

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021) Semester-IV

Course Title: Control Devices (Course Code: 4342001)

Diploma Programme in which this course is offered	Semester in which offered
Mechatronics Engineering	4 th Semester

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 used in Mechatronics systems. Also this course offers the students deep thorough knowledge of Advanced Mechatronics system and also teach students how to build a particular Mechatronic System.

2. COMPETENCY

The course content should be taught with the aim to develop different types of skills so that students are able to acquire following competency.

- Select and operate Mechatronics system as per requirements.
- Selection of Various Sensors & Actuators as per requirements.

3. COURSE OUTCOMES (COs)

- Differentiate open loop and closed loop system
- Convert signals (ADC to DAC / DAC to ADC)
- Identify components in automation systems.
- Understand specification & Working of different types of sensors and actuators.
- Recognize role of various control devices in Mechatronics system.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (CI+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	2	3	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, CA - Continuous Assessment; ESE - End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *These PrOs need to be attained to achieve the Cos.*

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	To convert given Analog signal into Digital signal.	I	02
2	To convert given Digital signal into Analog signal.	II	02
3	To measure the different parameter like Accuracy, Repeatability and Resolution for L.V.DT.	III	04
4	To measure the different parameter like Accuracy, Repeatability and Resolution for Thermocouple.	III	04
5	To Plot various characteristic of Single Phase and Three Phase A.C. Motor.	IV	02
6	To control the speed of DC motor by PWM Method.	IV	04
7	Demonstrate Hydraulic actuator and its working.	IV	04
8	Demonstrate Pneumatic actuator and its working.	IV	04
9	MINI PROJECT AND PRESENTATION on any one of the working of Mechatronics System used in: <ul style="list-style-type: none"> • Household applications • Packaging systems • Material handling/ transfer systems • Automobile systems • Security systems 	V	04

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

Notes:

- Term work report must not include any photocopy/i.e., printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
- Term work report content of each experience should also include following.
 - Experience description / data and objectives.
 - Drawing of experience / setup with labels/nomenclature to carry out the experience.
 - The specifications of machines / equipments / devices / tools / instruments / items/elements which is / are used to carry out and to check experience.
 - Process parameters / setup settings' values applied to

carryout experience.

- Mini project and presentation topic/area has to be assigned to the student in the beginning of the term by batch teacher. This may be assigned individually or in the group of maximum 2 to 3 students.
 - For 40 marks ESE, students are to be assessed for competencies achieved. Students should be given following tasks (any two).
 - v. Identify sensors.
 - vi. Convert signals
 - vii. Measure parameters like accuracy, resolution and repeatability of thermocouple/ strain gauge / LVDT
 - viii. Control speed of DC motor.
 - ix. Explain role of control devices for given mechatronics system.
- 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 are embedded in the COs and ultimately the competency..

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Introduction to Control Devices	20
2	Signal processing & Concept of Aliasing & Nyquist Frequency	10
3	Various types of Sensors Concepts	30
4	Various types of actuators & control signals	25
5	Design any of one Mechatronics System	15
Total		100

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Trainer Kit of LVDT , Thermocouple with Connecting Wires	All
2	Hydraulic Pneumatic trainer Kit	All
3	RTD, Thermocouple (Temperature Sensor Kit)	All
4	DC Motor Cross sections	All

• AFFECTIVE DOMAIN OUTCOMES

The following **sample** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfil the development of this course competency.

- a) Follow safety practices.
- b) Practice good housekeeping.
- c) Demonstrate working as a leader/a team member.

- d) Maintain tools and equipment
- e) Follow ethical practices.

7. UNDERPINNING THEORY

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I INTRODUCTION	1a. Compare open loop and close loop system. 1b. Identify sinking and sourcing device.	1.1. Control devices-Meaning, need and application. 1.2. Open loop control 1.3. Closed loop control 1.4. Sinking and sourcing concept.
Unit –II SIGNAL PROCESSING	2a. Explain Signal processing and filtration and Differentiate between Analog and digital Signal. 2b. Convert signals	2.1. Signal processing- Need and meaning 2.2. Data acquisition 2.3. Sampling 2.4. Digitized signal 2.5. Sampling rate 2.6. Nyquist frequency 2.7. Aliasing 2.8. Analog to digital signal conversion 2.9. Digital to analog signal conversion
Unit-III SENSORS	3a. Identify and select the different type of sensors based on given criteria. 3b. Make the connection of sensors. 3c. Explain working of different type of sensors.	3.1. Sensors- Need and classification. 3.2. Important parameters (such as sensitivity, linearity, range, response time, accuracy, repeatability, Resolution, threshold value etc.) Its definitions and Importance in sensor selection. 3.3. Working and application of sensing technique for following parameter. <ul style="list-style-type: none"> i. Position and speed. ii. Stress, strain. iii. Temperature. iv. Pressure. v. Flow and level. vi. Optical vii. Object detection 3.4. Selection criteria for sensors 3.5. Common troubles and remedies in sensor operations.

<p>Unit-IV</p> <p>ACTUATORS</p>	<p>4a. Identify different types of actuator.</p> <p>4b. Make the connections with actuators.</p> <p>4c. Describe different types of electrical motors used in</p>	<p>4.1. Definition, need, working, applications.</p> <p>4.2. Electrical actuator (working and application).</p> <ul style="list-style-type: none"> i. DC motors – series, shunt and compound. ii. AC Single-phase motor.
	<p>Mechatronics system.</p> <p>4d. Describe the working of different types of hydraulic and pneumatic cylinder.</p> <p>4e. Identify and interpret different hydraulic and pneumatic symbols.</p>	<ul style="list-style-type: none"> iii. AC poly phase motor. iv. Servo Motor v. Stepper motors. <p>4.3 Hydraulic & Pneumatic actuators (working and application)</p> <ul style="list-style-type: none"> i. Types of Cylinder. ii. Direction control valve. <p>4.4. Selection criteria.</p> <p>4.5. Common troubles and remedies.</p>
<p>Unit- V</p> <p>MECHATRONIC SYSTEMS</p>	<p>5a. Explain working and function of elements used in Mechatronics systems.</p>	<p>5.1. Introduction.</p> <p>5.2. Design steps and considerations</p> <p>5.3. Various mechatronics systems.</p> <ul style="list-style-type: none"> i. Being used in day-to-day life. ii. Expected use in future. <p>5.4. Working elements, its functions and applications of following system.</p> <ul style="list-style-type: none"> i. Hydraulic robot arm. ii. DC motor based bottle filling. iii. Temperature sensing system. <p>5.5. Mechatronics systems, which are in recent trend</p>

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Note: The Unit Outcomes (UOs) need to be formulated at the 'Application Level' and above of *Revised Bloom's Taxonomy* to accelerate the attainment of the COs and the competency.

8. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction	2	4	4	0	8
II	Signal processing.	2	2	3	3	8
III	Sensor	11	8	6	6	20
IV	Actuators	10	7	6	7	20
V	Mechatronics systems	3	1	5	8	14
Total		28	22	24	24	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.

9. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

Sr No	Activity
1	Prepare list of various mechatronics systems.
2	Study specifications and use of various sensors used in mechatronics system
3.	Study specifications and use of various actuators used in mechatronics system
4.	Identify alternative elements in mechatronics system
5.	Draw line diagram/ circuit of various mechatronics systems.
6.	Plot characteristics of motors.

10. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- a) Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- b) Guide students to take micro-projects.
- c) Blend the basic concepts with more specialized instruction
- d) Give at least 10 competitive problems for each course outcomes of this course
- e) Practice, practice and practice - expose students to wide range of problems
- f) About **20% of the topics/sub-topics** which are relatively simpler or descriptive in nature is to be given to the students for **self-learning**, but to be assessed using different assessment methods.
- g) Guide students on how to address issues on environment and sustainability using the knowledge of this course.

11. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

Suggested List of Micro-Project Definition :-

- The Microproject should consist of using of Various Sensors & Actuators and they should use different types of ideas to make the system automatic.
- The Microproject Should be made with the help of Charts & Drawing Sheets with good sketch and labelling.
- The Microproject should be made with the use of different types of Hydraulic & Pneumatic Actuators.

12. SUGGESTED LEARNING RESOURCES

Sr.No.	Title of Books	Author	Publication
1.	Robotics Control,Sensing,vision and intelligence	Ralph Gonzalez, C.S.G Lee, K.S. Fu	Tata Mc graw Hill Education
2	Industrial Robotics	Roger N Nagel, M.P. Groover, N.G. Odrey, Michell Weiss	Tata Mc graw Hill Education
3	Mechatronics- Electronics control systems in Mechanical and Electrical Engineering	W.Bolton Pearson	Tata Mc graw Hill Education
4.	Mechatronics	Ganesh Hegde	Jones & Bartlett

13. SUGGESTED LEARNING WEBSITES

1. www.nationalinstruments.com
2. www.controldevices.com
3. www.youtube.com
4. www.sensors-research.com
5. www.sensormag.com
6. www.honeywell.com
7. www.nptel.com

14. PO-COMPETENCY-CO MAPPING

Semester IV (Mechatronics Engg.)	Control Devices						
	POs						
Competency & Course Outcomes	PO1 Basic and Disci pline specif ic know ledge	PO2 Probl em analy sis	PO3 Design/ develop ment of solutio ns	PO4 Engineeri ng Tools, Experime ntation and Testing	PO5 Engineerin g practices for society, sustainabili ty and environme nt	PO6 Projec t Mana geme nt	PO7 Life- long learnin g
Competency <i>Develop structured, modular and memory efficient programs in 'C'.</i>							
Course Outcomes CO a) Differentiate open loop and closed loop system	2	1	-	1	-	-	2
CO b) Convert signals ADC to DAC / DAC to ADC)	2	2	2	2	-	-	2
CO c) Identify Components in Automation Systems	2	2	1	2	-	1	2
CO d) Understand specifications & working of different types of Sensors & Actuators.	2	2	2	2	-	-	1
CO e) Recognize role of Various Control Devices in Mechatronics Systems	2	2	2	3	-	3	2

Legend: '3' for high, '2' for medium, '1' for low and '-' for no correlation of each CO with PO.

➤ **COURSE CURRICULUM DEVELOPMENT COMMITTEE**

GTU Resource Persons

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