GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Robotics and Autotronics
(Course Code: 4361105)

Diploma programmer in which this course is offered	Semester in which offered
Electronics and Communication Engineering	6th

1. RATIONALE

The syllabus for a diploma program in Robotics and Autotronics is designed to provide students with a comprehensive understanding of the principles, theories, and practical applications in the field of automotive electronics and robotics. The rationale behind such a curriculum is to make students aware of the necessary knowledge and skills to work in industries related to robotics and autotronics.

2. COMPETENCY

Competencies in the field of Robotics and Autotronics refer to the knowledge, skills, and attributes that individuals should possess to effectively work in this specialized domain. The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Maintain Robotics and Autotronics Systems**

3. COURSE OUTCOMES (COs)

After successful completion of the course, the students are able to

1 **Classify Different Types of Robots**
2. **Use Different types of Grippers, Drives, and Sensors in Robots**
3. **Use Various Sensors and Actuators in Automotive Applications**
4. **Discuss Various Types of Vehicle Control Systems**

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+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

Note: (*) 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 It is the responsibility of the institute heads that marks for CA of theory & ESE and CA of practical for each student are entered online into the GTU Portal at the end of each semester within the dates specified by GTU.

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

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the subcomponents of the Course Outcomes (Cos) Some of the **PrOs** marked **'*'** are compulsory, 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	Determination of maximum and minimum position of links of robot	1,2	02*
2	Estimation of accuracy, repeatability and resolution in robot	1,2	02*
3	Robot programming and simulation for pick and place application	1,2	02*
4	Robot programming and simulation for Shape identification	1,2	02
5	Robot programming and simulation for machining (cutting, welding) application	1,2	02
6	Robot programming and simulation for Color identification	1,2	02*
7	Robot programming and simulation for writing practice	1,2	02
8	Robot programming and simulation for any industrial process (Packaging, Assembly)	1,2	02
9	Robot programming and simulation for multi-process application	1,2	02*
10	Test the performance characteristics of temperature sensor in Engine	3	02*
11	Test the performance characteristics of pressure sensor in Engine	3	02*
12	Test the performance characteristics of airflow rate sensor in Engine	3	02*
13	Test the performance characteristics of Exhaust Gas Recirculation (EGR)	3	02*
14	Demonstrate the working of ECU (Engine Control Unit)	4	02*
15	Demonstrate the ABS operation when wheels are rotated at different speeds	4	02
16	Demonstrate the ABS operation when wheels are rotated at same speed	4	02
17	Measure the Various control signals in the ABS system	4	02
18	Perform On Board Diagnostics to diagnose various electronics components	4	02
19	Demonstrate the Airbag control system for driver and passenger safety	4	02
20	Demonstrate the OBD codes using ELM 327 Bluetooth based reader or scanner	4	02*
	Minimum 10 – 12 Practical Exercises		**24**

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.*

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.

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare of experimental setup	20
2	Operate the equipment setup or circuit	30
3	Follow safe practices measures	10
4	Record observations correctly	30
5	Interpret the result and conclude	10
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

Sr.No.	Equipment Name with Broad Specifications	PrO. No.
1	**Robot Simulator OR** **Axis Robotic Trainer** **Specification** ● Arm : Jointed Arm ● Axis : 6 ● Motor : Stepper Motor ● Gripper : Pneumatic ● Drive : Stepper Motor Drive ● Controller : Microcontroller **Base:** ● Angle of movement : 320º ● Gear Type : Spur Gear ● Position Detector : Limit Switch **Intermediate ARM:** ● Angle of movement : 90º ● Gear Type : Spur Gear, Worm Gear ● Position Detector : Limit Switch **Vertical ARM:** ● Angle of movement : 90º ● Gear Type : Spur Gear ● Position Detector : Limit Switch	1 to 9
2	Autotronics simulator software	10 to20
3	Multiport Fuel Injection engine with sensors, actuators and Electronic Control Module, Exhaust Gas Regulation valve and Positive Crankcase Ventilation valve; Make: Reputed manufacturers; Power: 25 KW @ 5000 rpm to 55KW@ 5000 rpm; Cubic Capacity: 1000 CC to 2000 CC	10 to 20
4	Scan tool: On Board Diagnostics (OBD) 2nd Generation Scan Tool, Controller area network enabled, Color Display, Operating Temperature: 0 to 50°C, Internal Storage: 4 AAA batteries, External Power: 7 to 18 volts; Generic tool; Accessories: Extender cable, OBD II Cable; Relevant optional accessories Common Rail Direct Injection Engine with sensors, actuators and Electronic Control Module; Make: Reputed manufacturers Cubic Capacity: 1300 cc to 2200 cc; Power: 55 KW to 100 KW A 4000 rpm.	10 to 20

7. 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 fulfill the development of this course competency.

a. Prepare the list of equipment required in the laboratory session.
b. Always follow safety measures
c. Work in a team.
d. Complete experiment within given time.
e. Adhere to laboratory guidelines.

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year.
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

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.

UNIT NO	MAJOR LEARNING OUTCOMES	TOPICS AND SUBTOPICS
1.Introduction and Basic Concepts of Robots	a) Classification of Robots b) Various Concepts/Terminology of Robot c) Comparison of the Robot Manipulator with the Human d) Advantages Disadvantages and applications of Robot	1.1 Definition of Robots, History and Laws of Robotics 1.2 Classification of robot based on Application, Kinematics/Locomotion, Power Source and Control Method 1.3 Describe three Basic subsystems of Robot. 1.4 Define joints, Links, and Degree of Freedom 1.5 Define Orientation Axis, Position Axis, Tool Center Point (TCP), Accuracy, Precision, Repeatability , Manipulator, Work Space, Stability , Speed, Payload, Reach, Settling Time 1.6 Compare various parts of robot manipulator with human's chief manipulators i.e. the arm and the hand. 1.7 List Advantages, Disadvantages and Applications of Robots
2.Components of Robots	a) GRIPPERS of Robots b) DRIVES Used in Robots c) Sensors and	2.1 Gripper Function, Classification of Gripper with advantages and disadvantages 2.2 Different Types of Drives used in Robot, Brief introduction to Pneumatics,

	Transducers used in Robots **d)** The 3 Basic Robot Programming Methods	Hydraulics and Electric Drive 2.3 Function of Sensors in Robot Different types of Sensor and transducer used in Robots (Sensors Classification i.e. Internal and External sensors, Touch sensors, Tactile sensor, Proximity and range sensors, Force sensor, Light sensors, Pressure sensors, optical encoders, velocity sensor) 2.4 Brief explanation of various properties to be measured and types of sensors used in robots. 2.5 Brief introduction to the 3 Basic Robot Programming Methods, Lead-through programming, Teach pendant programming, Offline programming
3. Automotive Sensors and Actuators	a) Working Principles of Various Automotive Sensors b) Working Principles of Various Automotive Actuators	3.1 Need of sensor and Actuators in Vehicle 3.2 Airflow Rate Sensor 3.3 Pressure Sensor 3.4 Crankshaft Position Sensor 3.5 Hall effect Position Sensor 3.6 Temperature Sensors 3.7 Throttle Angle Sensor 3.8 Exhaust Gas Oxygen Sensors 3.9 Automotive Engine Control Actuators- Fuel Injector, Exhaust Gas Recirculation (EGR) 3.10 Electric Motor Actuators - Brushless DC Motor and Stepper Motors
4. Vehicle Systems and System Diagnosis	a) Introduction to Control System b) Vehicle Motion Control System c) Vehicle Engine Control System d) Vehicle and passenger Safety Control System e) Vehicle On Board Diagnostics (OBD) System	4.1 Define System, Control System, Open Loop Control System and Closed Loop Control System with respect to the vehicle control 4.2 Block diagram of Engine Control Unit(ECU) 4.3 Block Diagram of Vehicle Ignition Control System 4.4 Block Diagram of Cruise Control System 4.5 Block Diagram of Antilock Braking System (ABS) 4.6 Block Diagram of Vehicle Air Bag System 4.7 Describe the Diagnostics procedure to diagnose errors in vehicle using OBD scanner

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN:

Unit No	Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	Introduction and Basic Concepts of Robots	07	06	06	03	15
2	Components of Robots	07	07	07	06	20
3	Automotive Sensors and Actuators	07	07	05	03	15
4	Vehicle System and System Diagnosis	07	07	07	06	20
	Total	28	27	25	18	70

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

Note: This specification table shall be treated as only general guidelines for students and teachers. The actual distribution of marks in the question paper may 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 evidence for their (student's) portfolio which may be useful for their placement interviews:

- Teacher guided tutorial exercises to solve problems based on all units.
- Visit to automobile workshop
- Visit to automobile and other factories using robot for welding and painting
- Visit science city (for catering robot)

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/subtopics.
b) Guide student(s) in undertaking micro-projects.
c) 'L' in section No. 4 means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About 20% of the topics/sub-topics which are relatively simpler or descriptive in nature can be given to the students for self-learning, but to be assessed using different assessment methods.
e) With respect to section No.10, teachers need to ensure to create opportunities and provisions for co-curricular activities.

12. SUGGESTED PROJECT LIST

1. Develop small robot
2. Develop ignition control circuit
3. Develop charger circuit for battery of vehicle
4. Develop flashing side indicator for vehicle
5. Develop OBD-II reader
6. Develop wireless digital code lock for car

13. SUGGESTED LEARNING RESOURCES

Sr No	Title of Book	Author	Publisher
1	Understanding Automotive Electronics- 7th Edition	Ribbens William B	Butterworth-Heinemann 2012
2	Robotics Technology and Flexible Automation	Deb S. R and Sankhs Deb	Tata Mc Graw Hill 2010
3	Robotics and Control	R.K.Mittal and I.J.Nagrath	Tata Mc Graw Hill 2005
4	Industrial Robotics	M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrey	Tata Mc Graw Hill Singapore 1996
5	Introduction to Robotics	S. K. Shaha	Tata Mc Graw Hill

14. SOFTWARE/LEARNING WEBSITES

- **https://www.automationinc.com/post/robot-programming-methods**
- **https://centerstage.vrobotsim.online/homepage.html**
- **https://cyberbotics.com/**
- **https://robotbenchmark.net/**
- **https://edasim.com/en/robotics-simulator**
- **http://www.roboanalyzer.com**

15. PO-COMPETENCY-CO MAPPING:

Semester VI	Robotics and Autotronics (Course Code: 4361105)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning

Competency	**Maintain Robotics and Autotronics Systems**						
Course Outcomes **CO1 Classify Different Types Robots**	3	1	1	2	1	-	3
CO2 Use Different types of Grippers, Drives, and Sensors in Robot	3	2	1	3	1	1	3
CO3 Use Various Sensors and Actuators in Automotive Applications	3	1	-	3	1	1	3
CO4 Discuss Various Types of Vehicle Control Systems	3	2	-	3	1	-	2

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

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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