MRT 281	INTRODUCTION TO SENSORS AND ACTUATORS	CATEGORY	L	T	P	CREDIT
		VAC	4	0	0	4

Preamble:

Sensors and actuators play a vital role in manufacturing, machinery, aerospace, medicine and robotics. Most of the advancements of present day would be not possible without sensors. The main purpose of offering this course is to elaborate the theoretical and practical aspects of sensors and actuators, their classifications, recent trends and their applications 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 sensors and actuators and its importance in the real world.
CO 2	Explain the working of magnetic sensors and its applications in real time scenario
CO 3	Model linear actuators and differentiate various solenoids
CO 4	Explain the working principle of different types ofrotary actuators
CO 5	Understand the basic idea on the controls in NC machine and fluidic system.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	2	2						2			
CO2	**3**	2	2						2			
CO3	**3**	2	2						2			
CO4	**3**	2	2						2			
CO5	**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 do you mean by an actuator?
2. Compare Soft Magnetic and Hard Magnetic Materials with suitable example.
3. Identify any 3 applications of Rotary and Linear Actuators in the present scenario.

Course Outcome 2 (CO2)

1. What are the requirements of Magnetic Speed Sensors?
2. Explain Solid-State Sensors with neat sketches.
3. Select any 5 applications of Magnetic Position Sensor.

Course Outcome 3(CO3):

1. What are the applications of Solenoid Actuators?
2. Compare Disk Solenoids and Plunger Solenoids.
3. Construct a mathematical model for a linear actuators

Course Outcome 4 (CO4):

1. List the applications of Disk Rotary Actuator.
2. Explain about Claw Pole Rotary Actuator with necessary sketches.
3. Identify the various applications of Cylindrical Rotary Actuator in the field of mechatronics.

Course Outcome 5 (CO5):

1. Define Coanda effect.
2. Explain about basic fluidic devices.
3. Select the applications of fluidic sensors.

Model Question paper

Course Code: MRT 281

Course Name: INTRODUCTION TO SENSORS AND ACTUATORS

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

PARTA

Answer all Questions. Each question carries 3 Marks

1. What is the difference between a sensor and actuators?
2. Why stepper motors are widely used in Robotic applications?
3. What are the applications of Magnetic Speed Sensors?
4. What do you mean by Solid-State Sensors?
5. What are the applications of Solenoid Actuators?
6. Define linear actuator with an example.
7. List the applications of Claw Pole Rotary Actuator.
8. What do you mean by Rotary actuator?
9. Define Coanda effect.
10. Write a short note on encoders.

PART B

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

Module 1

11. Explain about - Linear and Latching Solenoid Actuators
12. Differentiate between soft and hard magnetic materials with suitable examples.

Module 2

13. Explain about VR sensors with suitable sketches.
14. Explain magnetic sensor in detail and identify some of its applications.

Module 3

15. Explain the working of Gasoline Injectors with neat sketches.
16. Compare Disk, Plunger and Ball solenoids.

Module 4

17. Explain Cylindrical Rotary Actuators with neat sketches.
18. Identify the various applications of Cylindrical Rotary Actuator and Disk Rotary Actuators in the field of mechatronics. Explain the working principle of Disk Rotary Actuators in detail.

Module 5

19. Explain the working principle of interruptible jet sensor with necessary sketches.

20. Write short notes on the following: i) Resolver ii) Inductosync

Syllabus

Module 1 (9 Hours)

Introduction- Classification of Sensors and Actuators - Magnetic Sensors - Linear and Latching Solenoid Actuators - Stepper Motors - Special Magnetic Devices - Rotary and Linear Actuators - Magnetic Materials and Technology - Soft Magnetic Materials - Hard Magnetic Materials - Coating Technologies - Magnetic Materials Market and Applications

Module 2(9 Hours)

Magnetic Sensors - Theory of Magnetic Sensors - Magnetic Sensor Analysis - VR Sensors - Solid-State Sensors - Magnetic Sensor Applications - Magnetic Speed Sensor Requirements - Magnetic Speed Sensor Applications - Magnetic Position Sensor Applications - VR Sensor Noise

Module 3 (9 Hours)

Linear Actuators - Mathematical Model for Linear Actuators - Fast-Acting Actuators - Disk Solenoids - Plunger Solenoids - Ball Solenoids - Conical Solenoids - Applications of Solenoid Actuators - Long Stroke Solenoid Fuel Pump - Gasoline Injectors - Natural Gas Injectors - Diesel Fuel Injectors - Compressor Solenoid Valves - Transmission Solenoids

Module 4 (9 Hours)

Rotary Actuators - Disk Rotary Actuators - Disk Rotary Actuator Analysis - Disk Rotary Actuator Design - Disk Rotary Actuator Excitation Electromagnetic Circuit - Disk Rotary Actuator Toothed Magnetic Part - Disk Rotary Actuator PM - Claw Pole Rotary Actuators - Claw Pole Rotary Actuator Analysis - Claw Pole Rotary Actuator Design -Claw Pole Rotary Actuator Excitation Electromagnetic Circuit - Claw Pole Actuator Toothed Magnetic Part - Claw Pole Actuator PM - Cylindrical Rotary Actuators - Cylindrical Rotary Actuator PM - Cylindrical Rotary Actuator Excitation Electromagnetic Circuit - Cylindrical Rotary Actuator Toothed Magnetic Structure - Rotary Actuator Applications - Disk Rotary Actuator Application - Claw Pole Rotary Actuator Application - Cylindrical Rotary Actuator Application

Module 5 (9 Hours)

Controls in NC Machines and fluidic control- stepping motors- feedback devices- encoders - resolvers - inductosync –Tachogenerators - principles of fluid logic control -Coanda effect - basic fluidic devices - fluidic logic gates - bistableflipflop - OR and NOR gates - exclusive OR gates - fluidic sensors - backpressure sensor - cone jet proximity sensor - interruptible jet sensor.

Text Books

1. Andrzej M. Pawlak , “Sensors and Actuators in Mechatronics, Design and Applications” , Taylor & Francis Group, 2006

Reference Books

1.Andrew Parr, “Hydraulics and Pneumatics“, Jaico Publishing House, Mumbai

2.YoramKoren, ‘Computer control of Manufacturing Systems’, TataMc.Graw Hill Publishers, New Delhi

3. Robert H. Bishop, “Mechatronic systems, Sensors and Actuators Fundamentals and Modelling, Taylor & Francis Group, 2007

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Sensors and Actuators	
1.1	Classification of Sensors and Actuators	1
1.2	Magnetic Sensors	1
1.3	Linear and Latching Solenoid Actuators	1
1.4	Stepper Motors - Special Magnetic Devices	1
1.5	Rotary and Linear Actuators	2
1.6	Magnetic Materials and Technology - Soft Magnetic Materials - Hard Magnetic Materials	2
1.7	Coating Technologies - Magnetic Materials Market and Applications	1
2	Magnetic Sensors	
2.1	Theory of Magnetic Sensors	1
2.2	Magnetic Sensor Analysis	2
2.3	VR Sensors	1
2.4	Solid-State Sensors	1
2.5	Magnetic Sensor Applications, Magnetic Speed Sensor Requirements -	2
2.6	Magnetic Speed Sensor Applications , Magnetic Position Sensor Applications -	1
2.7	VR Sensor Noise	1
3	Linear Actuators	
3.1	Mathematical Model for Linear Actuators	1
3.2	Fast-Acting Actuators	1
3.3	Disk Solenoids - Plunger Solenoids	1
3.4	Ball Solenoids, Conical Solenoids - Applications of Solenoid Actuators	2
3.5	Long Stroke Solenoid Fuel Pump	1
3.6	Gasoline Injectors, Natural Gas Injectors	1
3.7	Diesel Fuel Injectors - Compressor Solenoid Valves - Transmission Solenoids	2
4	Rotary Actuators	
4.1	Disk Rotary Actuators - Disk Rotary Actuator Analysis - Disk Rotary Actuator Design - Disk Rotary Actuator Excitation Electromagnetic Circuit - Disk Rotary Actuator Toothed Magnetic Part - Disk Rotary Actuator PM -	3
4.2	Claw Pole Rotary Actuators - Claw Pole Rotary Actuator Analysis - Claw Pole Rotary Actuator Design -Claw Pole Rotary Actuator Excitation Electromagnetic Circuit - Claw Pole Actuator Toothed Magnetic Part - Claw Pole Actuator PM	3
4.3	Cylindrical Rotary Actuators - Cylindrical Rotary Actuator PM - Cylindrical Rotary Actuator Excitation Electromagnetic Circuit - Cylindrical Rotary Actuator Toothed Magnetic Structure	2
4.4	Rotary Actuator Applications - Disk Rotary Actuator Application - Claw Pole Rotary Actuator Application - Cylindrical Rotary Actuator	1

	Application.	
5	Controls in NC Machines and fluidic control	
5.1	Stepping motors	1
5.2	Feedback devices, encoders, resolvers.	1
5.3	Inductosyn , Tacho generators	1
5.4	Principles of fluid logic control -Coanda effect	2
5.5	Basic fluidic devices, Fluidic logic gates	1
5.6	Bi stable flip flop - OR and NOR gates - exclusive OR gates -	1
5.7	Fluidic sensors, Backpressure sensor.	1
5.8	Cone jet proximity sensor, Interruptible jet sensor.	1

MRT 282	FUNDAMENTALS OF ANALOG AND DIGITAL ELECTRONICS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	-	4

Preamble:

This course enables students to analyse, design and implement analog and digital circuits and systems for the given specification and function.

Prerequisite: *Basics of Electronics*

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

CO 1	Understand the working of amplifiers and oscillators.
CO 2	Familiarisation of Op-amp and its different applications.
CO 3	Analysis of multivibrators and principles of PLL.
CO 4	Learn different simplification methods in digital electronics and also learn to design its combinational circuits
CO 5	Design of sequential circuits.

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	1	2	-	-	-	-	-
CO 2	3	3	2	1	2	1	2	-	-	-	-	-
CO 3	3	3	2	1	2	1	2	-	-	-	-	-
CO 4	3	3	3	1	2	1	2	-	-	-	-	-
CO 5	3	3	3	1	2	1	2	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (100 marks)
	Test 1	Test 2	
Remember	5	5	10
Understand	10	10	20
Apply	20	15	30
Analyse	10	10	15
Evaluate	5	5	15
Create		5	10

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. List out the applications of oscillators
2. Differentiate positive feedback from negative feedback.
3. Compare BJT with FET .Mention the usage of both.

Course Outcome 2 (CO2) :

1. Define offset current and offset voltage.
2. What are the characteristics of an ideal opamp?
3. Mention the disadvantages of ideal differentiator. Suggest a method to overcome it.
4. Explain the importance of isolation amplifier.
5. Design an inverting amplifier of gain 10.

Course Outcome 3(CO3):

1. Discuss on the output waveforms of different filters.
2. Design a circuit to generate a waveform of duty cycle 50%.
3. List out the applications of astable and monostable multivibrator.

4. Define capture range and lock range.
5. Explain any one application of PLL.

Course Outcome 4 (CO4):

1. Why are NAND and NOR called as universal gates? Justify.
2. State and prove De-Morgan's Theorems.
3. Reduce f= ∑ m(0,2,4,6,7,8,10,12,13,15) using K-map .
4. Implement the function F(a,b,c,d)= ab' + bd +b'cd' using 8:1 MUX.

Course Outcome 5 (CO5):

1. Explain race round condition.
2. Differentiate combinational circuit form sequential circuits.
3. Design a3 bit synchronous down counter.

Model Question paper

QP CODE:

Reg. No:----------

Name: ----------

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

Course code: MRT 282 **Duration :3hours**

FUNDAMENTALS OF ANALOG AND DIGITAL ELECTRONICS

(2019- Scheme)

Mechatronics Branch

PART A

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

1. Explain the working of Hartley Oscillators.
2. List out the differences between BJT and FET.
3. Briefly explain S/H circuit using opamp.
4. Design a non inverting amplifier of gain 11.Given input voltage is 2 Vpp.

5. Distinguish the different types of filter with its frequency response graph.
6. Explain the principle of PLL.
7. Reduce the expression f= Π M (0,1,2,3,4,7) using mapping and implement it in AOI logic.
8. Design a full adder circuit using universal gates.
9. Define race round condition. Explain a method to rectify it.
10. Explain parallel shift registers with necessary equations.

PART B

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

Module 1

11. (a) Explain the construction, working and characteristics of depletion MOSFET. (10 marks)

    (b) State and explain the condition for sustained oscillations. (4 marks)

12. (a) Explain the working of RC phase shift oscillators . (10 marks)

    (b) Explain how tank circuits aid in oscillations. (4 marks)

Module 2

12. (a) Explain ideal integrator using opamp. Suggest method to overcome its disadvantages. (10 marks)

    (b) List out the characteristics of op-amp. (4 marks)

13. (a) Explain 3 bit comparator circuit. (9 marks)

    (b) Write notes on isolation amplifier. (5 marks)

Module 3

14. (a) Explain the importance of VCO. (4 marks)

    (b) Define duty cycle . Explain the working of monostable multivibrator. (10 marks)

15. (a) Distinguish band pass and band stop filters. (6 marks)

    (b) Explain the working of astable multivibrator using IC555. (8 marks)

Module 4

16. (a) Design and implement 3 bit gray to binary code converter. (8 marks)

(b) Implement F(x,y,z)= ∑ m (0,2,3,5) using 8 to 1 MUX. (6 marks)

17. Using K-map , obtain minimal expression for f=∑ m (6,7,8,9) + d(10,11,12,13,14,15). (14 marks)

Module 5

18. Design a 3 bit asynchronous counter using T FFs. (14 marks)

19. Design 3 bit synchronous up counter using JK Flip flops. (14 marks)

Syllabus

Module 1-Amplifiers & Oscillators (9 hours)

BJT as an amplifier (CE configuration) - Concept of feedback-FET-construction and characteristics of JFET & MOSFET-Comparison of BJT & FET. Oscillators-Barkhausen criteria-Classification-Working of RC phase shift oscillators and Hartley Oscillator (no analysis required).

Module 2- Op-amp & its applications (9 hours)

Op-amp –ideal characteristics –offset voltage & offset current –frequency response-Inverting & non inverting amplifier- Integrator & Differentiator- Comparator-inverting,non-inverting;zero crossing detector, S/H, Isolation amplifier.

Module 3- Filters &Timers (9 hours)

Active Filters- First order LPF & HPF filter- Band Pass & Band stop Filters- (no analysis required) .Astable and Monostable multivibrator. Phase Locked Loops-Principles- building blocks of PLL-VCO-lock and capture ranges-capture process-frequency multiplication using PLL.

Module 4- Digital circuits (9 hours)

Logic gates-De-Morgan's theorem –Minimization of Boolean function using K-Map Combinational Circuits- Adder, Subtractor, Code converters (gray to binary & binary to gray). Encoders(3x8), Decoders(8x3), Multiplexers (1x8), De-multiplexers (8x1).

Module 5-Sequential Circuits (9 hours)

Flip Flop –SR,D,JK,T and master slave flip flop- Shift Registers-SISO,SIPO,PIPO,PISO,

Counters –3 bit Synchronous and asynchronous- Modulo 3 Counter- Ring Counter, Sequence detector

Text Books

1. Robert L.Boylestad and Louis Nashelsky, "*Electronic Devices and Circuit Theory*", Prentice Hall, Tenth Edition, 2009.

2. Ramakant A Gayakward, "*Op-amps and Linear Integrated* Circuits", IV edition , Pearson Education, 2002

3. M.Morris Mano, "*Digital Logic and Computer Design*", Pearson Education,2002

Reference Books

1. Allen Mottershead, "*Electronic Devices and Circuits:An Introduction*",Prentice Hall of India,2013

2.D.Roy Choudhury,Shail B Jain, "*Linear Integrated Circuits*",Fifth edition,New Age ,2018

3. Thomas L Floyd, "*Digital Fundamentals*",Eleventh edition,Pearson Education,2011

4. A.Anand Kumar, "*Fundamentals of Digital Circuits*",Second Edition,PHI,2009

Course Contents and Lecture Schedule

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No	Topic	No. of Lectures
1	**Amplifiers and Oscillators**	
1.1	BJT as an amplifier(CE configuration)- concept of feedback	1
1.2	FET- Construction and characteristics of JFET	2
1.3	MOSFET -depletion and Enhancement MOSFET	2
1.4	Comparison of BJT & FET	1
1.5	Oscillators-Barkhausen criteria-Classification	1
1.6	Working of RC and Hartley oscillator	2
2	**OP-AMP & its Applications**	
2.1	Ideal characteristics, offset voltage and offset current, frequency response	2
2.2	Applications-inverting & non inverting amplifier	1
2.3	Integrator & Differentiator	2
2.4	Comparator- zerocrossing detector	2
2.5	S/H, Isolation amplifier	2
3	**Filters & Timers**	
3.1	Active Filters- first order LPF & HPF filter	2
3.2	Band Pass & Band stop Filters	2

3.3	Astable and Monostable multivibrator using IC555	2
3.4	Phase Locked Loops-Principles- building blocks of PLL-VCO-lock and capture ranges-capture process-	2
3.5	Frequency multiplication using PLL	1
4	**Digital Circuits**	
4.1	Logic gates-De-Morgan's theorem –Minimization of Boolean function using K-Map (3 & 4 variables)	2
4.2	Combinational Circuits- Adder, Subtractor	2
4.3	Code converters (gray to binary & binary to gray)	1
4.4	Encoders(3x8), Decoders(8x3),	2
4.5	Multiplexers (1x8), De-multiplexers (8x1)	2
5	**Sequential Circuits**	
5.1	Flip Flop –SR,D,JK,T and master slave flip flop	2
5.2	Shift Registers-SISO,SIPO,PISO,PIPO	2
5.3	Counters –3 bit Synchronous -Problems	2
5.4	3 bit asynchronous Counters-Problems	1
5.4	Ring Counter	1
5.5	Sequence detector	1

MRT284	BASICS OF INDUSTRIAL HYDRAULICS AND PNEUMATICS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble:
This course enables students to analyse, design and implement hydraulic and pneumatic systems for automation in industries.
Prerequisite: Nil

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

CO1 provide an insight into the capabilities of hydraulic and pneumatic fluid power.
CO2 describe concepts and relationships surrounding force, pressure, energy and power in fluid power systems.
CO3 Identify sources of hydraulic power, rotary and linear actuators, distribution systems, hydraulic flow in pipes, and control components in fluid power systems.
CO4 Construct hydraulic and pneumatic circuits related to industrial applications.
CO5 familiarize with logic controls and trouble shooting

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	3	3	2	1	1	1	-	3	1	-	2
CO 2	3	3	3	3	1	1	1	-	3	1	-	2
CO 3	3	3	3	3	2	1	1	-	3	3	-	2
CO 4	3	3	3	3	3	1	1	-	3	3	-	2
CO 5	3	3	3	3	3	1	-	-	3	3	-	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 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.

Module 1: Introduction to fluid power systems

Fluid power system: components, advantages and applications. Transmission of power at static and dynamic states. Pascal's law and its applications.

Fluids for hydraulic system: types, properties, and selection. Additives, effect of temperature and pressure on hydraulic fluid. Seals, sealing materials, compatibility of seal with fluids. Types of pipes, hoses, and quick acting couplings. Pressure drop in hoses/pipes. Fluid conditioning through filters, strainers; sources of contamination and contamination control **9 Hours**

Module 2: Pumps and actuators

Pumps: Classification of pumps, pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump selection factors, problems on pumps.

Accumulators: Types, selection/ design procedure, applications of accumulators. Types of Intensifiers, Pressure switches /sensor, Temperature switches/sensor, Level sensor. Actuators: Classification cylinder and hydraulic motors, Hydraulic cylinders, single and double acting cylinder, mounting arrangements, cushioning, special types of cylinders, problems on cylinders.

Construction and working of rotary actuators such as gear, vane, piston motors, and Hydraulic Motor. Theoretical torque, power, flow rate, and hydraulic motor performance; numerical problems. Symbolic representation of hydraulic actuators (cylinders and motors). **9 Hours**

Module3: Components and hydraulic circuit design

Components: Classification of control valves, Directional Control Valves-symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, and check valves. Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation.

Hydraulic Circuit Design: Control of single and Double -acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, counter balance valve application, hydraulic cylinder sequencing circuits, cylinder synchronizing circuit using different methods, hydraulic circuit for force multiplication; speed control of hydraulic cylindermetering in, metering out and bleed off circuits. Pilot pressure operated circuits. Hydraulic circuit examples with accumulator. **9 Hours**

Module4: Pneumatic power systems

Introduction to pneumatic systems: Pneumatic power system, advantages, limitations, applications, Choice of working medium. Characteristics of compressed air and air compressors. Structure of pneumatic control System, fluid conditioners-dryers and FRL unit. Pneumatic Actuators: Linear cylinder – types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications. Rotary cylinders- types, construction and application, symbols.

Pneumatic control valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols.

9 Hours

Module5: Pneumatic control circuits

Simple pneumatic control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling. Signal Processing Elements: Use of Logic gates - OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates.

Multi- cylinder Application: Coordinated and sequential motion control, motion and control diagrams. Signal elimination methods, Cascading method- principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves).

Electro-pneumatic control: Principles - signal input and output, pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple signal cylinder application. **9 Hours**

Text Books

1. Anthony Esposito, “Fluid Power with applications”, Pearson edition,2000 .
2. Majumdar S.R., “Oil Hydraulics”, Tata McGRawHllL, 2002 .
3. Majumdar S.R., “Pneumatic systems - Principles and Maintenance”, Tata McGraw-Hill, NewDelhi, 2005

REFERENCE BOOKS:

1. John Pippenger, Tyler Hicks, “Industrial Hydraulics”, McGraw Hill International Edition, 1980.
2. Andrew Par, Hydraulics and pneumatics, Jaico Publishing House, 2005.
3. FESTO, Fundamentals of Pneumatics, Vol. I, II and III.
4. Herbert E. Merritt, “Hydraulic Control Systems”, John Wiley and Sons, Inc.
5. Thomson, Introduction to Fluid power, PrentcieHall, 2004.
6. John Watton, “Fundamentals of fluid power control”, Cambridge University Press, 2012.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1.1	Fluid power system, its components, advantages and applications	1
1.2	Transmission of power at static and dynamic states	1
1.3	Pascal’s law and its applications	1
1.4	Fluids for hydraulic system, types, properties, and selection	1
1.5	Additives, effect of temperature and pressure on hydraulic fluid	1
1.6	Seals, sealing materials, compatibility of seal with fluids	1
1.7	Types of pipes, hoses, and quick acting couplings	1
1.8	Pressure drop in hoses/pipes	1
1.9	Fluid conditioning through filters, strainers, sources of contamination and contamination control	1
2.1	Classification of pumps, pumping theory of positive displacement pumps	1
2.2	Construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps	1
2.3	Pump performance characteristics, pump selection factors, problems on pumps	1
2.4	Accumulators and intensidiers: Types, selection/ design procedure and applications	1
2.5	Pressure switches /sensor, Temperature switches/sensor, Level sensor. Actuators: Classification, cylinder and hydraulic motors	1

2.6	Hydraulic cylinders, single and double acting cylinder, mounting arrangements, cushioning, special types of cylinders, problems on cylinders	1
2.7	Construction and working of rotary actuators such as gear, vane, piston motors, and hydraulic motor	1
2.8	Theoretical torque, power, flow rate, and hydraulic motor performance; numerical problems	1
2.9	Symbolic representation of hydraulic actuators (cylinders and motors)	1
3.1	Components and Classification of control valves, Directional Control Valves-symbolic representation	1
3.2	Constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, and check valves	1
3.3	Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves (FCV) -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation	2
3.4	Hydraulic Circuit Design: Control of single and Double -acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, counter balance valve application	2
3.5	hydraulic cylinder sequencing circuits, cylinder synchronizing circuit using different methods, hydraulic circuit for force multiplication; speed control of hydraulic cylinder metering in, metering out and bleed off circuits	2
3.6	Pilot pressure operated circuits. Hydraulic circuit examples with accumulator	1
4.1	Introduction to Pneumatic systems: Pneumatic power system, advantages, limitations, applications, Choice of working medium	1
4.2	Characteristics of compressed air and air compressors. Structure of pneumatic control System, fluid conditioners-dryers and FRL unit	2
4.3	Pneumatic Actuators: Linear cylinder – types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications. Rotary cylinders- types, construction and application, symbols	2
4.4	Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve	3
4.5	Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols	1
5.1	Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling	1
5.2	Signal Processing Elements: Use of Logic gates - OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates	2
5.3	Multi- Cylinder Application: Coordinated and sequential motion control, motion and control diagrams. Signal elimination methods	2
5.4	Cascading method- principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves)	2
5.5	Electro- Pneumatic Control: Principles - signal input and output, pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple signal cylinder application	2

Model Question Paper
Course Code: MRT 284
Course Name: BASICS OF INDUSTRIAL HYDRAULICS AND PNEUMATICS
Max. Marks:100 **Duration: 3 Hours**

PART-A
Answer all the questions. Each question carries 3 marks

1.What are the different types of oil additives? Why are they used in hydraulic oils?
2.What are the different types of pipes used in hydraulic & pneumatic circuit? List the different accessories used in the piping.
3.With neat sketch explain the construction & working of a balanced vane pump.
4.With neat sketch explain the construction and working of internal gear pump.
5.What are the different types of direction control valves? State their application by using symbolic representation.
6. What are the controls used for speed control in the hydraulic and pneumatics systems? Explain metering in, metering out & bleed off circuit.
7. State five advantages of using air instead of hydraulic oil.
8. Explain the construction of a double acting cylinder used in pneumatics with a neat sketch.
9. Explain supply air throttling and exhaust air throttling with a net circuit diagram.
10. Design and draw a sequential circuit for the operation of two cylinders X and Y using cascade method.

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

Module 1

11. Describe the applications of fluid power system and list the main components required for a power pack with circuit.
12. Hydraulic oil of kinematic viscosity 0.9 strokes, flow through a 35mm diameter pipe at a velocity of 4 m/sec for a length of 100 m. Find the head loss due to friction (in units of bar). Assume sp.gravity of oil as 0.9.

Module 2

13. Classify the types of hydraulic cylinders. Describe the working of a double acting tandem cylinder and gear motor. Give its graphical symbols.
14. Explain the construction and operation of a variable discharge axial flow piston pump with a neat sketch. Describe how to estimate minimum and maximum discharge. Give its graphical method.

Module 3

15.Write short notes on:
(i) Direct acting pressure reducing valve
(ii) Pilot operated sequence valve
16.What is pressure compensation? Explain with a neat sketch the working of pressure compensated flow control valve.

Module 4

17. Sketch and explain commonly used 3-position 4 way direction control valves. Also state the applications for a closed centre, open centre and tandem centre valves.
18. Discuss the following with a neat sketch:
(i) Quick exhaust valves
(ii) Air control valves

Module 5

19. Design an electro pneumatic circuit for the following sequence: A+A-B+B-, where + is extension and - is retraction.
20. Explain logic OR function with a shuttle valve and double acting cylinder.

*****

MRT381	EMBEDDEED SYSTEMS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble:

To mould students into high calibre embedded real time application designers by enhancing their knowledge and skills in various system design aspects of embedded real time system.

Prerequisite:

Strong Electronics fundamentals, C/C++ programming, Microcontroller/Microprocessor programming, Communication Engineering

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Explain Embedded System, its challenges, technologies.
CO 2	Optimize the processor design.
CO 3	Design systems with a microprocessor having a superscalar architecture.
CO 4	Program a PIC microcontroller, CCP modules.
CO 5	Explain various protocols associated with an Embedded system.

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	2											2
CO 2	3											3
CO 3	3		3									3
CO 4	3				3							3
CO 5	2											2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	3		3
Understand	47	45	92
Apply		5	5
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 contains 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 Embedded system.
2. List the IC technologies.
3. Describe the design challenges.

Course Outcome 2 (CO2):

1. State the custom single purpose processor design.
2. List the RT level combinational components.
3. Describe optimizing custom single purpose processors.

Course Outcome 3 (CO3):

1. Demonstrate pipelining, superscalar and VLIW architecture.
2. Give example for ASIP.
3. Describe the features of the microcontroller, and DSP.

Course Outcome 4 (CO4):

1. Demonstrate the addressing mode of PIC Microcontroller.

2. Give example for Timers, Interrupt logic.
3. Describe about CCP modules and ADC circuitry.

Course Outcome 5 (CO5):

1. Illustrate about parallel, serial and wireless communication.
2. Describe about serial protocols.
3. Explain parallel and wireless protocol.

Model Question paper

Course Code: MRT 381

Course Name: EMBEDDED SYSTEMS

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

PARTA

Answer all Questions. Each question carries 3 Marks

1. Define an Embedded System with an example.
2. Distinguish between the IC technologies.
3. Write a short note on RT level sequential components.
4. Define optimization in FSMD.
5. Explain about pipelining.
6. Write short note on superscalar architecture in an Embedded System.
7. Explain Timers in PIC microcontrollers.
8. Compare the different addressing modes in a PIC microcontroller.
9. Write short note on AMBA Bus.
10. Explain with specific reason the relevance of IrDA bus.

PART B

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

Module 1

11. (a) Describe briefly the IC technologies. (10)
    (b) State the design challenges associated in Embedded System. (4)
12. Describe PLDs and its trends associated with a system.

Module 2

13. (a) Explain the formation of custom single purpose processors. (10)
    (b) How a custom single purpose processor is optimized? Explain. (4)
14. Compare the optimization process involved in FSMD and FSM.

Module 3

15. (a) Describe the architecture of general purpose processors. (10)

    (b) Illustrate VLIW and superscalar architecture with an application. (4)

16. Classify ASIP with an example program and how a microprocessor selected accordingly.

Module 4

17. Briefly explain the architecture of PIC microcontroller with a neat diagram.
18. (a) State interrupt logic associated in an Embedded System. (4)
    (b) With a neat diagram, explain the CCP modules in PIC microcontrollers. (10)

Module 5

19. (a) Show how a data or information is transmitted in a different manner in a communication system with few examples and list down the standards associated with it. (10)
    (b) Write a short note on communication protocols in an Embedded System. (4)
20. (a) Differentiate I2C bus and CAN bus with neat sketches. (10)
    (b) Explain IEEE802.11 standard and its relevance in a communication system. (4)

Syllabus

EMBEDDED SYSTEM DESIGN

Module 1 (8 Hours)

Introduction

Embedded system overview- Design challenges: optimizing design metrics, IC technology: Full-custom/VLSI, Semi-custom ASIC, PLD, Trends, Design technology.

Module 2 (9 Hours)

Custom Single purpose processors

RT- level combinational components, RT level sequential components, custom single purpose processor design, RT level custom single purpose processor design

Optimizing custom single purpose processors, the original program, FSMD, Datapath and FSM.

Module 3 (9 Hours)

General purpose processors

Basic architecture, Datapath, control unit, memory, pipelining, superscalar and VLIW architecture, Application-Specific Instruction Set Processor(ASIP), Microcontrollers, DSP, selecting a microprocessor/general purpose processor design.

Module 4 (9 Hours)

PIC Microcontroller

Basic concept of PIC microcontroller and architecture, Instruction Set, Addressing mode, Timers, Interrupt logic, CCP modules, ADC.

Module 5 (10 Hours)

Advanced communication principles

Parallel, serial, wireless communication; serial protocols: I2C Bus, CAN Bus, firewire Bus, USB; Parallel protocols: PCI Bus, AMBA Bus; wireless protocols: IrDA, Bluetooth, and IEEE802.11.

Text Books

1. Frank Vahid And Tony Givargis, "Embedded System Design - A Unified Hardware/Software Introduction", John Wiley & Sons, 2002
2. Rajkamal, "Embedded System- Architecture, programming, Design", Tata McGraw Hill, 2011.
3. John B. Peatman, "Design with PIC Microcontroller", Prentice Hall, 2003.

Reference Books

1. Steve Health, "Embedded System Design", Butteworth Heinemann.
2. Gajski and Vahid, "Specification and Design of Embedded System", Prentice Hall.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction(8 Hours)**	
1.1	Embedded system overview- Design challenges.	1 Hour
1.2	Optimizing design metrics.	2 Hour
1.3	IC technology: Full-custom/VLSI, Semi-custom ASIC.	2 Hours
1.4	PLD, Trends, Design technology.	3 Hours
2	**Custom Single Purpose Processors (9 Hours)**	
2.1	RT- level combinational components, RT level sequential components.	2 Hour
2.2	Custom single purpose processor design, RT level custom single purpose processor design.	2 Hours
2.3	Optimizing custom single purpose processors, optimizing the original program.	2 Hours
2.4	Optimizing FSMD, optimizing data path, optimizing FSM.	3 Hours
3	**General Purpose Processors (9 Hours)**	

3.1	Basic architecture, data path, control unit, memory.	2 Hours
3.2	Pipelining, superscalar and VLIW architecture.	2 Hours
3.3	Application-Specific Instruction Set Processor (ASIP), Microcontrollers, DSP.	2 Hours
3.4	Selecting a microprocessor/general purpose processor design.	3 Hours
4	**PIC Microcontroller (9 Hours)**	
4.1	Architecture, Instruction Set.	2 Hours
4.2	Addressing mode, Timers, Interrupt logic.	3 Hours
4.3	CCP modules.	2 Hour
4.4	ADC.	2 Hour
5	**Advanced Communication Principles (10 Hours)**	
5.1	Parallel, serial, wireless communication.	2 Hour
5.2	Serial protocols: I2C Bus, CAN Bus, fire wire Bus, USB.	2 Hours
5.3	Parallel protocols: PCI Bus, AMBA Bus.	3 Hours
5.4	Wireless protocols: IrDA, Bluetooth, and IEEE802.11.	3 Hours

MRT382	INTRODUCTION TO ROBOTICS & AUTOMATION	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims at imparting knowledge about the robotics as well as automation. This will include basics of robots, sensors, kinematics as well as control and industrial automation.

Prerequisite: NIL

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

CO 1	Understand the robot actuators and controls
CO 2	Get knowledge on robot sensors for robotic application
CO 3	Understand the kinematics of robots and adaptive control
CO 4	Understand the basics of Programming Logic Circuits
CO 5	Acquire proficiency in programming Programmable Logic Circuits

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	2								2
CO 3	3	3										
CO 4	3	3	2	2								2
CO 5	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. How do you classify robotic structures?
2. Define roll, pitch and yaw.
3. Which are the drives used in Robotics?

Course Outcome 2 (CO2):

1. What is the necessity of sensors in robotics?
2. Why is machine vision a superior sensor in robotics?
3. Mention few sensors used in robotics.

Course Outcome 3 (CO3):

1. What do you mean by forward kinematics?
2. Explain the inverse kinematics of robots.
3. What is the advantage of adaptive control structures?

Course Outcome 4 (CO4):

1. What is a PLC?
2. What is a ladder program? What are its components?
3. Explain the architecture of PLC.

Course Outcome 5 (CO5):

1. What are the advantages and capabilities of a PLC
2. Explain a PLC based system for automation
3. Explain alarms an interlocks.

Model Question paper

QP CODE:

Reg. No: _____

Name: _____

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

COURSE CODE: MRT 382 **Duration: 3 hours**

ROBOTICS & AUTOMATION

Mechatronics Branch

PART A

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

1. What are the advantages of PLC over electromechanical relay control? (3 marks)
2. With suitable example explain latching in PLC Ladder logic? (3 mark)
3. What is the scope of industrial automation? (3 mark)
4. What are the applications of Motion Actuators? (3 mark)
5. Differentiate between a serial and parallel robot (3 marks)
6. Write a short note on encoders. (3 marks)
7. Write a short note on Force-Torque sensors. (3 marks)
8. Draw and explain the components and structure of robotic arm? (3 marks)
9. When will hydraulic drive be preferred in robot? (3 marks)
10. Explain the common kinematic arrangements of robots based on various coordinate System? (3 marks)

PART B

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

Module 1

11. Explain different types of stepper motor (14 marks)
12. With illustrations, explain the basic robotic configurations. (14 marks)

Module 2

13 Explain different types of robot End effectors?(14 marks)

14 Illustrate the working principle of various position sensors used in a robotic system? (14 marks)

Module 3

15 Explain the structure of robot programming language (14 marks)

16 Explain about joint angle, joint distance, link length and link twist with the help of

D-H representation. (14 marks)

Module 4

17 (a) Illustrate the architecture of PLC? (8 marks)
(b)What are the different types of PLC? (6 marks)

18 What are the advantages and capabilities of a PLC? (14 marks)

Module 5

19 Explain a PLC based system for automation. Explain its ladder diagram. (14 marks)

20 (a) Explain the requirement of communication system in a PLC? (4 marks)
(b) Illustrate the importance of Alarms and Interlocks in a PLC program? (10 marks)

SYLLABUS

Module 1 (9 Marks)

Robotics –Introduction –Basic Structure-Classification of Robot and Robotic System-Law of Robotics-Robot Motion-Wrist Configuration-Motion – Roll –Pitch-Yaw-Drives-Hydraulic Motors-DC Motor-Stepper Motor-Power Transmission Systems

Module 2 (9 Marks)

Sensors in Robotics: Position Sensor-Potentiometer-Encoders-LVDT-Velocity Sensor-Acceleration Sensor-Force-Pressure and Torque Sensor-Touch and Tactile Sensor-Proximity –Range and Sniff Sensor-Robot End Effectors-Types of End Effectors- Mechanical Gripper –Types of Gripper Mechanism

Module 3 (11 Marks)

Position Orientation-Frames-Mapping-Changing Description from Frames to Frames. Transformation arithmetic's -Translation-rotation-transformation- transforms equations- transformation of the vectors-.Introduction to manipulations Forward Kinematics and inverse Kinematics- D-H representation-Method of Robotic Programming (Qualitative Treatment Only).

Module 4 (7 Marks)

Basics of PLC-Advantage- Capabilities of PLC-Architecture of PLC- Scan Cycle-Types of PLC-Types of I/O modules-Configuring of PLC –PLC wiring

Module 5 (9 Marks)

Simple process control programme using ladder logic- PLC arithmetic functions- Timer and Counters-Data transfer-comparison and manipulation instructions-Interlocks and Alarms-Requirement of communication networks in PLC –connecting PLC to computer.

Text Books

1. M.P Groover, Industrial Robotics-Technology, Programming and Applications, McGraw-Hill USA, 1986
2.John Craig, "Introduction to Robotics",Macmillan, 1985
3. Curtis Johnson Process Control Instrumentation Tech 8 TH Edition Prentice Hall June 2005
4. Petrezeulla, Programmable Controllers, McGraw Hills, 1989

Reference Books

1. D Roy Choudhury and shaail B. jain, Linear Integrated circuits New age international Pvt.Ltd 2003
2. Boltans w. "Mechatronics" Pearson Education , 2009

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Robotics: Introduction**	
1.1	Basic Structure- Law of Robotics	1
1.2	Classification of Robot and Robotic System	1
1.3	Robot Motion	1
1.4	Wrist Configuration-Motion – Roll –Pitch-Yaw	1
1.5	Drives-Hydraulic Motors	1
1.6	DC Motor	1
1.7	Stepper Motor	1
1.8	Power Transmission Systems	2
2	**Sensors in Robotics**	
2.1	Position Sensor-Potentiometer-Encoders-LVDT-	1
2.2	Velocity Sensor	1
2.3	Acceleration Sensor	1
2.4	Force-Pressure and Torque Sensor	1
2.5	Touch and Tactile Sensor	1
2.6	Proximity –Range and Sniff Sensor	1
2.7	Robot End Effectors	1
2.8	Types of End Effectors	1
2.9	Mechanical Gripper –Types of Gripper Mechanism	1
3	**Robotics Kinematics**	
3.1	Description-Position	1
3.2	Orientation-Frames- Mapping	1
3.3	Changing Description from Frames to Frames.	1
3.4	Translation-rotation-transformation	1
3.5	Transformation arithmetic's- transforms equations	1
3.6	transformation of the vectors	1
3.7	Introduction to manipulations Forward Kinematics and inverse Kinematics	1
3.8	D-H representation	2
3.9	Method of Robotic Programming (Qualitative Treatment Only).	2

4	**Basics of PLC**	
4.1	Advantage of PLC	1
4.2	Architecture of PLC	2
4.3	Scan Cycle-Types of PLC	1
4.4	Types of I/O modules	1
4.5	Configuring of PLC	1
4.6	PLC wiring	1
5	**PLC programming**	
5.1	Simple process control programme using ladder logic	1
5.2	PLC arithmetic functions- Timer and Counters	2
5.3	Data transfer	1
5.4	comparison and manipulation instructions	1
5.5	Interlocks and Alarms	2
5.6	Requirement of communication networks in PLC	1
5.7	connecting PLC to computer	1

MRT383	DATA AQUISTION & PLC SYSTEMS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble:

In simple terms PLC is a solid-state industrial control device which receives signals from user supplied controlled devices, such as sensors and switches, implements them in a precise pattern determined by ladder-diagram based application progress stored in user memory, and provides outputs for control of processes or user supplied devices, such as relays or motor starters. . Industry needs less manpower, more and accurate throughput. Accuracy enhances by exact reading of data from sources which further uses to control the whole system.

Prerequisite: NIL

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

CO 1	Study the evolution and advantages of PLC.
CO 2	Understand the various PLC instructions.
CO 3	Design specific applications using PLC
CO 4	Understand the need of computer control in automation.
CO 5	Study data acquisition 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	1	2	-	-	2	-	-	-	3	-	3
CO 2	3	3	2	-	-	2	-	-	-	3	-	3
CO 3	3	3	3	3	3	2	-	-	3	3	-	3
CO 4	3	2	2	-	3	2	-	-	3	3	-	3
CO 5	3	2	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. State the functionality of Programmable Logic Controllers.

2. List the different configurations used.

3. Define the different capabilities & advantages of PLCs.

Course Outcome 2 (CO2)

1.Demonstrate the different programs using PLCs

2. Give example for real time programming using PLCs

3. Describe the functionality of the different instructions.

Course Outcome 3(CO3):

1. Demonstrate different applications of PLC.

2. Give example for different control using PLC

3. Describe the functionality of automation.

Course Outcome 4 (CO4):

1. State the functionality of the data acquisition system.

2. List the functionality of a digital control interfacing.

3. Define the functionality of SCADA systems.

Course Outcome 5 (CO5):

1. State the signal conversions.

2. List the Practical implementation of sampling and digitizing.

3. Develop the ADC and DAC interfacing with microprocessors.

Model Question Paper

Course Code: MRT383

Course Name: DATA ACQUISITION & PLC SYSTEMS

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

PARTA

Answer all Questions. Each question carries 3 Marks

1. Explain opto isolator in PLC input output module
2. Explain ladder logic in PLC
3. What are various arithmetic functions used in PLC?
4. Explain the functions of retentive timer
5. Brief out the data handling functions in PLC
6. List out any three program control instructions in PLC
7. Explain the need of computer in control system
8. Explain data logger in computer control
9. The analog input signal ranges from -5v to +5v for a 9 bit ADC
   (a) How many step intervals are available within an ADC
   (b) What is the resolution in volt/increment
10. Explain the term aliasing

PART B

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

Module 1

11. (a) Explain the architecture of a PLC system with neat diagrams

    (b)Define PLC and explain how it is helpful in automated process.

12. a)Draw a ladder diagram for liquid level controller

    (b) State and explain advantages and disadvantages of PLC in detail.

Module 2

13. Develop a PLC adder diagram from the following sequence . Start the motor with push switch, and then after delay of 90 sec , start the pump. When the motor is switched off, the

pump will get switched off after a delay of 5 sec. Mention the logic used for each rung in the program to substantiate the answer

14. Timers and counters in the PLC with suitable example

Module 3

15. Design a ladder logic for the bottle filling systems for the following sequence
    i. Start the program by processing the start push button
    ii. Once the start push button is pressed the conveyor belt should be start moving.
    iii. If the proximity sensor senses the bottle in the conveyor belt. The belts have to stop moving.
16. Enumerate data transfer and program control instruction used in PLC

Module 4

17. (a) Draw and explain SCADA architecture in detail.

    (b) State applications of SCADA.

18. (a) Explain advantages and disadvantages of SCADA systems.

    (b) Explain first, second and third generations of SCADA architecture.

Module 5

19. Discuss in detail about analog to digital conversion procedure
20. How a DAC is interfaced to microprocessor. Explain the procedure with necessary block diagram

Syllabus

Module 1. BASICS OF PLC (9hrs)

Definition and History of PLC-PLC advantage and disadvantages- Over all PLC systems-CPU and Programmer/Monitors-PLC input and output models – Architecture- PLC Programming language – Relay logic – Ladder logic – Programming of Gates – Flow charting as a programming method – connecting PLC to computer - PLC Troubleshooting and Maintenance.

Module 2. PLC PROGRAMMING (9hrs)

Programming of Timers – Introduction - ON delay, OFF delay, Retentive Timers – PLC Timer functions – Examples of timer function Industrial application. Programming Counters –up/down counter – Combining counter - Examples of counter function Industrial application. PLC Arithmetic Functions – PLC number Comparison function

Module 3. PLC DATA HANDLING FUNCTIONS (9hrs)

PLC Program Control Instructions: Master Control Reset - Skip – Jump and Move Instruction. Sequencer instructions - Types of PLC Analog modules and systems, PLC analog signal processing –

BCD or multi bit data processing – Case study of Tank level control system, bottle filling system and Sequential switching of motors

Module 4. COMPUTER CONTROL – INTRODUCTION (9hrs)

Need of computer in a control system-Functional block diagram of a computer control system-Data loggers- Supervisory computer control- Direct digital control-Digital control interfacing-SCADA.

Module 5. DATA ACQUISITION SYSTEMS (9hrs)

Sampling theorem – Sampling and digitizing – Aliasing – Sample and hold circuit – Practical implementation of sampling and digitizing – Definition, design and need for data acquisition systems – Interfacing ADC and DAC with Microprocessor / Multiplexer - Multiplexed channel operation – Microprocessor/PC based acquisition systems.

TEXT BOOKS:

[1] Petrezeulla, "Programmable Logic Controllers", McGraw Hill, 1989.

[2] Curtis D. Johnson," Process Control Instrumentation Technology", 8th edition Prentice Hall June 2005

[3] D.Roy Choudhury and Shail B.Jain, " Linear Integrated Circuits", New age International Pvt. Ltd,

REFERENCES:

[1] Hughes .T, "Programmable Logic Controllers", ISA Press, 1989.

[2] G.B.Clayton," Data Converters", The Mac Millian Press Ltd., 1982.

[3] John w.Webb & Ronald A.Reis., "Programmable logic controllers- principles and applications", 5th Edition – PHI Learning Pvt. LTd, New Delhi -2010.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Basics of PLC**	
1.1	Definition and History of PLC	1
1.2	PLC advantage and disadvantages	1
1.3	Over all PLC systems-CPU and Programmer/Monitors-PLC input and output models	1
1.4	Architecture	1
1.5	PLC Programming language	1
1.6	Relay logic – Ladder logic – Programming of Gates	1
1.7	Flow charting as a programming method	1
1.8	connecting PLC to computer	1
1.9	PLC Troubleshooting and Maintenance.	1
2	**PLC Programming**	
2.1	Programming of Timers – Introduction - ON delay, OFF delay	1
2.2	Retentive Timers	1
2.3	PLC Timer functions	1
2.4	Examples of timer function Industrial application.	1
2.5	Programming Counters –up/down counter	1
2.6	Combining counter	1

2.7	Examples of counter function Industrial application.	1
2.8	PLC Arithmetic Functions	1
2.9	PLC number Comparison function	1
3	**PLC Data Handling Functions**	
3.1	PLC Program Control Instructions: Master Control Reset	2
3.2	Skip – Jump and Move Instruction	1
3.3	Sequencer instructions -	1
3.4	Types of PLC Analog modules and systems	1
3.5	PLC analog signal processing	1
3.6	BCD or multi bit data processing	1
3.7	Case study of Tank level control system, bottle filling system and Sequential switching of motors	2
4	**Computer Control – Introduction**	
4.1	Need of computer in a control system	1
4.2	Functional block diagram of a computer control system-	1
4.3	Data loggers-	2
4.4	Supervisory computer control	1
4.5	Direct digital control	1
4.6	Digital control interfacing.	2
4.7	SCADA	2
5	**Data Acquisition Systems**	
5.1	Sampling theorem – Sampling and digitizing	2
5.2	Aliasing – Sample and hold circuit.	1
5.3	Practical implementation of sampling and digitizing –	1
5.4	Definition, design and need for data acquisition systems –	1
5.5	Interfacing ADC and DAC with Microprocessor / Multiplexer - Multiplexed channel operation –	2
5.6	Microprocessor/PC based acquisition systems	2

MRT384	ADVANCED AUTOMATION SYSTEMS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble:

To make students familiar with automation and control technologies in modern manufacturing

To provide knowledge on the elements of modern manufacturing systems

Examine the mechanisms of CMM and FMS

To determine the modern application of automation systems in manufacturing industry

Prerequisite: Nil

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

CO1: Understand the principles of automation systems and to determine the relationship between product and production.

CO2: Analyze the different elements of automation system and to find the importance of control systems in automation.

CO3: Classify the manufacturing systems and what are the components of manufacturing systems.

CO4: Define Group technology and understand about CMM

CO5: Explain about Machine vision in manufacturing system and FMS

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	-	-	-	-	-	-	-	-		-	-
CO 2	2	-	2	-	-	-	-	-	-	-	-	-
CO 3	2	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	-	2	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	2	-	-	-	-	-	-	-	-

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):

1. Explain different types of production system facilities?
2. What do you mean by USA principle?
3. Describe product/production relationship with an example?
4. Manual labor is unavoidable in manufacturing? Justify
5. What are the limitation and capabilities of manufacturing plant?

Course Outcome 2 (CO2):

1. Describe about advanced automation function in manufacturing system
2. What are the elements of automated systems?
3. Explain about different types of control systems in manufacturing system?
4. Define levels of automation? Explain in detail?

Course Outcome 3 (CO3)

1. What are the components of manufacturing system?
2. Explain about learning curve?
3. How we can classify manufacturing systems?

Course Outcome 4 (CO4):

1. Define group technology? Explain how it's done?
2. Explain about contact and non-contact inspection techniques?
3. With neat sketch explain about CMM construction? Explain its application?

Course Outcome 5 (CO5):

1. With neat sketch explain in detail about machine vision? Explain its importance in manufacturing system?
2. What is meant by FMS? Explain its components and application?
3. Differentiate between lean and agile manufacturing?

SYLLABUS

MODULE – 1 (9 Hours)

Production system facilities-Manufacturing support systems-Automation in production systems-manual labor in production systems-automaton principles and strategies-USA principle-ten strategies of Automation and Production Systems-Automation Migration strategy-manufacturing industries and products-manufacturing operations-processing and assembly operations-product /production relationships- production quantity and product variety-limitations and capabilities of a manufacturing plant

MODULE – II (9 Hours)

Elements of an automated system- power to accomplish the Automated process-program of Instructions- control systems-advanced automation functions-safety monitoring-maintenance and repair diagnostics- Error detection and Recovery-levels of automation, variables and parameters in process industries and discrete manufacturing industries-continuous and discrete control systems-computer process control- control requirements-capabilities of computer control and levels of industrial process control-computer process monitoring-direct digital control-numerical control and robotics-PLC

MODULE – III (9 Hours)

Components of a manufacturing system-production machines-material handling system-computer control system-human resources-classification of manufacturing systems-types of operations performed-number of work stations-automation levels-part or product variety-Type I type II and type III manufacturing systems-manufacturing progress functions-learning curves

MODULE – IV (9 Hours)

Part families-parts classification and coding-features and examples of part classification and coding systems-production flow analysis-cellular manufacturing-application of group technology. Inspection metrology-contact and non-contact inspection techniques-conventional measuring and gauging techniques-coordinate measuring machines-CMM construction-CMM operation and planning-CMM softwares-CMM applications and benefits.

MODULE – V(9 Hours)

Machine vision-image acquisition and digitizing-image processing, digitizing analysis and interpretation- machine vision applications. Flexible manufacturing systems-types of FMS-FMS components-workstations-material handling and storage systems-computer control systems-human resources-FMS applications and benefits-FMS planning and implementation issues-FMS planning and design issues-FMS operational issues. Comparison of lean and agile manufacturing.

Text Books

1. Mikell P Groover, Automation, Production Systems and Computer –Integrated Manufacturing, PearsonEducation

Reference

1. Groover , Automation , Production systems and CIM , Prentice Hall ofIndia
2. Radhakrishnan, P Subramanian S,CAD/CAM and CIM ,WileyEastern
3. HMT Mechatronics, TATA Mc GrawHill

MODEL QUESTION PAPER

ADVANCED AUTOMATION SYSTEMS – MRT384

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

Part – A

Answer all questions.

Answer all questions, each question carries 3 marks

1. Explain the ten strategies of automation systems?
2. What are the limitation and capabilities of manufacturing plant?
3. Explain how safety monitoring is done in manufacturing systems?
4. Differentiate between continuous and discrete control systems?
5. Describe about the objectives of material handling systems?
6. Classify FMS workstations and give its feature?
7. List down the advantages of cellular manufacturing?
8. Differentiate between contact and non-contact inspection technique with the help of examples?
9. What are the applications of machine vision?
10. Explain material handling system?

PART -B

Answer one full question from each module.

MODULE – 1

11. **a.** Write short note on manual labor in production system? (4 marks)

    b. Explain in detail about the ten strategies of automation systems? (10 marks)

OR

12. a. Explain about automation migration strategy? (5 marks).

    b. Discuss the factors that are determining how the products are being manufactured? (9 marks)

MODULE – 2

13. **a**. Write short note on error detection and recovery in an automated system? (8 marks).

b. Differentiate between different modes of control systems with the help of diagrams? (6 marks).

OR

14. a**.** Explain in detail about the elements of an automated systems? (10 marks).

b**.** Explain why advanced automation functions are implemented in manufacturing systems? (4 marks)

MODULE – 3

15. What are the components of manufacturing systems? Explain the role of human resources in manufacturing systems? (14 marks)

OR

16. a. Briefly explain classification of manufacturing systems? (8marks).

b. Define learning curves? Explain its importance in manufacturing systems? (6marks)

MODULE – 4

17. a. Explain group technology? List the application of group technology? (10marks).

b. List any four CMM softwares? (4marks)

OR

18. a. Define CMM? (4 marks).

b. Describe about six types of mechanical structure of CMM? (

MODULE – 5

19. a Describe about image acquisition and digitalization, image processing and analysis and interpretation (10 marks)

b. Explain the importance of machine vision in manufacturing? (4 marks).

OR

20. a. Define FMS (5marks).

b. Describe about the types of flexible manufacturing systems and mentioned its features(10 marks)

COURSE CONTENT AND LECTURE SCHEDULES.

Module	TOPIC	No. of hours	Course outcomes
1.1	Production system facilities-Manufacturing support systems-Automation in production systems	2	CO1
1.2	Manual labor in production systems-automaton principles and strategies-USA principle-ten strategies of Automation and Production Systems.	2	CO1
1.3	Automation Migration strategy-manufacturing industries and products	1	CO1
1.4	manufacturing operations-processing and assembly operations	1	CO1
1.5	product /production relationships-production quantity and product variety	2	CO1 C
CO1CC 1.6	Limitations and capabilities of manufacturing plant	1	CO1
2.1	Elements of an automated system- power to accomplish the Automated process-program of Instructions-control systems	1	CO2
2.2	advanced automation functions-safety monitoring-maintenance and repair diagnostics-Error detection and Recovery	2	
2.3	levels of automation, variables and parameters in process industries and discrete manufacturing industries	1	CO2
2.4	continuous and discrete control systems-computer process control-control requirements	1 1	
2.5	capabilities of computer control and levels of industrial process control- computer process monitoring-direct digital control	2	CO2
2.6	direct digital control-numerical control and robotics-PLC	2	

3.1	Components of a manufacturing system-production machines-material handling system-computer control system-human resources	2	CO3
3.2	classification of manufacturing systems-types of operations performed-number of work stations	3	
3.3	automation levels-part or product variety-Type I type II and type III manufacturing systems	2	CO3
3.4	manufacturing progress functions-learning curves	2	
4.1	Part families-parts classification and coding-features and examples of part classification and coding systems	3	CO4
4.2	production flow analysis-cellular manufacturing-application of group technology	1	CO4
4.3	Inspection metrology-contact and non-contact inspection techniques-conventional measuring and gauging techniques	2	CO4
4.4	Coordinate measuring machines-CMM construction-CMM operation and planning-CMM softwares-CMM applications and benefits.	3	CO4
5.1	Machine vision-image acquisition and digitizing-image processing, digitizing analysis and interpretation- machine vision applications	3	CO5
5.2	Flexible manufacturing systems-types of FMS-FMS components-workstations	1	CO5
5.3	material handling and storage systems-computer control systems-human resources-FMS applications and benefits	2	CO5
5.4	FMS planning and implementation issues-FMS planning and design issues- FMS operational issues	2	CO5
5.5	Comparison of lean and agile manufacturing.	1	CO5

MRD481	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:

- Survey and study of published literature on the assigned topic;
- Preparing an Action Plan for conducting the investigation, including team work;
- Working out a preliminary Approach to the Problem relating to the assigned topic;
- Block level design documentation
- Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/ Feasibility;
- 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.

MRD 482	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;
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5. Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/ Feasibility;
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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

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