GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma in Engineering

Level: Diploma

Branch: Mechatronics Engineering (20)

Course / Subject Code : DI01020011

Course / Subject Name : Elements of Mechatronics Engineering

w. e. f. Academic Year:	2024-25
Semester:	1st
Category of the Course:	PCC

1. Rationale:

Due to labor crisis and high quality products in demand, now a day company move towards Automation. In automation there are lots of components are used. This course is intended to learn basic concept of Automation and working of common components. Knowledge of this subject will lead to understanding working of Sensors and Actuators, PLC, CNC Machines, CAD/CAM & Robotics used in Mechatronics systems. Also this course offers the students deep thorough knowledge of Elements of Mechatronics system and also teaches students how to build a particular Mechatronic System. At the intersections of Mechanical, Electronics, and Computing — Mechatronics specialists create simpler, smarter systems.

2. Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Understanding Importance of Mechatronics systems.	U
02	Understand specification & Working of different types of Sensors and Actuators	U
03	Operate and select PLC for relevant applications.	A / U
04	Identification CNC machines, CAD/CAM software and hardware for its mechatronics system applications.	A
05	To operate the robot through Industrial automation.	R/U/C

3. Teaching and Examination Scheme: (*): CA (Continuous Assessment), PA (Progressive Assessment)

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
03	00	02	04	70	30	20	30	150

4. Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Introduction to Mechatronics	04	12
2.	Sensors and Transducers	08	20
3.	Actuators-Mechanical & Electrical	12	25
4.	Programmable logic controllers	06	14
5.	Elements of CNC Machines	10	23
6.	Robotics	05	06
	Total	45	100

5. Suggested Specification Table with Marks (Theory):

Sr.No	Unit Title	Teaching Hours	Distribution of Theory Marks (in %)						
			R	**U**	**A**	**N**	**E**	**C**	**Total Marks**
1.	Introduction to Mechatronics	04	2	2	2	-	2	-	**08**

2.	Sensors and Transducers	08	2	4	4	2	-	2	**14**
3.	Actuators-Mechanical &Electrical	12	4	4	4	2	2	2	**18**
4.	Programmable logic controllers	06	2	4	2	2	-	-	**10**
5.	Elements of CNCMachines	10	2	4	4	2	2	2	**16**
6.	Robotics	05	2	2	-	-	-	-	**04**
		45	**14**	**20**	**16**	**08**	**06**	**06**	**70**
			20%	**28%**	**23%**	**11%**	**9%**	**9%**	**100%**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

6. COURSE DETAILS:-

Unit	Major Learning Outcomes(Course Outcomes in Cognitive Domain accordingto NBA terminology)	Topics and Sub-topics
UNIT – I Introduction to Mechatronics Systems	a. Define the Mechatronics system indetail. b. Draw the blockdiagram of mechatronics systemwith neat figure. c. Write the Advantages & Dis-Advantages of Mechatronics System. d. Write the Importance of Mechatronics in today's automation.	1.1 Definition of mechatronics 1.2 Advantages & disadvantages of Mechatronics 1.3 Application of Mechatronics 1.4 Scope of Mechatronics in Industrial Sector 1.5 Components of a Mechatronics System 1.6 Importance of Mechatronics in automation

UNIT – II Sensors and Transducers	a. Identify and select the different type ofsensors based on given criteria. b. Make the connection of sensors. c. Explain working of different type ofsensors.	2.1 Definition of Sensors and Transducers 2.2 Classification of Sensors and Transducers 2.3 Electromechanical Transducers 2.4 Transducers Actuating Mechanisms 2.5 Displacement & Positions Sensors 2.6 Velocity, motion, force and pressure sensors. 2.7 Temperature and light sensors.
Unit – III Actuators-Mechanical andElectrical	a. Identify different types of actuators. b. Distinguish between CAM, NC, CNC, and DNC Distinguish between CAM, NC, CNC, and DNC c. Make the connections with actuators. d. Describe different types of electrical motors used in Mechatronics system. e. Define Various terms related to mechanisms f. Select suitable drivesfor the given application with justification.	3.1 Mechanical Actuators 3.1.1 Machine, Kinematic Link,Kinematic Pair 3.1.2 Mechanism, Slider crank Mechanism 3.1.3 Gear Drive, Spur gear, Bevel gear, Helical gear, worm gear 3.1.4 Belt & Belt drive 3.1.5 Bearings 3.2 Electrical Actuators 3.2.1 Switches and relay 3.2.2 Solenoid 3.2.3 D.C Motors 3.2.4 A.C Motors 3.2.6 Specification and control of stepper motor Servo Motors D.C & A.C
Unit- IV Programmable logic controllers (PLC)	a) Describe principle of operation of PLC. b) Explain the block diagram of PLC. c) Explain various programme control instructions of PLC.	4.1 Introduction to PLC 4.2 Advantages of PLC 4.3 Selection and uses of PLC 4.4 Block diagram of PLC 4.5 Input/output Processing and Programming 4.6 Master and Jump Controllers

Unit – V Elements of CNC Machines	a) Basic of CAD, CAM & its application. b) Distinguish between CAM, NC, CNC, andDNC. c) Explore Modes of Operations in CNCMachines.	5.1 Introduction to Numerical Control of machines and CAD/CAM 5.1.1 NC machines 5.1.2 CNC machines 5.1.3.CAD/CAM 5.1.3.1 CAD 5.1.3.2 CAM 5.1.3.3 Software and hardware for CAD/CAM 5.1.3.4 Functioning of CAD/CAM system 5.1.3.5 Features and characteristics of CAD/CAM system 5.1.3.6 Application areas for CAD/CAM 5.2 Elements of CNC machines 5.2.1 Introduction 5.2.2 Machine Structure 5.2.3 Guide ways/Slide ways 5.2.3.1 Introduction and Types of Guide ways 5.2.3.2 Factors of design of guide ways 5.2.4 Drives 5.2.4.1 Spindle drives 5.2.4.2 Feed drive 5.2.5 Spindle and Spindle Bearings
Unit –VI Robotics	a. Explain the Function & Importance of Robotics in Industrial Automation.	6.1 Definition, Function and laws of robotics 6.2 Types of industrial robots 6.3 Robotic systems 6.4 Advantages and Disadvantages of robots

7. SUGGESTED PRACTICAL EXERCISES:-

The following practical outcomes (PrOs) are the sub-components of the COs. Some of the PrOs marked '*' arecompulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1.	Preparatory activity (a) Get Familiar to the Digital Multi-meter (DMM)& prepare itschart (b) To Measure the Values of Resistors using color code & DMM.	ALL	04
2.	To measure the different parameter like Accuracy, Repeatabilityand Resolution for LVDT & Thermocouple.	II	02
3.	Demonstrate Mechanical Actuator and its working.	III	02
4.	Demonstrate Electrical Actuator and its working.	III	04
5.	Demonstrate Rs Logix Pro Software and the S7-200 PLC.	IV	02
6.	Identify Different types of PLC LADDER LOGIC	IV	02
7.	Demonstrate constructional features of CNC: a. Demonstrate the CNC machines and their operations. b. Identify the major parts of CNC and draw a sketch. c. Write the specifications of CNC taken for demonstration. d. Importance of tool holders, and types of CNC tools.	V	04
8.	Prepare 2D drawings of minimum one mechanical assembly and its components with all necessary views, dimensions, tolerances, notes,title block, etc. using CAD software.	V	04
9.	Demonstrate configurations and anatomy of Robots	VI	03
10.	Prepare a PPT on Various topics given by Subject Teacher / Preparethe report on Industrial Visit.	ALL	03
	Total (Hours)	----	**30**

NOTES:-

I. More Practical Exercises can be designed and offered by the concerned course teacher to developthe industry-relevant skills/outcomes to match the COs. The above table is only a representative list.

II. It is compulsory to prepare log book/continuous records of exercises. It is also required to get each exercise recorded in log book/continuous records, checked and duly dated signed by teacher. CA component of practical marks is dependent on continuous and timely evaluation of exercises.

III. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It mustbe hand written / hand drawn by student only.

a. Brief details of industry visited.

b. Type, location, products, rough layout, human resource, etc., of industry.

c. Details, description and broad specifications of machineries/processes observed.

d. Safety norms and precautions observed.

e. Student's own observation on industrial environment, productivity concepts, quality consciousness and quality standards, cost effectiveness, culture and attitude.

f. Any other details/ observations asked by accompanying faculty.

IV. For practical ESE part, students are to be assessed for competencies achieved. They should be assigned the necessary data and should be given any one experience to perform. The following are some sample 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed Practical Exercises of this course required, which areembedded in the COs and, ultimately, the competency.

8. References/Suggested Learning Resources:

(a) Books:

Sr. No.	Title of Book	Author	Publication
1.	Mechatronics- Electronics control systems in Mechanical and Electrical Engineering	W.Bolton Pearson	Tata Mcgraw HillEducation
2.	Robotics Control, Sensing, vision and intelligence	Ralph Gonzalez, C.S.GLee, K.S. Fu	Tata Mcgraw HillEducation
3.	A Textbook of Fluid Mechanics&Hydraulic Machines	Dr. R.K.Bansal	Lakhsmi publication (P) Ltd

4.	Programmable Logic Controllers,5th Edition	W. Bolton	Newnes
5.	CNC Fundamentals And Programming	P. M. Agrawal, Dr. V. J. Patel	Charotar Publication
6.	CAD/CAM/CIM	P. Radhakrishnan, S.	New Age
7.	Principles Of Electrical Engineering AndElectronics	V.K Mehta	S. Chand

(b) Open source software and website:

1. https://youtu.be/ew8K3apqs8E?si=gTDe1gPPdg40H1wD
2. www.controldevices.com
3. www.nptel.com
4. https://nptel.ac.in/courses/112105206
5. www.plcs.net
6. https://www.autodesk.com/education/edu-software/autocad
7. Autodesk AutoCAD (Educational network or stand-alone licensed latest Version).
8. http://www.robotics.org

9. List of Laboratory/Learning Resources Required:

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Digital Multimeter with 10 MΩ DC/AC	1,2
2.	Trainer Kit of LVDT , Thermocouple with Connecting Wires	2
3.	Hydraulic Pneumatic trainer Kit	3
4.	DC Motor , Servo Motor & Stepper Motor (DC Controlled)	4
5.	CNC turning Machine (Tutor or productive) Min Diameter: 30 mm, Min Length: 120mm, ATC facility	7
6.	2D AutoCAD Software with Minimum PC Requirements	8

7.	Programmable Robot trainer kit • Minimum 3 linkages, • Minimum 4 degree of freedom, • Mechanical end effector with servo control • Interfacing card(RC servo output, sensors input)	9

10. Suggested Project List & Student Activities:

Sr. No.	Activity.
1.	• Prepare list of various mechatronics systems. • Study specifications and use of various sensors used in mechatronics system • Study specifications and use of various actuators used in mechatronics system
2.	• Make a Hydraulic Based Robot with the help of Wooden Card boards & Medical Syringes with a group of Maximum 3 to 4 Students.

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