Numerical processor and its interfacing with 8086. Introduction to 8051 micro-controller family: Pin description of 8051 and its internal structure, connections of I/O ports and Memory organization Addressing mode. Instruction set & its format and simple programs. Atmel micro-controller 89C51 and 89C2051.

Introduction to 8096/8097 family and essential difference with 8051.

Applications of microprocessors and micro-controller

***Text Books / References*:**

1. D V Hall, Microprocessor and It's Applications, TMH.
2. B.B. Bray, The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium pro processor, architecture, programming and interfacing, PHI India.
3. Mohammed Refiguzzaman, Microprocessor & Microcomputer Based System Design, Universal Books Stall, New Delhi.
4. James L. Antonakos, The Pentium Microprocessor, Pearson Education
5. Muhammad Mazidi and Janice Mazidi, The 8051 Microcontrollers and Embedded Systems. 2000. Prentice Hall
6. Walter Triebel and Avtar Singh, The 8088 and 8086 Microprocessors: Programming, Interfacing. Software, Hardware, and Applications, 3rd Ed., 2000, Prentice Hall.
7. Ajay V. Deshmukh "Micro-controllers Theory and Applications." Tata – McGraw Hill companies – 2005.
8. Jan Axelson "Micro-controller Idea Book ". PenramInternation Publishing Company.
9. B.P. Singh and Renu Singh "Advanced Microprocessors & Micro-controllers." New Age Publisher-2002.
10. Kenneth J. Ayala "The 8085 micro controller-Architecture, Programming & Applications" Penram Publishing 1997.

1MEMRE2-10 ROBOTICS & CONTROL 3 Credits

Introduction: Definition, Classification of Robots, Geometric classification and control classification.

Robot Elements: Drive systems, Control systems, sensors, End effectors, Gripper actuators and gripper design.
Robot Coordinate Systems and Manipulator Kinematics: Robot co-ordinate system representation, Transformation, Homogeneous transforms and its inverse, Relating the robot to its world.

Manipulators Kinematics, Parameters of links and joints, Kinematic chains, Dynamics of kinematic chains, Trajectory planning and control, Advanced techniques of kinematics and dynamics of mechanical systems, Parallel actuated and closed loop manipulators.
Robot Control: Fundamental principles, Classification, Position, path and speed control systems, adaptive control.

Robot Programming: Level of robot programming, Language based programming, task level programming, Robot programming synthesis, robot programming for foundry, press work and heat treatment, welding, machine tools, material handling, warehousing assembly, etc., automatic storage and retrieval system, Robot economics and safety, Robot integration with CAD/CAM/CIM, Collision free motion planning

Books:

1.	Robotic Technology (Vol. I-V)	Phillipe Collet	Prentice Hall
2.	An Introduction to Robot Technology	Coiffet and Chirooza	Kogan Page
3.	Robotics for Engineers	YKoren	McGraw Hill
4.	Robotics	K.S. Fu, R.C. Gonzalez & CSG Lee	McGraw Hill International
5.	Robotics	J.J. Craig	Addison-Wesley
6.	Industrial Robots	Groover, Mitchell Weiss, Nagel Octrey	McGraw Hill
7.	Robots & Manufacturing Automation	Asfahl	Wiley Eastern

1MEMPE3-12: HUMAN VALUES AND PROFESSIONAL ETHICS

Need, Basic Guidelines, Content And Process For Value Education:

Understanding the need, basic guidelines, Self Exploration - its content and process; Natural Acceptance and Experiential Validation, Continuous Happiness and Prosperity- Human Aspirations, Right understanding, Relationship and Physical Facilities, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfill the above human aspirations: understanding and living in harmony at various levels.

Understanding Harmony in The Human Being - Harmony in Myself:

Understanding human being as a co-existence of the sentient 'I' and the material 'Body' Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha Understanding the Body as an instrument of 'I', Understanding the characteristics and activities of 'I' and harmony in 'I' Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya.

Understanding Harmony in the Family And Society- Harmony in Human-Human Relationship: Understanding harmony in the Family, Understanding values in human-human relationship; meaningof Nyaya and program for its fulfillment to ensure Ubhay-tripti; Trust (Vishwas) and Respect(Samman) , meaning of Vishwas; Difference between intention and competence, meaning of Samman,Difference between respect and differentiation; the other salient values in relationship, harmony in thesociety , Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals ,Visualizing auniversal harmonious order in society- Undivided Society (AkhandSamaj), Universal Order (SarvabhaumVyawastha)- from family to world family.

Understanding Harmony in the Nature And Existence - Whole Existence As Coexistence:

Understanding the harmony in the Nature. Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature. Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all pervasive Space. Holistic perception of harmony at all levels of existence

Implications of the Above Holistic Understanding of Harmony on Professional Ethics. Natural Acceptance of Human Values:

Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in Professional Ethics: a) Ability to utilize the professional competence for augmenting universal human order, b) Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, technologies and management models. Strategy for transition from the present state to Universal Human Order: At the level of individual: as socially and ecologically responsible engineers, technologists and managers. Case studies related to values in professional life and individual life.

Suggested Readings:

1. R. R. Gaur, R Sangal, G P Bagaria, A Foundation Course in Human Values and Professional Ethics, Excel Books.
2. R. Subramanian, Professional Ethics includes Human Values, Oxford Univ. Press.
3. A. N. Tripathy, Human Values, New Age International Publishers.

4. M. Govindrajran, S. Natrajan, V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
5. B. P. Banerjee, Foundations of Ethics and Management, Excel Books.
6. B. L. Bajpai, Indian Ethos and Modern Management, New Royal Book Co.

1MEMPE4-14: FIELD WORK

Student is required to work in the organization/industry concerned with his/her course.

1MEMPE5-15: HUMAN VALUES PRACTICE SCHOOL

This practice school in first semester will have two parts -

I. Industry Interaction

In this, students will start his industry interaction in the very first semester of the M.Tech. Course. He/ She has to visit an organization for 3 hours /week in any industry finalized/selected by competent authority. This interaction will give him feel and insight to the real time working.

A. This 3 hours /work will be after the classroom studies
B. Selection criteria of organisation:
   1. Have turnover more than 20 lakhs.
   2. Have more than 20 employees.
C. During these hours, student will observe following points in the organisation:
   1. Organisational structure and hierarchy.
   2. Different kind of jobs/works done by the employees at all levels in the company.
   3. Working of different departments.
   4. Types of skills required to work in an organisation.
   5. Ways of internal and external communication.
   6. Formal dressing and attitude.
   7. Coordination and team work.

II. Social Responsibility

To make students understand his role and responsibility in society & nature and co-existence as whole, student has to take an initiative towards contribution in any relevant social and environmental issue.

A. This work will be performed after the time of regular classes

B. Student will perform one or more of the following activities after the approval of mentor andHOD:
   1. Making contribution in increasing the income of any street vender or any needy person fromunder privileged section
   2. Cleanliness Campaign
   3. Donation of his/her belongings which is of no use to him/her to needy ones
   4. Plantation and care for nature (soil, natural resources, plants and animals)
   5. Girl child and women safety, education and empowerment.
   6. Blood donations and help of needy people at hospitals

7. Helping the under – privileged section of the society
8. Educating the street children or in schools when and where needed.
9. Nukkad Natak on any topic of social or environmental concern.
10. Any other relevant activities.

M.TECH – ROBOTICS ENGINEERING

YEAR-I, SEMESTER-II

2MEMRE1-01- DRIVES AND CONTROL SYSTEMS FOR AUTOMATION 3 Credits

Unit I

Introduction: Working principle of synchronous, Asynchronous & stepper motors, Difference betw Induction and servo motors, Torque v/s speed characteristics, Power v/s. Speed characteristics, Vect induction motors, Concepts of linear and frameless motors, Selection of feedback system, Duty cycl control, Flux Vector control.

Unit II

Industrials Drives: DC and AC motors operation and selection, method of control and application of brushless DC motor, PMSM, stepper motor, A.C servomotor, selection criteria for servo motor and servo amplifier, universal motor, electric drive, types of industrial drives, the characteristics of drive, advantages of drives over other prime movers, motor rating, heating effects, electric braking, rheostatic and regenerative braking principles in power converters.

Unit III

Motion laws for rotary and linear systems: converting rotary to linear system, conceptsand principles of ball screws, rack and pinion, belt and pulley, chain drives, gear drives, Selection of converting systems, Dynamic response gearing, and control approaches ofRobots, Control loops using Current amplifier

Unit IV

Introduction to Programmable Logic Controllers: Definitions of PLC, basic structure ofPLC, working principles, data storage methods, inputs / outputs flag processing's, types of variables, definition of firmware, software, programming software tool and interfacing with PC (RS232 & TCP-IP), methods of PLC programming (LD, ST, FBD & SFC), function blocks logical / mathematical operators & data types, array & data structure, PID, types of tasks and configuration, difference between relay logic and PLC, selection of PLC controller

Unit V

Logic, instructions & Application of PLC: What is logic, Conventional Ladder v/s PLCladder, series and parallel function of OR, AND, NOT logic, Ex Or logic, Analysis of rung. Timer and Counter Instructions; on delay and Off delay and retentive timer instructions, PLC counter up and

down instructions, combining counters and timers, Comparison and data handling instructions, Sequencer instruction, Visualization Systems, Types of visualization system, PC based Controller, Applications of HMI's, and Interfacing of HMI with

Text Books:

1. Process Control Instrumentation Technology, Johnson Curties, Prentice hall of India, 8th edition
2. Andrew Parr, Industrial drives, Butterworth – Heineamann
3. G.K.Dubey.Fundamentals of electrical drives
4. Programmable Logic Controllers by W.Bolton

References:

1. Introduction to Programmable Logic Controllers by Garry Dunning, 2nd edition, Thomson, ISBN:981-240-625-5
2. Instrumentation Engineers Hand Book - Process Control, Bela G Liptak, Chilton book company, Pennsylvania
3. A.E. Fitzerald ,C.Kingsley and S.D Umans, Electric Machinery - McGraw Hill Int. Student edition
4. S.K.Pillai. A First course on electric drives –Wiley Eastern 1990
5. Programmable Logic Controllers by Hugh Jack.

2MEMRE1-02 ADVANCE COMPUTER CONCEPTS FOR AUTOMATION 3 Credits

Introduction to computer Automation, Elements of Automation and Types of Automation, Importance of Computers in Automation, Computer Networks and Topology Types. Computer Graphics, Display Adapters, Video Display Modes.

Object Oriented Programming Introduction: Necessity of Object Oriented Programming,Procedural Language and Object Oriented Approach, Characteristics of Object Oriented Languages. OOP's Concepts: Objects, Classes, Inheritance, Overloading, Virtual Functions, and Polymorphism.

OOP's features for Automation: Templates and Exceptions, C++ Input and output concepts, OOPSfor Automation. Introduction to JAVA Features of JAVA, OOPS through JAVA.

Database Management System Introduction: Comparison of File System, Database Management System, Characteristic Features of Database Management Systems.

Database Design: Relational Database, Logical Database Design, Data Base Models, DBMS Languages and Interfaces. Data Base Security and Authorization.Data Ware House.

Operating Systems and Protocols: Basic Concepts of batch Systems, Multi Programming, Time-Sharing, Distributed and Real Time Systems.

Operating System Structures: Operating System Components and Services & brief discussion aboutprotocols-FTP, TCP/IP & HTTP.

Text Books / References:

1. C++ Programming-BjarneStroustrup, Addison Wesley.
2. Fundamentals of DBMS – RamezElmasri and Navathe, Addison Wesley.
3. Operating System Concepts – Silberschatz, Galvin, Gagne, Sixth edition, John Wiley.
4. Computer Graphics, C version – Donald Hearn, M. Pauline Baker, Pearson Education.
5. Object Oriented Programming with C++ - E. Balaguruswamy, TMH.
6. Object Oriented Programming with C++ - Robert Lafore, PHI
7. Operating Systems-A concept based approach", D M Dhamdhere, TMH
8. Internet Working with TCP/IP – Douglas, PHI
9. Introduction to DBMS – Date C.J. Addison Wesley

2MEMRE1-03 SIMULATION, MODELLING AND ANALYSIS 3 Credits

Introduction: A review of basic probability and statistics, random variables and their properties, Estimation of means variances and correlation.

Physical Modelling: Concept of System and environment, Continuous and discrete systems, Linear and non-linear systems, Stochastic activities, Static and Dynamic models, Principles of modeling, Basic Simulation modeling, Role of simulation in model evaluation and studies, advantages of simulation

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

System Dynamics: Growth and Decay models, Logistic curves, System dynamics diagrams.

Probability Concepts in Simulation: Stochastic variables, discrete and continuous probability functions,

Random numbers, Generation of Random numbers, Variance reduction techniques, Determination of length of simulation runs. Simulation of Mechanical Systems: Building of Simulation models, Simulation of translational and rotational mechanical systems, Simulation of hydraulic systems.

Simulation of Manufacturing Systems: Simulation of waiting line systems, Job shop with material handling and Flexible manufacturing systems, Simulation software for manufacturing, Case studies.

Books:

1	System Simulation	Geoffrey Gordon	Prentice Hall
2.	System Simulation: The Art and Science	Robert E. Shannon	Prentice Hall
3.	System Modelling and Control	J. Schwarzenbach and K.F. Gill	Edward Arnold
4.	Modelling and Analysis of Dynamic Systems	Charles M Close and Dean K. Frederick	Houghton Mifflin
5.	Simulation of manufacturing	Allan Carrie	John Wiley & Sons

2MEMRE2-04 PROCESS CONTROL & AUTOMATION 3 credits

Process Modeling- Introduction to Process control and process instrumentation-Hierarchies in process control systems-Theoretical models-Transfer function-State space models-Time series models-Development of empirical models from process data-chemical reactor modeling-. Analysis using softwares

Feedback &Feedforward Control- Feedback controllers-PID design, tuning, trouble shooting-Cascade control- Selective control loops-Ratio control-Control system design based on Frequency response Analysis-Direct digital design-Feedforward and ratio control-State feedback control- LQR problem-Pole placement -Simulation using softwares-Control system instrumentation-Control valves- Codes and standards- Preparation of P& I Diagrams.

Advanced process control-Multi-loop and multivariable control-Process Interactions-Singular value analysis-tuning of multi loop PID control systems-decoupling control-strategies for reducing control loop interactions-Real-time optimization-Simulation using softwares

Model predictive control-Batch Process control-Plant-wide control & monitoring- Plant wide control design- Instrumentation for process monitoring-Statistical process control-Introduction to Fuzzy Logic in Process Control-Introduction to OPC-Introduction to environmental issues and sustainable development relating to process industries. Comparison of performance different types of control with examples on softwares

References

1. Seborg, D.E., T.F. Edgar, and D.A. Mellichamp, Process Dynamics and Control, John Wiley , 2004
2. Johnson D Curtis, Instrumentation Technology, (7th Edition) Prentice Hall India, 2002.
3. Bob Connel, Process Instrumentation Applications Manual, McGrawHill, 1996.
4. Edgar, T.F. & D.M. Himmelblau, Optimization of Chemical Processes, McGrawHill Book Co, 1988.
5. Macari Emir Joe and Michael F Saunders, Environmental Quality Innovative Technologies

2MEMRE2-05 VIRTUAL INSTRUMENTATION 3 Credits

UNIT- I

Virtual Instrumentation: An introduction

Historical perspective, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, comparison with conventional programming. Development of Virtual Instrument using GUI, Real-time systems.

UNIT- II

VI programming techniques:

VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

UNIT- III

Data acquisition basics:

Introduction to data acquisition on PC, Sampling fundamentals, Input/Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements.

UNIT -IV

VI Interface requirements:

Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

UNIT- V

VI toolsets:

Distributed I/O modules. Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control.

TEXTBOOKS

1. LabVIEW Graphical Programming , Gary Johnson, Second edition, McGraw Hill, Newyork, 1997.
2. LabVIEW based Advanced Instrumentation Systems, S. Sumathi and P. Surekha, Spinger.

REFERENCES

1. PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Kevin James, Newnes, 2000.
2. WEB RESOURCES: www.ni.com.
3.LabVIEW for everyone, Lisa K. wells & Jeffrey Travis Prentice Hall, New Jersey, 1997.

2MEMRE2-06 ARTIFICIAL INTELLIGENCE & EXPERT SYSTEM IN AUTOMATION 3 Credits

Expert system.Architecture, knowledge base, inference engine, expert system shell, applications. Fuzzy Logic: Fuzzy sets, membership functions, operation on fuzzy sets; fuzzy control system, Fuzzyfication, knowledge base, inference, defuzzification, application.

Neural Network : Neuron structure, classification, artificial neural network, back propagation training and algorithm, neuro-fuzzy controllers, applications.

Genetic algorithms: Concepts, encoding and selection methods, genetic operators (crossover and Mutation), applications.

Text Books / References:

1. Haykin "Neural Networks – A comprehensive Foundation" (Mc-millan)
2. J.M. Zureda "Introduction to artificial neural networks" (Jaico)
3. A Cichocki& R Unbehauen " Neural Networks for optimization and signal Processing" John Wiley
4. George J. Klin& Tina A Polgar "Fuzzy sets, uncertainty and Information"
5. BaertKosko "Neural network and fuzzy systems"
6. Peterson "Introduction to Artificial Intelligence and expert system (PHI)
7. Michell "Introduction to Genetic Algorithm" (PHI)
8. Vidyasagar M "Theory of learning and generalization" Springer
9. S. Rajasekaran, G.A. VijaylakshmiPai "Neural Networks, Fuzzy Logic and Genetic Algotithm", PHI.
10. T.J. Ross: "Fuzzy Logic with Engineering Applications" Second Edition John Wiley India.

2MEMRE2-07 ADDITIVE MANUFACTURING & TOOLING 3 Credits

Introduction: Historical developments, Fundamentals of RP Systems and its Classification, Rapid prototyping processchains, 3D modeling and mesh generation, Data conversion and transmission.

RP Systems: Liquid polymer based rapid prototyping systems, Teijin Seikis' solid form and other similar commercial RPsystems, Solid input materials based rapid prototyping systems, laminated object manufacturing (LOM) and fused deposition modelling systems etc., Power based rapid prototyping systems, selective Laser sintering, SoligenDiren's shell production casting (DSPC), Fraunhofer's multiphase jet solidification (MJS) and MIT's 3D printing (3DP) etc.

RP Database: Rapid prototyping data formats, STL format, STL file problems, STL file repair, Network based operations,Digital inspection, Data warehousing and learning from process data.

RP Applications: Development of dies for moulding, RP applications in developing prototypes of products, application inmedical fields, Development of bone replacements and tissues, etc., RP materials and their biological acceptability

Books:

1. Rapid Prototyping Of Digital Systems: A Tutorial Approach, Hamblen James O , Kluwer Aca
2. Rapid Prototyping: Principles And Applications, Kai Chua Chee, World Science
3. Rapid System Prototyping With Fpgas: Accelerating The Design Process, R C Cofer, Newnes
4. Rapid Prototyping of Digital Systems, James O Hamblen, Springer

2MEMRE2-08 OPTIMIZATION TECHNIQUES& DESIGN OF EXPERIMENTS3 Credits

SINGLE VARIABLE NON-LINEAR UNCONSTRAINED OPTIMITION: One dimensional Optimization methods, Uni-modal function, elimination method, Fibonacci method, golden section method, interpolation methods- quadratic & cubic interpolation methods.

MULTI VARIABLE NON-LINEAR UNCONSTRAINED OPTIMIZATION: Direct search method – Univariant Method – pattern search methods – Powell's – Hook – Jeeves, Rosenbrock search methods – gradient methods, gradient of function, steepest decent method, Fletcher reeves method, Variable metric method.

GEOMETRIC PROGRAMMING: Polynomials – arithmetic – geometric inequality – unconstrained G.P – constrained G.P

DYNAMIC PROGRAMMING: Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic programming, production inventory. Allocation, scheduling replacement.

LINEAR PROGRAMMING: Formulation – Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints. Simulation: Introduction – Types – Steps – application – inventory – queuing – thermal system.

INTEGER PROGRAMMING: Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method.

STOCHASTIC PROGRAMMING: Basic concepts of probability theory, random variables – distributions – mean, variance, Correlation, co variance, joint probability distribution – stochastic linear, dynamic programming.

REFERENCES:

1. Optimization theory & Applications/ S.S Rao/ New Age International
2. Introductory to operation research/Kasan& Kumar/Springar
3. Optimization Techniques theory and practice / M.C Joshi, K.M Moudgalya/ Narosa Publications.
4. Operation Research/H.A. Taha/TMH
5. Optimization in operations research/R.L Rardin.
6. Optimization Techniques/Benugundu&Chandraputla/Person Asia.
7. Optimization Techniques /Benugundu&Chandraputla / Pearson Asia.

2MEMRE2-09 PNEUMATIC AND HYDRAULIC CONTROL3 Credits

Introduction to control system, Types of control system and their utility. Hydraulic power generation and transmission, valve control pressure flow relationship for hydraulic valves, valve configurations and constructions, steady state operating forces, transient forces and valve instability. Circuit design, Pneumatic valves, Hydraulic and pneumatic drives.

Introduction to fluidic devices and sensors lumped and distributed parameter fluid systems. Fluid mechanics of jets, wall attachment and vortex devices. Pure fluidic analog amplifiers. Analog signal control techniques. Design of pure fluid digital elements.

Physical concepts of pneumatics and electricals. Electropneumatic components operation and application interpretation of electric ladder diagram.

P.PI & PID – controllers & applications.

Text Books / References:

1. J.F. Blackburn, G. Rechthof, J.L. Shearer. Fluid Power Control MIT, 1960
2. B.W. Anderson, The Analysis and Design of Pneumatic Systems, Wiley, 1967.
3. K. Foster, G.P. Parker, Fluidic Components and Circuits, Wiley, 1970.
4. A.B. Goodwin, Fluid Power Systems, Macmillan, 1976.
5. Oil Hydraulic Systems by S.R. Majumdar, Tata Megraw Hill Pub. Co. Ltd. 2001
6. Pneumatic Systems by S.R. Majumdar, Tata Megraw Hill Pub. Co. Ltd. 1995
7. Hydraulic and Pneumatic Control by Srinivasan, Vijay Nikole, Imprints Pvt. Ltd. 2004
8. Hydraulic Control of Machine Tools by Khaimovich, Pergamon Press Ltd.196

2MEMRE2-10 DESIGN OF MECHANISM AND MANIPULATORS 3 Credits

Mobility analysis, Degree of Freedom (DOF), Mixed Mobility, Total, Partial and Fractional DOF, Closed and Open Chain Systems, Application of D-H representation for 1) Kinematic parameter tables for standard robot structures like.

Link coordinate diagram and arm matrix of SCARA, Alpha-II, PUMA articulated robot, standard robot, polar frame, structure robot, Enter transform solution, Arm matrix of standard Robots, Polar frame, structure robots

Structural Analysis and Synthesis of mechanisms, Alternative design solutions; Coding, evaluation and selection of optimum mechanism. Type synthesis, number synthesis and design of mechanisms. Indexes of merit; Graphical, Algebraic and Optimization techniques, Matrix methods of design and analysis; Design of function, Path and Motion Generators; Structural and Mechanical error; Design and Analysis using software like ADAMS.

Manipulators- Classifications, actuation and transmission systems; Coordinate Transformation – DH notations, Inverse and Forward kinematics, Manipulator dynamics from Lagrangian and Newtonian point of view.

Forces in Manipulator, manipulate Dynamics, selecting of robots for Robot Application Reliability of Robotic & Automation systems and their evaluation.

Text Books / References:

1. Andeen, G.B., "Robort Design Hand Book", SRI International, McGraw Hill,
2. Craig, J.J., "Introduction to Robotics", Mechanics and Control, Addison Wesley
3. Spong, M., and Vidyasagar, M. "Robot Dynamics and Control", John Wiley, NY, 1989.
4. Venkataraman. S.T., and liberall. T., "Dextrous Robot Hands", S
5. AppuKuttan, "Robotics", I.K. International Publishing house

2MEMRE2-11 FLEXIBLE MANUFACTURING SYSTEM 3 Credits

Introduction: FMS definition and classification of manufacturing systems, automated production cycle, Need offlexibility, Concept of flexibility, Types of flexibilities and its measurement.

FMS Equipment: Why FMS, Factors responsible for the growth of FMS, FMS types and applications, Economicjustification for FMS, Functional requirements for FMS equipments, FMS processing and QA equipment, e.g., turning and machining centers, Co-ordinate measuring machines, Cleaning and deburring machines, FMS system support equipment, Automated material handling and storage equipment, cutting tool and tool management, Work holding considerations, Fixture considerations in FMS environment.

Group Technology: GT concepts, Advantages of GT, Part family formation-coding and classification systems; Part-machine group analysis, Methods for cell formation, Use of different algorithms, mathematical programming and graph theoretic model approach for part grouping, Cellular Vs FMS production.

FMS related problem and Solution Methodology:

- FMS design problems: Part assignment, Machine selection, Storage system selection, Selection of pallets and fixtures, Selection of computer hardware and software, designing for layout integration of machine storage, Material handling System and computer system, Communication networks.
- FMS planning problems: Strategic planning, Part type selection, Machine grouping, production ratio and resource allocation, Machine loading problems.
- Operational & Control problems: Part scheduling, Machines robots & AGVS, Process monitoring & control.
- FMS Implementation: Objectives, acceptance testing, Performance goals and expectation maintenance concerns.

Books:

1.	Automation, Production System & Computer Integrated Manufacturing	Groover	Englewood
2.	Design and Operation of SMS	Rankey	IFS
3.	Flexible Manufacturing System	Wernecks	Spring-Verlag
4.	FMS in Practice	Bonctto	Northox Ford
5.	Flexible Manufacturing Cells and systems	W.W. Luggen	Prentice Hall India
6.	Performance Modelling of Automated ManufacturingSystems	Vishwanathan&Narahari	Prentice Hall India

2MEMPE3-12: RESEARCH METHODOLOGY

Research Methodology: Objectives and Motivation of Research, Types of Research, Research Approaches,

Significance of Research, Research Methods verses Methodology, Research and Scientific Method, Important of Research Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general.
Defining the Research Problem: Definition of Research Problem, Problem Formulation, Necessity of Defining the Problem, Technique involved in Defining a Problem.

Literature Survey: Importance of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet.
Literature Review: Need of Review, Guidelines for Review, Record of Research Review.

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes.

Data Collection: Collection of primary data, Secondary data, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Sample Design, Need for sampling, some important sampling definitions, Estimation of population, Role of Statistics for Data Analysis, Parametric V/s Non Parametric methods, Descriptive Statistics, Measures of central tendency and Dispersion, Hypothesis testing, Use of Statistical software. Data Analysis: Deterministic and random data, Uncertainty analysis, Tests for significance: Chisquare, student's t-test, Regression modeling, Direct and Interaction effects, ANOVA, F-test, Time Series analysis, Autocorrelation and Autoregressive modeling.

Research Report Writing: Format of the Research report, Synopsis, Dissertation, Thesis its Differentiation, References/Bibliography, Technical paper writing/Journal report writing, making presentation, Use of visual aids, Intellectual property, Plagiarism. Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

Suggested Readings:

1. C.R Kothari, Research Methodology, Methods & Technique, New Age International Publishers,2004.
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011.
3. Ratan Khananabis and Suvasis Saha, Research Methodology, Universities Press, Hyderabad, 2015.
4. Y. P. Agarwal, Statistical Methods: Concepts, Application and Computation, Sterling Publs., Pvt.,Ltd., New Delhi, 2004.
5. Vijay Upagade and Aravind Shende, Research Methodology, S. Chand & Company Ltd., NewDelhi, 2009.
6. G. Nageswara Rao, Research Methodology and Quantitative methods, BS Publications, Hyderabad, 2012.
7. Naval Bajjai, Business Research Methods, Pearson 2011.
8. Prahalad Mishra, Business Research Methods, Oxford 2016.

2MEMRE4-14: FIELD WORK

Student is required to work in the organization/industry concerned with his/her course.