MRT 292	MICRO MECHATRONIC SYSTEMS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	3

Preamble:

This course enables students to understand, design and analyse micro mechatronics systems.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to know

CO 1	The behavior of materials used in MEMS
CO 2	To impart knowledge on Micro actuation
CO 3	The technology for fabrication of MEMS
CO 4	To impart knowledge on Micro-fabrication special machining
CO 5	The applications of MEMS.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1	2	-	2	2	1	-	1	1	-	-
CO 2	3	2	3	2	2	2	1	1	1	1	1	1
CO 3	2	1	3	2	3	3	3	1	1	-	1	1
CO 4	2	1	3	2	3	2	2	1	1	-	1	1
CO 5	3	2	3	2	2	2	2	2	2	1	1	3

3	HIGH	1	LOW
2	MODERATE	-	NIL

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40

Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. To impart knowledge on Micro Mechatronics Systems
2. To impart knowledge on Materials In Micro Mechatronics Systems

Course Outcome 2 (CO2)

1. To impart knowledge onMicrosensors
2. To impart knowledge on Microactuation
3. To impart knowledge on MEMS with micro actuators

Course Outcome 3(CO3):

1. To impart knowledge on the technology for fabrication of MEMS
2. To impart knowledge on Micro Manufacturing Techniques
3. To impart knowledge on Vapour Deposition

Course Outcome 4 (CO4):

1. To impart knowledge on Micro-fabrication special machining
2. To impart knowledge on environmental conditions of fabrication

Course Outcome 5 (CO5):

1. To impart knowledge on Applications of MEMS in various industries
2. To impart knowledge on Future of MEMS

Syllabus

Module 1 (9 hours)

Micro electro mechanical system: MEMS and microsystems– microsystems and miniaturization-Materials for MEMS, CZ Method- Microsystems packaging.

Module 2 (9 hours)

Microsensors:acoustic-biomedical-chemical-optical-pressure-thermal

Micro actuators : Concept of micro actuations- actuation using thermal forces-electrostatic forces -shape memory alloys-piezo electric crystals-. MEMS with micro actuators: microgrippers – micromotors-microvalves- Micro Accelerometers-micropumps.

Module 3 (9 hours)

Micro Manufacturing Techniques: Photolithography-chemical Vapour Deposition – Physical Vapour Deposition-Etching Processes-Bulk micro manufacturing-surface micro manufacturing-LIGA process.

Module 4 (9 hours)

Micro-fabrication special machining: Laser beam micro machining-Electrical Discharge Machining-Ultrasonic Machining-Electro chemical Machining-Electron beam machining. Clean room

Module 5 (9 hours)

Laws of scaling: Scaling in Geometry ,Scaling in Rigid-Body Dynamics ,Scaling in Electrostatic Forces, Scaling in Electromagnetic Forces.

Applications of MEMS in various industries : Automobile- Defense- Healthcare-Aerospace-industry-Future of MEMS

Text Books

1. Tai-Ran Hsu MEMS &Microsytems Design and Manufacture, Tata McGraw-Hill publishing company Ltd.
2. N. Maluf, an Introduction to Microelectro Mechanical Systems Engineering, Artech House, 2000.

Reference Books

1. V.C.Venaktesh , Precision Engineering, Tata McGraw-Hill Publishing Company Limited
2. Madou M.J., Fundamentals of micro fabrication, CRC Press, 1997.
3. Chang Liu, Foundation of MEMS, Illinois ECE Series, Pearson Prentice Hall 2006.

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Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Micro electro mechanical system:	
1.1	MEMS and microsystems	2
1.2	microsystems and miniaturization	2
1.3	Materials for MEMS, CZ Method-	3
1.4	Microsystems packaging.	2
2	Microsensors&Microactuation	
2.1	Microsensorsacoustic-biomedical-chemical-optical-pressure-thermal-	2
2.2	Microactuation : actuation using thermal forces-shape memory alloys-piezo electric crystals-electrostatic forces.	2
2.3	MEMS with micro actuators: microgrippers -micromotors- micro accelerometers- microvalves-micropumps.	5
3	Micro Manufacturing Techniques:	
3.1	Photolithography-chemical Vapour Deposition –Physical Vapour Deposition-Etching Processes-	4
2	Bulk micro manufacturing-surface micro manufacturing-	3
3.3	LIGA process.	2
4	Micro-fabrication special machining:	
4.1	Clean room, Laser beam micro machining-	3
4.2	Electrical Discharge Machining-Ultrasonic Machining-	3
4.3	Electro chemical Machining-Electron beam machining.	3
5	Laws of scaling&Applications of MEMS in various industries	
5.1	Scaling in Geometry ,Scaling in Rigid-Body Dynamics ,Scaling in Electrostatic Forces, Scaling in Electromagnetic Forces	4
5.2	Applications of MEMS in various industries : Automobile-defence-healthcare-Aerospace-industry-	4
5.3	Future of MEMS	1

Model Question paper

QP CODE: PAGES:2

RegNo:_____

Name :_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code:MRT292

Course Name: **MICRO MECHATRONIC SYSTEMS**

Duration: 3 Hours

Max.Marks:100

PART A

Answer all Questions.

Each question carries 3 Marks

1. Draw and explain components of microsystem.
2. What are the advantages of silicon over other materials.
3. Explain with a neat block diagram of 'MEMS as a micro actuator'.
4. Explain the working principle of Shape memory alloys.
5. Explain Photolithography.
6. Draw the block diagram and steps behind LIGA process.
7. Describe the working principle of laser beam micro machining.
8. Explain about the standard clean room for micro machining.
9. What is scaling? Explain scaling in Geometry.
10. Explain about applications in Aerospace Industry. (10×3=30)

Part B

11 a) Explain CZ method for producing pure silicon crystal (10 marks)
b) Explain the importance of miniaturisation of MEMS (4 marks)

OR

12. Describe 3 level packaging systems (14 marks)

13. a) Write a short note on (10 marks)
    I. Micro valves
    II. Micro pumps

b) Explain the working principle of Micro accelerometer (4 marks)

OR

14. Discuss actuation using (14 marks)
    I. Thermal force.

II. Electrostatic force.

15. Explain and Compare bulk and surface micro-manufacturing. (14 marks)

OR

16. a) Compare and explain different types of CVD process. (10 marks)
    b) What are the limitations of Photolithography. (4 marks)
17. a) Describe the working principle of Electro chemical micro machining. (7 marks)
    b) Explain ultrasonic machining with a neat diagram. (7 marks)

OR

18 Explain and compare the principle, working and application of laser beam micromachining and electron beam machining. (14 marks)

19 Discuss on Scaling in rigid body dynamics. (9 marks)

20 Discuss on future of MEMS. (5 marks)

(14×5=70)

MRT294	INDUSTRIAL AUTOMATION	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble:

This course enables students to understand automation, and its applications in industries.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify and justify potential areas and scope of industrial automation
CO 2	Understand the components of automation systems
CO 3	Select suitable control system for automation
CO 4	Select suitable control structure depending on the application
CO 5	Integrate computers in industrial automation
CO 6	Incorporate robots in automation structures

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	2			2			2			
CO 2	3	2	2			2			2			
CO 3	3	2	2			2			2			
CO 4	3	2	2			2			2			
CO 5	3	2	2			2			2			3
CO 6	3	2	2			2			2			3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the need and scope of industrial automation.

2. List the components of an industrial automation system with examples.

3. Illustrate an automated material handling system.

Course Outcome 2 (CO2)

1. Classify sensors used in automation systems with examples

2. Outline the need of signal conditioning and processing.

3. List out different industrial bus configurations and applications.

Course Outcome 3(CO3):

1. Explain the operation of PLC.

2. Describe SCADA? Demonstrate an application.

3. Describe the features of distributed control systems.

Course Outcome 4 (CO4):

1. Give an example of a feedback system and explain.

2. Compare a feedback control structure with feed forward control.

3. Describe any two special control schemes.

Course Outcome 5 (CO5):

1. Illustrate the role of computers in automation.

2. Explain the operation of an FMS

3. Explain the operation of CNC machines.

Course Outcome 6 (CO6):

1. Illustrate the geometric configurations of industrial robots.

2. Demonstrate how IoT can influence industrial automation.

3. list the applications of machine vision in automation.

Model Question paper

Course Code: MRT 294

Course Name: INDUSTRIAL AUTOMATION

Max.Marks:100 **Duration: 3 Hours**

PARTA

Answer all Questions. Each question carries 3 Marks

1. What is the scope of industrial automation?
2. What do you mean by HMI?
3. What are the applications of Motion Actuators?
4. What is the need of signal conditioning?
5. What do you mean by ladder program? What are its components?
6. With an application, explain a Distributed Control System.
7. How does a CNC differ from conventional systems?
8. What do you mean by Manufacturing Cells?
9. Differentiate between a serial and parallel robot.
10. What is the role of IoT in industrial automation?

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. Explain the need of industrial automation with reference to a material handling system.
12. What are the different measures adopted for industrial safety inautomation?

Module 2

13. Classify sensors used in automation and give examples for each.
14. What is the need of industrial bus systems? Give two examples and their applications.

Module 3

15. Explain a PLC based system for automation. Explain its ladder diagram.
16. What do you mean by SCADA? What is its role in automation?

Module 4

17. Explain any two control structures used in automation systems.
18. With an example, explain FMS.

Module 5

19. With illustrations, explain the basic robotic configurations.
20. Write short notes on the following: i) Machine Vision ii) Robotic Workcells

Syllabus

Module 1 (9 Hours)

Introduction: Potential areas and need of industrial automation. Architecture of industrial automation systems. Levels of automation. Examples of automation systems, Material Handling System. Transfer lines and automated assembly. Need of HMI systems. Safety Measures in Automation.

Module 2 (9 Hours)

Introduction to sensors and measurements: Motion actuators: types and applications. Sensors: Classifications and examples, Encoders and applications. Measurement of temperature, pressure, force, displacement, flow and level. Signal conditioning and processing: need and examples. Industrial bus systems: examples and applications.

Module 3 (9 Hours)

PLC and Supervisory Control: Programmable Logic Controllers: applications in industries. PLC programming: ladder diagram examples. SCADA systems: applications, Distributed Control Systems: Overview, features, applications.

Module 4 (9 Hours)

Computer controlled systems: Control structures: PID control, feed forward, ratio control and predictive control. Role of microcontrollers, microcomputers and computers in industrial control applications. Computer aided process control, CNC: overview, control and applications. Manufacturing Cells and Flexible Manufacturing Systems, examples.

Module 5 (9 Hours)

Robots and IoT in industrial automation: Basic robotic configurations and their applications in industries. Examples of automated work cells with robots. Machine vision and its applications. IoT in industrial automation- IoT enabled PLC, applications of IoT in automation systems.

Text Books

1. Automation, Production Systems and Computer Integrated Manufacturing M.P.Groover, Pearson Education.5th edition, 2009.

2.Computer Based Industrial Control- Krishna Kant, EEE-PHI, 2nd edition, 2010

Reference Books

1. Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies

2. Process Control Instrumentation Technology By. C.D. Johnson, PHI

3.Pessen, Industrial Automation: Circuit Design and Components

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	INTRODUCTION	
1.1	Potential areas and need of industrial automation	1
1.2	Architecture of industrial automation systems.	2
1.3	Levels of automation. Examples of automation systems	2
1.4	Material Handling System. Transfer lines and automated assembly.	2
1.5	Need of HMI systems	1
1.6	Safety Measures in Automation	1
2	INTRODUCTION TO SENSORS AND MEASUREMENTS	
2.1	Motion actuators: types and applications	1
2.2	Sensors: Classifications and examples. Encoders and applications	2
2.3	Measurement of temperature, pressure, force, displacement, flow and level.	2
2.4	Signal conditioning and processing: need and examples	2
2.5	Industrial bus systems: examples and applications.	2
3	PLC AND SUPERVISORY CONTROL	
3.1	Programmable Logic Controllers: applications in industries	2
3.2	PLC programming: ladder diagram examples.	3
3.3	SCADA systems: applications	2
3.4	Distributed Control Systems: Overview, features, applications.	2
4	COMPUTER CONTROLLED SYSTEMS	
4.1	Control structures: PID control, feed forward, ratio control and predictive	2

	control	
4.2	Role of microcontrollers, microcomputers and computers in industrial control applications.	2
4.3	Computer aided process control, CNC: overview, control and applications	3
4.4	Manufacturing Cells and Flexible Manufacturing Systems, examples	2
5	ROBOTS AND IoT IN INDUSTRIAL AUTOMATION	
5.1	Basic robotic configurations and their applications in industries.	2
5.2	Examples of automated work cells with robots	2
5.3	Machine vision and its applications	2
5.4	IoT in industrial automation- IoT enabled PLC, applications of IoT in automation systems.	3

MRT 393	DRIVES & CONTROL SYSTEM FOR AUTOMATION	CATEGORY	L	T	P	CREDIT
		VAC	4	1	0	4

Preamble: To introduce to the students the different types of drives, and their control in automation.

Prerequisite: Knowledge of drives and linear control theory

Course Outcomes: After the completion of the course the student will be able to:

CO 1	Understand working principles of various types of motors, their characteristics and selection criteria for various industrial applications.
CO 2	Explain control methods of special drives.
CO 3	Elucidate various linear and rotary motion principles and methods and apply them for industrial automation.
CO 4	Carry out programming of PLC and use them for automation in industries.
CO 5	Discuss supervisory control and data acquisition method and use the same in complex automation applications.
CO 6	Understand and use logical elements and use of Human Machine Interfacing (HMI) devices to enhance control & communication aspects of automation.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2							2			
CO 2	3	2							2			
CO 3	3	2							2			
CO 4	3	2							2			
CO 5	3	2							2			
CO 6	3	2							2			

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain with diagram the working of a multi stack variable reluctance stepper motor
2. What is micro stepping? Determine the step angle of a variable reluctance stepper motor with 12 teeth in stator and 8 rotor teeth.
3. A 3-phase, 400 V, 50 Hz induction motor has a rotor resistance of 0.1 Ω and standstill reactance of 0.9 Ω per phase. The full load slip is 4%, Calculate (i) Full load torque as a percentage of maximum torque and the value of extra resistance to be added in the rotor circuit to have 80% of maximum torque at start.

Course Outcome 2 (CO2)

1. With suitable block diagrams explain the control of stepper motors.
2. A microprocessor based control scheme is required to be implemented with DC separately excited motor to keep the speed of the motor at desired speed. Give the scheme and outline the steps in software design.
3. Explain the principle of speed control of a 3-phase induction motor by V/F method and draw the corresponding torque-speed characteristics and discuss the applications and limitations of these methods.

Course Outcome 3(CO3):

1.Under what circumstances chain drives are preferred over V belt drives.
2.With the help of a sketch, indicate the normal pitch and axial pitch in a helical gear.Name two important modes of failure in gear.
3. Write notes on chordal action in chain drives. What do you understand by simplex, duplex and triplex chains?

Course Outcome 4 (CO4):

1. Develop a ladder diagram of OR and EX-OR Logic gates.
2. What is the importance of PLC scanning? Explain PLC scanning with the help of necessary figures.
3.What is the use of interrupt instructions in PLC? Explain anyone instruction.

Course Outcome 5 (CO5):

1. With a neat diagram, explain signal sources and O/P loads of SCADA.

2. What do you mean by off-line configuration in DCS? What is software wiring in context of DCS?
3. Briefly explain PROFIBUS, its BUS access method, features & acceptance.

Course Outcome 6 (CO6):

1. Explain working of HMI with sketch.
2. What is RTU? Explain various types of RTUs in the context of SCADA.
3. Explain in short: (i) Relay Instruction (ii) Data Handling Instruction.

Model Question Paper

Course Code: MRT 393
Course Name: DRIVES & CONTROL SYSTEM FOR AUTOMATION
Max. Marks: 100Duration: 3 Hours

	PART A **Answer all the questions. Each question carries 3 Marks**	
1.	Discuss briefly any two assumptions made in Potier method.	
2.	Define synchronizing power coefficient and also mention its units.	
3.	Explain, why the speed of 3-phase induction motor cannot be equal to synchronous speed?	
4.	Show that a Synchronous motor has no net starting torque? Explain different methods of starting synchronous motor?	
5.	What are the effects of centrifugal tension on flat belt.	
6.	Express the following equation in ladder logic program: (i)4 to 1 line multiplexer (ii)F (a,b,c) = Σ (2,4,6,7)	
7.	Describe various move instructions: BIT,BYTE,WORD,DOUBLEWORD, REAL.	
8.	How will you implements communication network for PLC? Explain with industrial communication.	
9.	List the shift Register in PLC. Explain Shift Register function with suitable application.	
10.	Name the three forms of PLC counter instructions, and explain the basic operation of each.	

	PART B **Answer any one full question from each module. Each question carries 14 Marks**	
	Module 1	
11	(a) The frequency of the e.m.f in the stator of a 4 pole induction motor is 50Hz, and that in the rotor is 1.5 Hz. What is the slip, and at what speed is the motor running? (b) Explain the procedure of drawing the circle diagram of an induction motor. What information can be drawn from the circle diagram? (c) A 4-pole, 50 Hz, 3-phase induction motor develops a maximum torque of 120 Nmat1460r.p.m.Theresistanceofthestarconnectedrotoris0.35Ω/phase.	3 4 7

	Determine the value of resistance that must be inserted in series, with each rotor phase to produce a starting torque equal to half the maximum torque.	
12	(a)Compare voltage source inverter and current source inverter as applied to their use in speed control of induction motor (b) Explain with a neat circuit diagram rheostatic braking of DC shunt motor. Sketch also the braking characteristics. (c) Draw the circle diagram from no-load and short circuit test on a 3-phase, 14.92 kW, 440V, 6-pole induction motor from the following results: No-load: 400V, 11A, PF=0.2 Short-circuit test : 100V, 25A, PF=0.4 Rotor Cu losses at stand still is half the total Cu losses from the circle diagram ,find (i) Line current, slip, efficiency and PF at full load (ii) Maximum torque.	4 3 7
	Module2	
13	(a)Draw the V and inverted V curves and explain the effect of excitation on armature current and power factor of synchronous motor. (b) What are the conditions for regenerative braking of an induction motor to be possible ? (c) A 50 KW motor with a heating time constant of 100 minutes has a final temperature rise of 50°C on continuous rating. Find the half-an hour rating of the motor for this temperature rise assuming that it cools down completely between each load period. the motor has maximum efficiency of 80% at full load.	4 3 7
14	(a) Describe the operation of dynamic braking for a 3 phase squirrel cage induction motor. (b)A three phase induction motor has 2 poles and is connected to 400 V, 50 Hz supply. Calculate the actual rotor speed and rotor frequency when slip is 4%. (c)A 1000 kVA, 11,000 V, 3-Phase star connected synchronous motor has an armature resistance and reactance per phase of 3 Ω and 40 Ω respectively. Determine the induced emf and angular retardation of the motor when fully loaded at (i) unity PF (ii) 0.9 PF lead Discuss how the dynamic braking can be made in a single phase induction motor.	4 3 7
	Module 3	
15	(a) What are the effects of increasing or decreasing the pressure angle in gear design? (b) Draw a block diagram of a PLC showing the main functional items and how buses link them, explaining the functions of each block. (c) Write a PLC ladder logic equivalent for NAND and NOR as universal gates.	3 4 7
16	(a) Write notes on chordal action in chain drives. What do you understand by simplex, duplex and triplex chains? (b) Draw and explain the three phase motor control in forward and reverse direction with PLC. (c) Describe PID function of PLC in detail.	3 4 7

	Module 4	
17	(a) Describe how each of the five common types of PLC registers is used in PLC operation. (b) Describe the networking in PLC (c) Explain the following functions in PLC with examples of each. (i) ADDITION (ii) SQUARE ROOT (iii) Conversion of INTEGER TO DOUBLE INTEGER (iv) SET & RESET BIT (iv) MOV_W	3 3 8
18	(a) Why Latch and Unlatch Instruction required in PLC Programming? How it is close to retentive timer operation. (b) Setup a PLC program to obtain an output, P, in registerOR0055. The output is to give a value based on two inputs, M and N. P equals the square of M plus the square root of N. (c) There are 30 bit patterns of 27 bits each to be moved sequentially into or 0011 one every 7 seconds. Design a double tr function program with a timer to accomplish the data transfer. Two tr functions are required because there are more than 16 bits (the amount available in one register) to be transferred.	3 5 6
	Module 5	
19	(a) What is sub-commutation and super-commutation in context of Multiplexer system? (b) Explain in detail MODBUS bus access methods, transmission modes, application services and acceptance (c) Explain about Integration of PLCs and DCS with Direct I/O.	4 3 7
20	(a) What is controller function configuration in context of DCS? Discuss SAMA symbology and ISA symbology. (b) What is Profibus? Explain its access methods, application services and acceptance (c) Describe the system architecture of a SCADA system. Explain and justify how it is an open ended system architecture comprising of the system hardware, the system software and the human machine interface (HMI), HCI (Human-Computer Interface).	4 4 6

Syllabus

Module 1 (8 Hours)

Working principle of synchronous, asynchronous & stepper motors: difference between induction and servo motors, torque v/s speed characteristics, power v/s. speed characteristics, vector duty induction motors, concepts of linear and frameless motors, selection of feedback system, duty cycle, V/F control, flux vector control, sensor less vector control, digital technique in speed control, advantages and limitations, microprocessor based control of drives.

Module 2 (7 Hours)

Industrial drives:DC and AC motors operation and selection, method of control and application of brushless DC motor, Permanent Magnet Synchronous Motor (PMSM),

stepper motor, AC 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, hydraulic motor.

Module 3 (10 Hours)

Motion laws for rotary and linear systems, converting rotary to linear system, concepts and principles of ball screws, rack and pinion, belt and pulley, chain drives, gear drives, selection of converting systems, dynamic response, gearing, and control approaches of robots, control loops using current amplifier, control loops using voltage amplifier.

Introduction to Programmable Logic Controllers (PLC):Definitions of PLC, basic structure of PLC, working principles, conventional Ladder v/s PLC ladder, instructions & application of PLC, series and parallel function of OR, AND, NOT logic, EXOR 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.

Module 4 (10 Hours)

Methods of PLC programming (LD, ST, FBD & SFC), function blocks logical/ mathematical operators & data types, array & data structure, data storage methods, inputs/ outputs flag processing, types of variables, definition of firmware, software, programming software tool and interfacing with PC (RS232 & TCP-IP), PID, types of tasks and configuration, selection of PLC controller (case study), centralized concept, types of field bus systems, 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 controllers, programming of HMI and its implementation.

Module 5 (11 Hours)

Introduction to supervisory control & data acquisitions: Distributed Control System (DCS):computer networks and communication in DCS, different BUS configurations used for industrial automation, GPIB, HART and OLE protocol, industrial field bus, Factory Instrumentation Protocol (FIP), PROFIBUS (Process field bus), bit bus. interfacing of SCADA with controllers, basic programming of SCADA, SCADA in PC based controller/ HMI.

Text Books

1. G. K. Dubey, Fundamentals of Electrical Drives, CRC Press, 2002.
2. R. Krishnan, Electric Motor Drives Modeling, Analysis, and Control, 2nd Ed., Prentice Hall, 2012.
3. W. Leonhard, Control of Electric Drive, Springer Science & Business Media, 2001.
4. V. Subramaniam, Electric Drives: Concepts and Applications, Tata McGraw Hill, 2011.
5. B. K. Bose, Modern Power Electronics and AC Drive, Pearson Education, 2002.
6. N. K. De, P. K. Sen, Electric Drives, PHI, New Delhi 2001.
7. S. K. Bhattacharya, Electrical Machines, Tata McGraw-Hill, 2nd Ed., 1999.
8. J. Nagrath, D. P. Kothari, Electric machines, 3rd Ed., Tata McGraw Hill, 2011.
9. W. Bolton, Programmable Logic Controllers
10. V. B. Bhandari, Design of Machine Elements, 2nd Ed., Tata McGraw-Hill, 2007.
11. R. L. Norton Machine Design - An Integrated Approach, 2nd Ed., Prentice Hall, 2004.

12. R. C. Juvenile, K. M. Marshek, Fundamentals of Machine Component Design, 3rd Ed., John Wiley, 2000.

Reference Books:

1. J. D. Edwards, Electrical Machines and Drives, Macmillan publications, 3rd Ed., 1991.
2. G. Dunning, Introduction to Programmable Logic Controllers, 3rd Ed., Delmar Cengage, 2005.
3. A. Parr, Industrial drives, Butterworth-Heineamann.
4. A. E. Fitzerald, C. Kingsley, S. D. Umans, Electric Machinery, McGraw Hill
5. S. K. Pillai, A First course on electric drives, Wiley Eastern, 1990.
6. P. C. Sen, Principles of Electrical Machines and Power Electronics, 2nd Ed., John Wiley & Sons.
7. B. R. Gupta, V. Singhal, Fundamentals of Electrical Machines, New Age International, 2001.
8. M. G. Say, Alternating Current Machines, 5th Ed., Pitman.
9. T. Wildi, Electrical Machines, Drives and Power Systems, 6th Ed., Pearson Education.
10. H. Jack, Programmable Logic Controllers.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
	Module 1	
1.1	Working principle of synchronous, asynchronous & stepper motors	1
1.2	difference between Induction and servo motors, torque v/s speed characteristics, power v/s. speed characteristics	1
1.3	Vector duty induction motors, concepts of linear and frameless motors	2
1.4	selection of feedback system, duty cycle, V/F control, flux vector control, sensor less vector control	2
1.5	Digital technique in speed control, Advantages and limitations, Microprocessor based control of drives	2
2	**Module 2**	
2.1	Industrial drives, DC and AC motors operation and selection	1
2.2	method of control and application of brushless DC motor, PMSM, stepper motor	1
2.3	AC servomotor, selection criteria for servo motor and servo amplifier, universal motor	2
2.4	electric drive, types of industrial drives, the characteristics of drive, advantages of drives over other prime movers, motor rating, heating effects	1
2.5	electric braking, rheostatic and regenerative braking principles in power converters, hydraulic motor	2
3	**Module 3**	
3.1	Motion laws for rotary and linear systems, converting rotary to linear system, concepts and principles of ball screws, rack and pinion, belt and pulley, chain drives, gear drives, selection of converting systems,	1

3.2	dynamic response, gearing and control approaches of Robots, control loops using current amplifier, control loops using voltage amplifier.	2
3.3	Introduction to Programmable Logic Controllers (PLC), Definitions of PLC, basic structure of PLC, working principles, Conventional Ladder v/s PLC ladder	1
3.4	instructions & application of PLC, series and parallel function of OR, AND, NOT logic, EXOR logic, analysis of rung, timer and counter Instructions	3
3.5	on delay and off delay and retentive timer instructions, PLC counter up and down instructions, combining counters and timers	3
4	**Module 4**	
4.1	Methods of PLC programming (LD, ST, FBD & SFC), function blocks logical/ mathematical operators & data types, array & data structure, data storage methods, inputs/ outputs flag processing, types of variables,	3
4.2	definition of firmware, software, programming software tool and interfacing with PC (RS232 & TCP-IP), PID, types of tasks and configuration	2
4.3	selection of PLC controller (case study), centralized concept, types of field bus systems, comparison and data handling instructions, sequencer instruction	2
4.4	visualization systems, types of visualization system, PC based controller, applications of HMI's, and interfacing of HMI with controllers, programming of HMI and its implementation.	3
5	**Module 5**	
5.1	Introduction to supervisory control & data acquisitions, Distributed Control System (DCS): computer networks and communication in DCS	2
5.2	different BUS configurations used for industrial automation, GPIB, HART and OLE protocol, industrial field bus	2
5.3	Factory Instrumentation Protocol (FIP), PROFIBUS (Process field bus), bit bus.	3
5.4	interfacing of SCADA with controllers, basic programming of SCADA, SCADA in PC based controller/ HMI.	3

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MRT394	ARTIFICIAL INTELLIGENCE & EXPERT SYSTEM IN AUTOMATION	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble:

Artificial intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions. Expert systems in Artificial Intelligence are a prominent domain for research in AI. The main purpose of offering this course is to elaborate the theoretical and practical aspects of Artificial intelligence (AI)& expert system in day to day life.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Get an exposure to the basics of Artificial intelligence
CO 2	Understand the concepts of Searching algorithms
CO 3	Interpret about Prediction logic
CO 4	Identify various learning methods of AI
CO 5	Acquire knowledge on expert systems

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3		2	2	3							3
CO 2	3		2	2	3							3
CO 3	3		2	2	3							3
CO 4	3		2	2	3							3
CO 5	3		2	2	3							3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the various AI techniques?
2. Compare Supervised and Unsupervised learning
3. Explain various Mathematical foundations of machine learning.

Course Outcome 2 (CO2)

1. Distinguish between breadth first search & depth first search.
2. Explain about A* & AO* Algorithms
3. Write a short note on Alpha-Beta pruning.

Course Outcome 3(CO3):

1. What are the various knowledge representation issues
2. Write a short note on Baye's probabilistic interferences.
3. Define Dempster-Shafer theory

Course Outcome 4 (CO4):

1. Discuss about Inference in first order logic.
2. Explain about Statistical Learning methods.
3. Briefly explain about Reinforcement Learning.

Course Outcome 5 (CO5):

1. Explain the structure of expert systems.

2. How can we select an appropriate knowledge acquisition method?
3. Explain how expert system works.

Model Question paper

Course Code: MRT 394

Course Name: ARTIFICIAL INTELLIGENCE & EXPERT SYSTEM IN AUTOMATION

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Write a short note on various AI techniques.
2. Distinguish between Supervised and Unsupervised learning.
3. Give a brief description about uniformed search strategies.
4. What do you meant by Alpha-Beta pruning.
5. What are the various knowledge representation issues?
6. Define Dempster-Shafer theory.
7. Summarize about first order logic.
8. What do you meant by forward chaining?
9. Explain the basic concept of expert systems.
10. List out the problem areas addressed by expert systems.

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. Explain about Regression and its classification
12. Differentiate between Supervised and Unsupervised learning.

Module 2

13. Explain about Breadth first search & depth first Search algorithms.
14. Explain about A* & AO* Algorithms.

Module 3

15. How can werepresent knowledge using rules and explain rules based deduction systems.
16. Describe in detail aboutBaye's probabilistic interferences.

Module 4

17. Explain in detail about Reinforcement Learning.

18. Identify the various Statistical Learning methods. Explain in detail.

Module 5

19. Explain aboutscope of knowledge and difficulties in knowledge acquisition methods.

20. Distinguish between model based reasoning & case based reasoning.

Syllabus

Module 1 (9 Hours)

Defining Artificial Intelligence, Defining AI techniques, Using Predicate Logic and Representing Knowledge as Rules, Representing simple facts in logic, Computable functions and predicates, Procedural vs Declarative knowledge, Logic Programming, Mathematical foundations: Matrix Theory and Statistics for Machine Learning, Idea of Machines learning from data, Classification of problem – Regression and Classification, Supervised and Unsupervised learning

Module 2(9 Hours)

Searching- Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Hill climbing, A* ,AO* Algorithms, Problem reduction, Game Playing-Adversial search, Games, mini-max algorithm, optimal decisions in multiplayer games, Problem in Game playing, Alpha-Beta pruning, Evaluation functions.

Module 3 (9 Hours)

Knowledge representation issues, predicate logic- logic programming, semantic nets- frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems. Reasoning under uncertainty, review of probability, Baye's probabilistic interferences and Dempster-Shafer theory.

Module 4 (9 Hours)

First order logic. Inference in first order logic, propositional vs. first order inference, unification & lifts forward chaining, Backward chaining, Resolution, Learning from observation Inductive learning, decision trees, Explanation based learning, Statistical Learning methods, Reinforcement Learning.

Module 5 (9 Hours)

Expert systems:- Introduction, basic concepts, structure of expert systems, the human element in expert systems how expert systems works, problem areas addressed by expert systems, expert systems success factors, types of expert systems, expert systems and the internet interacts web, knowledge engineering, scope of knowledge, difficulties, in knowledge acquisition methods of knowledge acquisition, machine learning, intelligent agents, selecting an appropriate knowledge acquisition method, societal impacts reasoning in artificial intelligence, inference with rules, with frames: model based reasoning, case based reasoning, explanation & meta knowledge inference with uncertainty representing uncertainty.

Test book:

1. S. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach", Second Edition, Pearson Education
2. Anindita Das Bhattacharjee, "Practical Workbook Artificial Intelligence and Soft Computing for beginners, Shroff Publisher-X team Publisher.
3. Saroj Kaushik, Artificial Intelligence, Cengage Learning, 1st Edition 2011

Reference Books:-

1. David Poole, Alan Mackworth, Randy Goebel, "Computational Intelligence : a logical approach", Oxford University Press.
2. G. Luger, "Artificial Intelligence: Structures and Strategies for complex problem-solving", Fourth Edition, Pearson Education.
3. J. Nilsson, "Artificial Intelligence: A new Synthesis", Elsevier Publishers.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Artificial intelligence**	
1.1	Defining Artificial Intelligence, Defining AI techniques	1
1.2	Using Predicate Logic and Representing Knowledge as Rules, Representing simple facts in logic	1
1.3	Computable functions and predicates, Procedural vs Declarative knowledge, Logic Programming	2
1.4	Mathematical foundations: Matrix Theory and Statistics for Machine Learning	2
1.5	Idea of Machines learning from data	1
1.6	Classification of problem –Regression and its classification	1
1.7	Supervised and Unsupervised learning	1
2	**Searching algorithms**	
2.1	Searching for solutions	1
2.2	Uniformed search strategies – Breadth first search, depth first Search	2
2.3	Search with partial information (Heuristic search) Hill climbing	1
2.4	A* ,AO* Algorithms, Problem reduction	2
2.5	Game Playing-Adversial search, Games, mini-max algorithm	1
2.6	Optimal decisions in multiplayer games	1
2.7	Problem in Game playing, Alpha-Beta pruning, Evaluation functions	1
3	**Prediction logic**	
3.1	Knowledge representation issues, predicate logic	1
3.2	Logic programming, semantic nets	1
3.3	Frames and inheritance, constraint propagation	1
3.4	Representing knowledge using rules, rules based deduction systems	2
3.5	Reasoning under uncertainty	1
3.6	Review of probability	1
3.7	Baye's probabilistic interferences and Dempster-Shafer theory.	2
4	Learning methods of AI	
4.1	First order logic. Inference in first order logic, propositional vs first order inference,	2
4.2	Unification & lifts, forward chaining, Backward chaining	2
4.3	Resolution, Learning from observation Inductive learning, decision	3

	trees, Explanation based learning	
4.4	Statistical Learning methods, Reinforcement Learning	2
5	**Expert systems**	
5.1	Expert systems:- Introduction, basic concepts, structure of expert systems, the human element in expert systems	1
5.2	How expert systems works, problem areas addressed by expert systems, expert systems success factors	2
5.3	Types of expert systems, expert systems and the internet interacts web	1
5.4	Knowledge engineering, scope of knowledge, difficulties, in knowledge acquisition methods of knowledge acquisition	2
5.5	Machine learning, intelligent agents, selecting an appropriate knowledge acquisition method, societal impacts, reasoning in artificial intelligence	1
5.6	Inference with rules, with frames: model based reasoning, case based reasoning	1
5.7	Explanation & meta knowledge inference with uncertainty representing uncertainty	1

MRT395	ADVANCED CONTROL SYSTEMS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims the student to analyse stability of linear and non-linear control systems.

Prerequisite: LINEAR CONTROL SYSTEMS

Course Outcomes: After the completion of the course the student will be able to

CO 1	Design a compensator.
CO 2	Analyse a linear system using state space analysis technique.
CO 3	Design feedback controllers and observers, analyse sampled data systems.
CO 4	The basic concept of nonlinearities.
CO 5	Analyse a nonlinear system and basic concept of stability of nonlinear systems

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	3			2	2	2				3
CO 2	3	2	3			2	2	2				3
CO 3	3	2	3			2	2	2				3
CO 4	3	2	3			2	2	2				3
CO 5	3	2	3			2	2	2				2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State the functions of a compensator.

2. Design of various compensators.

3. Explain types of controllers.

Course Outcome 2 (CO2)

1. Define state transition matrix.

2. Obtain state model.

3. Transformation from canonical form to phase variable form.

Course Outcome 3(CO3):

1. Define controllability and observability

2. Design state feedback controllers and observers.

3. Check stability of sampled data systems.

Course Outcome 4 (CO4):

1. List different types of nonlinearities.

2. Determine the describing function of nonlinear system.

3. Analyse nonlinear systems.

Course Outcome 5 (CO5):

1. Classify singular points.

2. Concept of stability in the sense of Liapunov.

3.Analyse the stability using Liapunov.

Model Question paper

Course code: MRT 395

ADVANCED CONTROL SYSTEMS

Max. Marks: 100 **Duration: 3 Hours**

(2019- Scheme)

PART A

(Answer all the questions, each question carries 3 marks)

1. What are the effects of Lag, Lead, Lag-Lead compensator?
2. Compare the effects and performance of P, PI, PID controllers in a closed loop system.
3. Define a) state b) state variables c) state vectors d) state model e) state space.
4. What are the advantages of state space analysis?
5. State and explain sampling theorem.
6. The characteristic polynomial of certain sampled data system is given by
   P (z) = z4- 1.2z3+ 0.07z2+ 0.3z - 0.08 = 0, test the stability of the system using Jury's stability test.
7. Mention any two characteristics of Nonlinear systems. What are limit cycles?
8. What is the difference between describing function and phase plane method of stability analysis?
9. Define Singular point. Explain the nature of Eigen values of system matrix for any five types of singular points.
10. Explain Liapunov direct method of stability for nonlinear systems.

PART B

(Answer one full question from each module .each question carries 14 marks)

Module 1

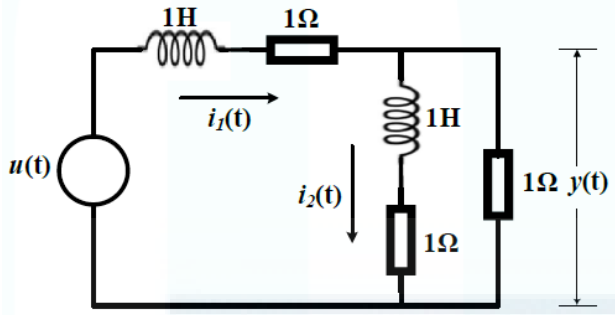
11. (a) The open loop transfer function of a unity feedback control system is given by G(S) = K/[S(1+0.5S)(1+0.2S)]. It is desired that (i) the steady state error to unit ramp input is less than 0.125 (ii) Phase margin≥300 (iii) Gain margin≥10 db. Design a suitable compensator. (10)

    (b) What is a lead compensator? Obtain its frequency response characteristics? (4)

12. (a) Explain the Ziegler-Nichols method of tuning a PID controller when (a) dynamic model is known (b) dynamic model is not known. (10)
    (b) Explain the effects of adding PID controller to a system. (4)

Module 2

13. (a) Selecting i1(t) =x1(t) and i2(t) =x2(t) as state variables, obtain state equation and output equation of the network shown in Fig. below.



(7)

(b) Obtain the state model of the system whose transfer function is given by

Y(s)/U(s)= 10/[s3+4s2+2s+1] (7)

14. (a)A discrete time system is described by the difference equation y(k+2)+5y(k+1)+6y(k)=u(k) y(0)=y(1)=0; T=1 sec. (a) Determine state model in a canonical form (b) Find the state transition matrix . (10)

(b) Derive the state model of an R-L-C series circuit (4)

Module 3

15. (a) Derive the transfer function of a ZOH circuit. (4)

(b) Transform the system in to controllable canonical form

$$\dot{x} = \begin{bmatrix} -1 & 1 \\ 0 & 2 \end{bmatrix} x + \begin{bmatrix} 2 \\ 1 \end{bmatrix} u \text{ and } y = \begin{bmatrix} 1 & 2 \end{bmatrix} x$$

(10)

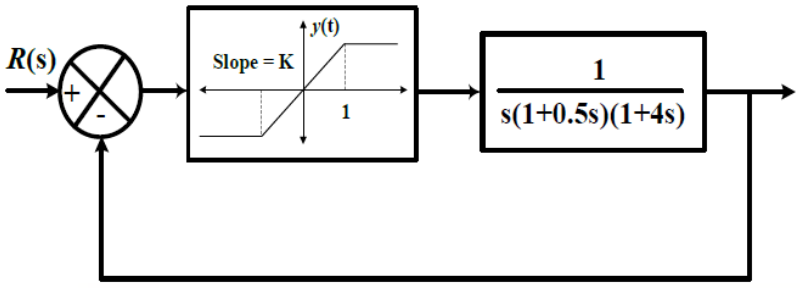
16. (a)Consider a linear system described by the transfer function Y(s)/U(s) =10/[S(S+1)(S+2)]. Design a feedback controller with a state feedback so that the closed loop poles are placed at -2, -1±j1. (10)

(b) Define controllability and observability. Explain any method to check controllability and observability. (4)

Module 4

17. (a) Derive the Describing function of saturation with relay. (7)

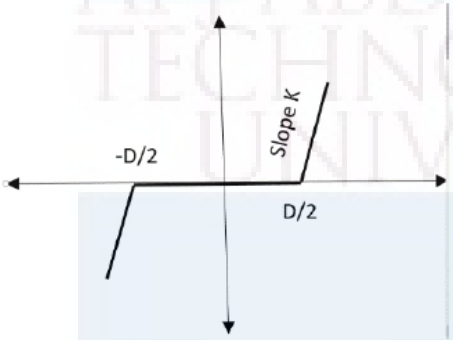
(b) A common form of an electronic oscillator is represented as shown in Fig. . For what value of *K,* the possibility of limit cycle predicted? If *K*=3, determine amplitude and frequency of limit cycle. Also find the maximum value of *K* for the system is stable.



(7)

18. (a) Derive the Describing function of saturation with deadzone. (7)

(b)Identify the following non linearity and derive a describing function for the same



(7)

Module 5

19. (a) A linear second order system is described by the equation $\ddot{e} + 2\delta\omega n\dot{e} + \omega n2e=0$ Whereδ = 0.15, ωn = 1rad/sec, e(0)=1.5, and $\dot{e}(0)$ = 0 .Determine the singular point and state the stability by constructing the phase trajectory using the method of isoclines. (10)

(b) What is the difference between describing function and phase plane method of stability analysis? (4)

20. (a) Explain Liapunov direct method of stability for nonlinear systems. (4)

(b)Test the stability of the system using Lyapunov stability theorem

(a) $\dot{x_1} = -x_1 + 2x_1^2x_2$, $\dot{x_2} = -x_2$

(b) $\dot{x_1} = x_2, \dot{x_2} = -sin(x_1) - x_2$

(10)

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Syllabus

Module 1 (9 Hours)

Compensator design:
Realization of compensators – lag, lead and lag-lead -Design of compensator using bode plot.
Design of compensator using rootlocus.
Types of controller- Feedforward-feedback-cascade-P, PI and PID .Design of P, PI and PID controller using Ziegler-Nichols tuning method.

Module 2 (11 Hours)

State space analysis of systems:
Introduction to state concept-definition-state ,state variables ,state vectors, state model - state equation of linear continuous time systems, matrix representation of state equations. Phase variable and canonical forms of state representation-controllable, observable, diagonal and Jordan canonical forms- solution of time invariant autonomous systems, forced system-state transition matrix-relationship between state equations and transfer function. Properties of state transition matrix-Computation of state transition matrix using Laplace transform-Cayley-Hamilton method. Conversion from canonical form to phase variable form.

Module 3 (8 Hours)

State feedback controller design:
Controllability & observability. State feed-back design via pole placement technique. State observers.
Sampled data control system:
Pulse Transfer function-sampler circuits with ZOH and FOH. Analysis of sampled data systems using Z-transform. Stability of sampled data system -Routh Hurwitz criterion and Jury's test. Introduction to state-space representation of sampled data systems.

Module 4 (8 Hours)

Nonlinear systems:
Introduction - characteristics of nonlinear systems. Types of nonlinearities. Analysis through harmonic linearisation - Determination of describing function of nonlinearities (relay, dead zone and saturation only) - application of describing function for stability analysis of autonomous system with single nonlinearity.

Module 5 (9 Hours)

Phase Plane Analysis:
Concepts- Construction of phase trajectories for nonlinear systems and linear systems with static nonlinearities - Singular points – Classification of singular points. Definition of stability- asymptotic stability and instability Liapunov methods to stability of linear and nonlinear, continuous time systems.

Stability of Nonlinear Systems - Liapunov stability - local stability - local linearization and stability in the small- Direct method of Liapunov - generation of Liapunov function for linear and nonlinear systems – variable gradient method.

Text Books

1. Nise N. S., Control Systems Engineering, 6/e, Wiley Eastern, 2010.
2. Nagarath I. J. and Gopal M., Control System Engineering, Wiley Eastern, 2008.
3. Hassan K Khalil, Nonlinear Systems, Prentice - Hall International (UK), 2002.
4. Ogata K., Modern Control Engineering, Prentice Hall of India, New Delhi, 2010.
5. Kuo B.C, Analysis and Synthesis of Sampled Data Systems, Prentice Hall Publications.

Reference Books

1. Alberto Isidori, Nonlinear Control Systems, Springer Verlag, 1995.
2. Gibson J. E., F.B. Tuteur and J. R. Ragazzini, Control System Components, Tata McGraw Hill, 2013
3. Gopal M., Control Systems Principles and Design, Tata McGraw Hill, 2008.
4. Jean-Jacques E. Slotine & Weiping Li, Applied Nonlinear Control, Prentice-Hall., NJ, 1991.
5. Shankar Sastry, “Nonlinear System Analysis, Stability and Control”, Springer, 1999.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Compensator design:**	
1.1	Realization of compensators – lag, lead and lag-lead -Design of compensator using bode plot.	3
1.2	Design of compensator using rootlocus.	3
1.3	Types of controller- Feedforward-feedback-cascade-P, PI and PID .	1
1.4	Design of P, PI and PID controller using Ziegler-Nichols tuning method.	2
2	**State space analysis of systems:**	
2.1	Introduction to state concept - state equation of linear continuous time systems, matrix representation of state equations.	2
2.2	Phase variable and canonical forms of state representation-controllable, observable, diagonal and Jordan canonical forms-	3
2.3	solution of time invariant autonomous systems, forced system-	2
2.4	state transition matrix-relationship between state equations and transfer function. Properties of state transition matrix-Computation of state transition matrix using Laplace transform-Cayley-Hamilton method	3
2.5	Conversion from canonical form to phase variable form.	1
3	**State feedback controller design:**	
3.1	Controllability & observability. State feed-back design via pole placement technique.	2
3.2	State observers.	1
	Sampled data control system:	

3.3	Pulse Transfer function-sampler circuits with ZOH and FOH.	2
3.4	Analysis of sampled data systems using Z-transform	1
3.5	Stability of sampled data system -Routh Hurwitz criterion and Jury's test	1
3.6	Introduction to state-space representation of sampled data systems	1
4	**Nonlinear systems:**	
4.1	Introduction - characteristics of nonlinear systems. Types of nonlinearities.	2
4.2	Analysis through harmonic linearisation	1
4.3	Determination of describing function of nonlinearities (relay, dead zone and saturation only) -	3
4.4	Application of describing function for stability analysis of autonomous system with single nonlinearity.	2
5	**Phase Plane Analysis:**	
5.1	Concepts- Construction of phase trajectories for nonlinear systems and linear systems with static nonlinearities - Singular points – Classification of singular points.	3
5.2	Definition of stability- asymptotic stability and instability Liapunov methods to stability of linear and nonlinear, continuous time systems.	2
	Stability of Nonlinear Systems	
5.3	Liapunov stability - local stability - local linearization and stability in the small-	1
5.4	Direct method of Liapunov - generation of Liapunov function for linear and nonlinear systems	2
5.5	variable gradient method.	1

MRT 396	ADVANCED COMPUTER CONCEPT FOR AUTOMATION	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: Introduction of automated machines into production systems helped them to achieve improved efficiency and productivity. Computer controlled systems and automated machines took over manual production systems and became common in almost all types of production systems. Hence it is a necessity to learn about automated systems and application of computers in automation.

Prerequisite: Basic knowledge about computers and programming languages

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the principles and types of automated production systems
CO 2	Learn about object-oriented concepts of programming language
CO 3	Acquire the knowledge of object-oriented programming and JAVA and their application in automation
CO 4	Understand principles and designing of database management system
CO 5	Develop awareness about basic operating system principles and real time systems

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	**3**	2	2						2			
CO 2	**3**	2	2						2			
CO 3	**3**	2	2						2			
CO 4	**3**	2	2						2			
CO 5	**3**	2	2						2			

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is the function of a display adaptor?
2. What are the different types of Automations?
3. Explain about – Open loop and Closed group systems?

Course Outcome 2 (CO2)

1. What is the use of creating an Object?
2. Compare procedural and object oriented approach.
3. Explain a brief on OOPS concepts.

Course Outcome 3(CO3):

1. Explain C++ input and output concepts?
2. Explain the working of exception handling in C++.
3. Discuss the application of oops in automation.

Course Outcome 4 (CO4):

1. Enlist and explain characteristic Features of Database Management Systems?
2. Briefly explain about the Relational Database system.
3. Compare File System and Database Management System-.

Course Outcome 5 (CO5):

1. Write a short note on the components of an operating system
2. Compare Distributed system and Real Time systems.
3. Write short notes on the following: i) FTP ii) TCP/IP

Model Question paper

Course Code: MRT 236

Course Name: ADVANCED COMPUTER COMMUNICATION SYSTEM FOR AUTOMATION

Max.Marks:100 **Duration: 3 Hours**

PARTA

Answer all Questions. Each question carries 3 Marks

3. What is the function of a display adaptor?
4. What are the different types of Automations?
5. What is the use of creating an Object?
6. What do you mean modularity in terms of OOPS?
7. What are the functions of JVM?
8. Define the term template.
9. What do you mean by a Data Warehouse?
10. Explain how authorisation helps in providing security for a database?
11. Define Time sharing system.
12. Write a short note on the components of an operating system.

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

13. Explain about – Open loop and Closed group systems
14. Differentiate VGA and XGA.

Module 2

15. Compare procedural and object oriented approach.
16. Explain a brief on OOPS concepts.

Module 3

17. Explain the working of exception handling in C++.
18. Discuss the OOPS features that makes JAVA a purely object-oriented language.

Module 4

19. Compare File System and Database Management System-.
20. Explain briefly about the Relational Database system.

Module 5

21. Compare Distributed system and Real Time systems.
22. Write short notes on the following: i) FTP ii) TCP/IP

Syllabus

Module 1 (9 Hours)

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.

Module 2 (9 Hours)

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.

Module 3 (9 Hours)

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

Module 4 (9 Hours)

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

Module 5 (9 Hours)

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 about protocols-FTP, TCP/IP & HTTP.

Text Books

1. Object Oriented Programming with C++ - E. Balaguruswamy, TMH
2. C++ Programming-BjarneStroustrup, Addison Wesley.
3. Operating System Concepts – Silberschatz, Galvin, Gagne, Sixth edition, John Wiley.

Reference Books

1. Fundamentals of DBMS – RamezElmasri and Navathe, Addison Wesley.

2. Computer Graphics, C version – Donald Hearn, M. Pauline Baker, Pearson Education.
3. Object Oriented Programming with C++ - Robert Lafore, PHI
4. Operating Systems-A concept based approach", D M Dhamdhere, TMH
5. Internet Working with TCP/IP – Douglas, PHI 9. Introduction to DBMS – Date C.J. Addison Wesley

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Introduction to computer Automation-	
1.1	Elements of Automation	1
1.2	Types of Automation	1
1.3	Importance of Computers in Automation	1
1.4	Computer Networks	1
1.5	Topology Types	2
1.6	Computer Graphics	2
1.7	Display Adapters and Video Display Modes	1
2	**Object Oriented Programming Introduction**	
2.1	Necessity of Object Oriented Programming	1
2.2	Procedural Language and Object Oriented Approach	2
2.3	Characteristics of Object Oriented Languages	1
2.4	OOP's Concepts: Objects, Classes	1
2.5	Inheritance, Overloading	2
2.6	Virtual Functions	1
2.7	Polymorphism	1
3	**OOP's features for Automation**	
3.1	Templates and Exceptions	1
3.2	C++ Input and output concepts	2
3.3	OOPS for Automation.	1
3.4	Introduction to JAVA	2
3.5	Features of JAVA	1
3.6	OOPS through JAVA	2
4	**Database Management System Introduction**	
4.1	Comparison of File System-Database Management System	2
4.2	Characteristic Features of Database Management Systems	2
4.3	Database Design: Relational Database- Logical Database Design	2
4.4	Logical Database Design-Data Base Models-DBMS Languages and Interfaces	2
4.5	Data Base Security and Authorization. Data Ware House	1
5	**Operating Systems and Protocols**	
5.1	Basic Concepts of batch Systems-Multi Programming, Time Sharing-Distributed and Real Time Systems	3
5.2	Operating System Structures: Operating System Components and Services	3
5.3	Brief discussion about protocols-FTP, TCP/IP & HTTP.	3

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MRT495	ADVANCED APPLICATIONS OF MECHATRONICS	VAC	3	1	0	4

Preamble: NIL

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain basic concepts of Robotics and its characteristics
CO 2	To get a detailed idea of design of robotic structures
CO 3	Explain the working of sensors
CO 4	Conceptualize the application of Robotics
CO 5	Promote rationalized knowledge of recent trends in Mechatronics application

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	3	1	2	3						1
CO 2	3	3	3	2	1	2						
CO 3	3	1	3		3	3				1		
CO 4	2	2	3	2	1	3				1	1	2
CO 5	1	2	3	1	3	3			1	2		2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each full question carries 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. How do you classify robots based on their coordinate systems?

2. What is meant by payload of a robot?

Course Outcome 2 (CO2)

1. How do you represent pose of the end effector?

2. What are the steps in trajectory planning?

Course Outcome 3(CO3):

1. What are the different sensors used in Robotics?

2. What is machine vision? What are its advantages?

Course Outcome 4 (CO4):

1. Mention few industrial applications of robots.

2. What is the use of parallel robots?

Course Outcome 5 (CO5):

1. Explain digital engine control.

2. What is mobile robotics?

Syllabus

Module 1

Introduction 4L Definition of robot, classification of robots according to coordinate system and control method, Main components of robots – manipulator, sensors, controller etc, Robot characteristics – payload, reach, repeatability, accuracy, resolution.

Module 2

Kinematics of Robot 6L Homogenous coordinates, Homogeneous transformation matrices, Direct and Inverse Kinematics of robots, Trajectory Planning.Robot End effecters & Actuators 6L Types, mechanical grippers, other types of grippers, Tools as end effecters. Characteristics of actuating systems, Actuating System – Hydraulic devices, pneumatic devices, electric motors, other special actuators

Module 3.

Sensors and Artificial Intelligence 6L Characteristics of Sensors, Position sensors, velocity sensors, acceleration sensors, force and pressure sensors, force and torque sensors, micro switches, touch and slip sensors, non-contact proximity sensors, Robot Vision System, Robot programming Languages – VAL, AML/2, ARM BASIC.

Module 4.

Application of Robots 4L Handling, loading, & unloading, Welding, Spray painting, Assembly, Machining, Inspection, Rescue robots, Underwater robots, Parallel robot, and Medical robot. Mechatronic Elements of Modern CNC Machines 8L Machine Structure, Guide ways, Feed drives, Spindle and Spindle bearings, Measuring systems, Controls, software & operator interface, Ganging, Tool Monitoring.

Module 5

Other Mechatronic Applications 6L Electronic Thermostat, Automatic Camera, Air fuel ratio controller in Automobiles, Digital Engine Control, Vehicle Motion Control, Mobile robots etc.

COURSE CONTENT AND LECTURE SCHEDULES

Module	TOPIC	No. of hours
1		8
1.1	Introduction 4L Definition of robot	1
1.2	classification of robots according to coordinate system and control method	2
1.3	Main components of robots – manipulator, sensors, controller etc,	3
1.4	Robot characteristics – payload, reach, repeatability, accuracy, resolution.	2
2		9
2.1	Kinematics of Robot 6L Homogenous coordinates, Homogeneous transformation matrices,	2
2.2	Direct and Inverse Kinematics of robots, Trajectory Planning	2
2.3	Robot End effecters & Actuators 6L Types, mechanical grippers, other types of grippers, Tools as end effecters	2
2.4	. Characteristics of actuating systems, Actuating System – Hydraulic devices, pneumatic devices, electric motors, other special actuators	3
3		9
3.1	Sensors and Artificial Intelligence 6L Characteristics of Sensors	2
3.2	Position sensors, velocity sensors, acceleration sensors, force and pressure sensors, force and torque sensors, micro switches, touch and slip sensors, non-contact proximity sensors	3
3.3	Robot Vision System	2
3.4	Robot programming Languages – VAL, AML/2, ARM BASIC.	2
4		10
4.1	Application of Robots 4L Handling, loading, & unloading, Welding, Spray painting, Assembly,	2
4.2	Machining, Inspection, Rescue robots, Underwater robots, Parallel robot, and medical robot.	2
4.3	Mechatronic Elements of Modern CNC Machines 8L Machine Structure, Guide ways, Feed drives, Spindle and Spindle bearings	3
4.4	Measuring systems, Controls, software & operator interface, Ganging, Tool Monitoring.	3
5		7
5.1	Other Mechatronic Applications 6L Electronic Thermostat, Automatic Camera, Air fuel ratio controller in Automobiles	4
5.2	Digital Engine Control, Vehicle Motion Control, Mobile robots etc.	3

Text Books

1.Khafter, R.D., Chimelewski, T.A. and Negin, M. – Robot Engineering – An Integrated Approach, PHI, New Delhi, 1994

2.Mair, G.M. –Industrial Robotics, Prentice Hall, NY, 1988

3.Mittal and Nagrath,- Robotics and Control, Tata Mc. Graw Hill,.

Reference Books

1.Patranabis, D – Sensors and Transducers, Wheeler Pub., New D

2.B C Kuo Automatic Control Systems 7th Edition Prentice Hall 1995

3.Lee, C.S.G. – Robot Arm Kinematics, Dynamics and Control, Computer, IEEE, Vol. 15, No. 12.

Model Question paper

QP CODE: **Duration: 3hours**

Reg. No:---------- **Name: ----------**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR

Course code: MRT495

ADVANCED APLICATION OF MECHATRONICS (2019- Scheme)

Mechatronics Branch

PART A

(Answer all the questions, each question carries 3 marks)

1. Define a Robot?

2. Write a short note on Manipulator.

3. Briefly explain Actuator.

4. Differentiate Hydraulic and Pneumatic devices

5. List the characteristics of Sensors.

6. Write a note on VAL.

7.List the Application of Robotics

8. What is a measuring system?

9. Explain Working of Thermostat.

10. Illustrate the operation of Automatic Camera.

PART B

(Answer one full question from each module .each question carries 14 marks)

Module 1

11. (a) List and explain main components of robots. (10 marks)

(b) Write a note on payload (4 marks)

12. (a) Explain 4L definition of Robot. (8 marks)

(b) Comment on Classification of robots. (6 marks)

Module 2

13. (a) Explain Kinematic of Robot 6l. (14 marks)

14. Explain with the help of neat sketches 6l Types of grippers. (14 marks)

Module 3

15. (a)Write down Characteristics of sensors. (14 marks)

16. (a) differentiate between Val and Arm basic(10 marks)

(b) Discuss about Robot vision system(4 marks)

Module 4

17. (a) Write down the application of robots. (10 marks)

(b) differentiate between the Measuring systems and Control systems. (4 marks)

18. (a) Differentiate underwater robots and Rescue robots.(10 marks)

(b) Write a note on spindle bearings. (4 marks)

Module 5

19. List and explain Mechatronic Application of 6L Electronics . (14 marks)

20. (a)Explain Digital Engine Control with the help of a neat diagram. (7 marks)

(b) Write a note on Mobile Robots. (7 marks)

MRD 496	MINI PROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	4

Preamble:

Mini Project Phase I: A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The object of Project Work I is to enable the student to take up investigative study in the broad field of Mechatronics, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on a group of three/four students, under the guidance of a supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic;
2. Preparing an Action Plan for conducting the investigation, including team work;
3. Working out a preliminary Approach to the Problem relating to the assigned topic;
4. Block level design documentation
5. Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/ Feasibility;
6. Preparing a Written Report on the Study conducted for presentation to the Department;

CO1	Identify and synthesize problems and propose solutions to them.
CO2	Prepare work plan and liaison with the team in completing as per schedule.
CO3	Validate the above solutions by theoretical calculations and through experimental
CO4	Write technical reports and develop proper communication skills.
CO5	Present the data and defend ideas.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3					3	3		2
CO2	3			3				3	3	3	3	
CO3	3	3	3	3	3					3		
CO4					3			3	3	3		1
CO5	3	3	3	3				3		3	3	1

*1-slight/low mapping, 2- moderate/medium mapping, 3-substantial/high mapping

Continuous Internal Evaluation Pattern:

Sl. No.	Level of Evaluation	Marks
1	Interim evaluation by the committee	**20**
2	Project Guide	**30**
3	Final Seminar evaluation by the committee	**30**
4	The report evaluated by the evaluation committee	**20**
	Total	**100**
	Minimum required to pass	**50**

The evaluation committee comprises a panel of HoD or a senior faculty member, Project coordinator and project supervisor.

MRT 497	CNC MACHINE SYSTEMS DESIGN	CATEGORY	L	T	P	Credits	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

To make students familiar with basis of CNC machines and CNC machine tools

To provide knowledge on write manual part program and program using APT

To provide knowledge about computer numerical control system.

Prerequisite: Advanced automation system

Course Outcomes - At the end of the course students will be able to

CO 1	Understand about basics of CNC system and CNC machine tools
CO 2	Understand about constructional features of CNC machine tools
CO 3	Write manual part program and program using APT
CO 4	Understand about computer numerical control system
CO 5	Understand about manufacturing automation

Mapping of course outcomes with program outcomes (Minimum requirements)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	-	-	-	-	-	-	-	-		-	3
CO 2	2	-	-	-	-	-	-	-	-	-	-	3
CO 3	2	-	-	-	-	-	-	-	-	-	-	3
CO 4	2	-	-	-	-	-	-	-	-	-	-	3
CO 5	3	-	-	-	-	-	-	-	-	-	-	3

ASSESSMENT PATTERN

Bloom's taxonomy	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 11 (Marks)	
Remember	25	25	25
Understand	15	15	45
Apply	10	10	30
Analyze			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE duration
150	50	100	3 Hours

Continuous Internal Evaluation (CIE) Pattern:

Attendance	10 marks
Regular class work/tutorials/assignments	15 marks
Continuous Assessment Test(Minimum 2 numbers)	25 marks

End semester pattern:- There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

COURSE LEVEL ASSESSMENT QUESTIONS

Part -A

Course Outcome 1 (CO1): Understand about basics of CNC system and CNC machine tools

1. List the operations that could be performed on a machining center
2. What are the different types machining centers?
3. Describe the classification of CNC turning machines.
4. List the operations that could be performed an a machining center.

Course Outcome 2 (CO2): Understand about constructional features of CNC machine tools

1. What are the special constructional features of CNC machine tools?
2. What are the requirements of the slideway system of CNC machine tools?
3. What is the purpose of a feedback device in a CNC machine tool?
4. Describe the broad classification of feed- back transducers.

Part -B

Course Outcome 3 (CO3): Write manual part program and program using APT

1. What are the various word address codes used in a CNC program
2. What is contouring?
3. Describe programming procedure for CNC turning.
4. Describe with the aid of a block diagram the various steps involved in computer aided part programming

Course Outcome 4 (CO4): Understand about computer numerical control system

1. Describe with the aid of a block diagram the principal components of a typical CNC system
2. What are the different types of interpolation systems? Explain each one of them

Course Outcome 5 (CO5): Understand about manufacturing automation

1. Discuss the principle of direct numerical
2. Describe the elements of a typical flexible manufacturing cell.
3. What are the factors influencing the selection of CNC machines.
4. Describe the different types of preventive maintenance programs for CNC machine tools.

SYLLABUS

MODULE – 1

INTRODUCTION TO COMPUTOR NUMERICAL CONTROL: Introduction, CNC system-an overview, fundamental aspects of machine control, types of interpolation, CNC machine components

CNC MACHINE TOOLS: machining centers, turning centers/CNC lathes, CNC drilling and milling machines, CNC grinding machines, other CNC machines

MODULE – II

CONSTRUCTIONAL FEATURES OF CNC MACHINE TOOL: Introduction, spindle drives of CNC machine tools, transmission belting, axes feed drives, slide ways for machines, ball screws, accessories of machining centers, accessories and constructional features of CNC lathes

FEEDBACK DEVICES IN CNC MACHINE TOOLS: Introduction, digital incremental displacement measuring systems, the digital absolute measuring system, electro-magnetic analogue position transducers

MODULE - III

MANUAL PART PROGRAMMING: Introduction, manual part programming, nomenclature of the CNC machines, preparatory functions (G-functions), miscellaneous functions (M-functions), further part programming examples, hints for programming, program examples of machining centers.

COMPUTER AIDED PART PROGRAMMING: Introduction, languages for computer programming, geometric system in APT, point-to-point programming, programming in tool path, motion commands, post processor statements, part programming examples in APT

MODULE - IV

COMPUTER NUMERICAL CONTROL SYSTEMS: Introduction, description of a simple CNC control system, interpolation systems, interpolator, types of interpolators, contour programming, hardware of interpolation systems, functions of a CNC system, advantages microprocessor based numerical control systems, programmable machine interface(PMI), features available in typical CNC system, new developments in CNC systems

MODULE - *V*

CNC AND MANUFACTURING AUTOMATION: introduction, direct numerical control (DNC), requirements of modern batch production, flexible manufacturing cells(FMC), flexible manufacturing systems(FMS), integration of manufacturing systems, tools for manufacturing-factors influencing selection of CNC machines- cost of operation of CNC machines-practical aspects of introduction of CNC-maintenance of CNC machines

Text Books

1. *P RADHAKRISHNAN, computer numerical control machines, New central book agency(p) ltd.*
2. *MIKELL P. GROOVER,Automation production systems, computer – integrated manufacturing*

Reference

1. *P M AGRAWAL , CNC fundamentals and programming*
2. *ASHOK KUMAR SINGH, CNC programming, vayu education of India.*

MODEL QUESTION PAPER

MRT 497- CNC MACHINE SYSTEMS DESIGN

Max. Marks : 100 **Duration : 3 Hours**

Part – A

Answer all questions.

Answer all questions, each question carries 3 marks

1. Define CNC systems.
2. Write a short note on machine centers .
3. What are the major types of spindle drives.
4. Write a short note on electro-magnetic analog position transducers.
5. List out the common G-codes used for manual part programming.
6. write a short note on geometric statements APT
7. List out the types of interpolators.
8. Shortly explain the functions of CNC systems.
9. Define direct numerical control(DNC)
10. List out the advantages of a FMS.

PART -B

Answer one full question from each module.

MODULE – 1

11. Explain the working of CNC system with the help of a block diagram. (14 marks)

OR

12. Discuss in detail about CNC grinding machines. What are the types of CNC grinding machines?(14 Marks)

13. Discuss in detail about accessories and constructional features of CNC lathes. (14 Marks)

OR

14. Compare digital incremental displacement measuring systems and digital absolute measuring systems. (14 Marks)

MODULE – 3

15. Write an example of a manual part program for turning operations. (14 marks)

OR

16. Write a part program example in APT.(14 Marks)

MODULE – 4

17. What are the major features available in a typical CNC system. (14 Marks)

OR

18. Compare the advantages and disadvantages of hardware and software interpolations. (14 Marks)

MODULE – 5

19. Draw block diagram of a typical manufacturing cell and compare FMC and FMS. (14 Marks)

OR

20. Explain in detailed about factors influencing selection of CNC machines. (14 Marks)

COURSE CONTENT AND LECTURE SCHEDULES.

Module	TOPIC	No. of hours	Course outcomes
1.1	Introduction, CNC system-an overview	2	CO1
1.2	fundamental aspects of machine control	1	CO1
1.3	types of interpolation, CNC machine components	1	CO1
1.4	machining centers, turning centers/CNC lathes	1	CO1
1.5	CNC drilling and milling machines	2	CO1
1.6	CNC grinding machines	1	CO1
1.7	other CNC machines	1	CO1
2.1	Introduction, spindle drives of CNC machine tools	1	CO2
2.2	transmission belting, axes feed drives, slide ways for machines	2	
2.3	ball screws, accessories of machining centers	1	CO2
2.4	accessories and constructional features of CNC lathes	1	
2.5	Introduction, digital incremental displacement measuring systems	2	CO2
2.6	the digital absolute measuring system	1	
2.7	electro-magnetic analogue position transducers	1	CO2

3.1	Introduction, manual part programming	1	CO3
3.2	nomenclature of the CNC machines, preparatory functions (G-functions), miscellaneous functions (M-functions)	1	
3.3	further part programming examples	1	CO3
3.4	hints for programming, program examples of machining centers	2	
3.5	Introduction, languages for computer programming, geometric system in APT	1	CO3
3.6	point-to-point programming, programming in tool path, motion commands, post processor statements,	1	CO3
3.7	part programming examples in APT	2	CO3
4.1	Introduction, description of a simple CNC control system	1	CO4
4.2	interpolation systems, interpolator, types of interpolators	2	CO4
4.3	contour programming	1	CO4
4.4	hardware of interpolation systems, functions of a CNC system	1	CO4
4.5	advantages microprocessor based numerical control systems	1	CO4
4.6	advantages microprocessor based numerical control systems, programmable machine interface(PMI)	2	CO4
4.7	features available in typical CNC system, new developments in CNC systems	1	CO4

5.1	introduction, direct numerical control (DNC)	1	CO5
5.2	requirements of modern batch production	1	CO5
5.3	flexible manufacturing cells(FMC), flexible manufacturing systems(FMS)	2	CO5
5.4	integration of manufacturing systems, tools for manufacturing	1	CO5
5.5	factors influencing selection of CNC machines- cost of operation of CNC machines	2	CO5
5.6	practical aspects of introduction of CNC	1	CO5
5.7	maintenance of CNC machines	1	CO5