GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2022) Semester – II

Course Title: Mechanical Engineering for Robotics
(Course Code: C4324103)

Diploma programme in which this course is offered	Semester in which offered
Automation and Robotics	2nd semester

1. RATIONALE

Now a days as an advancement of technology interdisciplinary knowledge is must for the engineering diploma holders. An engineering diploma holder expected to look after many activities at work place, which may be of interdisciplinary. Knowledge other than own discipline plays important role in the development of individual as well as society. This course mainly encompasses the major areas of mechanical engineering which are being used by engineering diploma holders and are required to perform tasks such as selection of hand tools, power tools, machining processes, automation, hydro-pneumatic devices/equipment, and material handling equipment used for various purposes. Such skills can be developed by knowing the basic principles of mechanical engineering. The motive of this subject is to enhance the knowledge & skill level in the interdisciplinary area. This course is designed in such a way that practical performed in this course will develop these basic skills to perform well in industry as well as in field work.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Apply basic principles of mechanical engineering in various engineering applications.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Use relevant mechanical power and hand tools in real life applications.
b) Select relevant power transmission mode in simple engineering situation.
c) Identify different automation system and components used in it.
d) Identify various hydro-pneumatic devices/equipment.
e) Select material handling equipment for given situations.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)	Total Credits (L+T+P/2)	Examination Scheme		
		Theory Marks	Practical Marks	Total

L	T	P	C	CA	ESE	CA	ESE	Marks
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 the 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. *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'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Use different hand, power tools for the given application	I	02*
2	Assemble/dismantle given power transmission setup.	I	02*
3	Identify basic machine tools and operations	I	02*
4	Fix different transmission elements between two parallel shaft systems (Bike, Cycle, Washing Machine, etc.)	II	02
5	Assemble/dismantle different brakes, clutches and couplings.	II	02*
6	Identify different automation system used in different machines used in day to day use.	III	02*
7	Dismantle different appliances used in day to day use and identify automation system used in it.	III	02*
8	Identify different application of given automation system.	III	02
9	Identify different automation system used in industrial automation.	III	02
10	Identify different pneumatic components used in pneumatic circuits	IV	02
11	Identify different hydraulic components used in hydraulic circuits	IV	02
12	Design a pneumatic circuit that extends and retracts a single acting (spring return) and double acting cylinder on a given training kit.	IV	02
13	Assemble a pneumatic circuit that extends and retracts a single acting (spring return) and double acting cylinder on a given training kit.	IV	02

14	Design a hydraulic circuit that extends and retracts a single acting (spring return) and double acting cylinder on a given training kit.	IV	02*
15	Assemble a hydraulic circuit that extends and retracts a single acting (spring return) and double acting cylinder on a given training kit.	IV	02*
16	Identify different material handling equipment.	V	02*
	Minimum 14 Practical Exercises #		**28 Hrs**

Note

i. (#)Minimum 14 (fourteen) practical have to be performed which is equal to 28 hours and it should be a proper mix of practical which cover all the units. ii. 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 of practical.*

iii. 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	Preparation of experimental set up.	20
2	Observation and recording.	20
3	Interpretation of result and conclusion.	20
4	Answer to sample questions.	10
5	Safety measures and good housekeeping.	10
6	Submission of report in time and attendance.	20
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's in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Hand tools - Different spanners (Wrench), Pliers, Screw drives, Chisel, Hand hacksaw, Hammers.	1
2	Power tools- Portable Drilling and grinding machine, power screw driver.	1
3	Working models of different belts in different arrangement.	2 , 3
4	Working models of belt drives, chain and sprocket, various gear drives.	2 , 3
5	Working and cut section models of various types of brake assemblies.	2 , 3 , 4
6	Models (Wooden/Plastic/Metallic) of various clutch (suitable for dismantling)	4
7	Models (Wooden/Plastic/Metallic) of various coupling.(suitable for dismantling)	4
8	Lathe machine, Drilling Machine, Grinding Machine	3
9	Various automation components	6,7,8,9
10	Automation trainer Kit	6,7,8,9
11	Hydraulic and Pneumatic trainer	11,12,13,14,15

12	Working models of material handling equipment	16

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) Work as a leader/a team member.
b) Maintain tools and equipment.
c) Follow safety Practices.
d) Practice good housekeeping.
e) Follow ethical practices.
f) Practice energy conservation.

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	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics

Unit – I **Basic Mechanical Tools and Components**	1a. Describe the significance of mechanical engineering in daily routine. 1b. Describe the procedure to Identify mechanical tools in general use. 1c. Use of different hand and power tools. 1d. Identify basic machine tools and operations. 1e.Describe the significance of Industry 4.0 in 21st century	1.1. Introduction of mechanical engineering. 1.2. Use of mechanical engineering a. In day to day life. b. Interdisciplinary use 1.3. Items in general use- identification criteria, major types, specifications and uses: such as bolts, nuts, washers, bearings, valves, bushes, springs, levers, o' rings, oil seals, shafts, axles. 1.4. Hand and power tools a. Types, specifications and uses of spanners (such as fix, ring, box, pipe, Allen, adjustable). b. Types, specifications and uses of hand tools (such as, Pliers, Screw drives, Chisel, Hand hacksaw, Hammers). c. Types, specifications and

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		uses of power tools (Portable Drilling and grinding machine, power screw driver) 1.5. Basic machine tools. a. Types and uses of lathe, drill, milling and grinding machines. 1.6. Industry 4.0, Fourth Industrial Revolution, Industry 4.0 Technologies
Unit – II **Power Transmission**	2a. Identify different mode of power transmission. 2b. Select suitable power transmission mode for given application. 2c. Identify the different types of Brake, Clutch and Coupling. 2d. Explain with sketches construction and working of given brake, clutch and coupling.	2.1. Power transmission: a. Importance. b. Modes (belt drives, chain drives and gear trains). c. Types of belt and belt drive. d. Types of gear and gear train. e. Applications. 2.2. Brakes, Clutch and Coupling. a. Classification. b. Construction and working. c. Application.

Unit– III **Introduction to Industrial Automation**	3a. Describe the benefits of the given industrial automation system. 3b. Describe function of the given components of automation system. 3c. Identify the type of automation system. 3d. Identify various automation system used in day to day used appliances. 3e. Identify the application of given automation system.	3.1. Need and benefit of industrial automation. 3.2. Automation hierarchy a. Basic components of automation system. b. Description of automation system components. 3.3. Type of automation system. a. Fixed. b. Programmable. c. Flexible 3.4. Different automation system used in appliances/ machines used in day to day life. 3.5. Different system of industrial automation.
Unit– IV **Hydraulic and Pneumatic Devices**	4a. Explain different fluid properties. 4b. Explain classification and application of pump and air compressor 4c. Describe working and application of other pneumatic/ hydropneumatic equipment.	4.1. Concept of theory of fluid flow. 4.2. General properties of fluids. 4.3 Pump and Air Compressor a. Classification b. Application. 4.4. Other hydraulic/pneumatic/ hydro-pneumatic equipment. a. working Principle of hydraulic lift, hydraulic pump, hydraulic power pack, hydraulic jack. b. application.

Unit	**Unit Outcomes (UOs)** (4 to 6 UOs at different levels)	**Topics and Sub-topics**
Unit– V **Material Handling Devices**	5a. Identify different material handling equipment. 5b. Describe the procedure for selecting relevant material handling equipment.	5.1. Need of material handling. 5.2. Types and applications of material handling equipment. a. Hoisting equipment. b. Conveying equipment. c. Surface & overhead equipment. d. Robot in material handling e. Earth moving machineries. 5.3. Criteria for selection of material handling equipment.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

	Unit Title		**Distribution of Theory Marks**

Unit No.		Tutorial Hours	R Level	U Level	A Level	Total Marks
I	Basic Mechanical Tools and Components	08	7	7	4	18
II	Power Transmission	05	5	5	2	12
III	Introduction to Industrial Automation Systems	07	7	7	4	18
IV	Hydraulic and Pneumatic Devices	04	5	5	2	12
V	Material Handling Devices	04	4	4	2	10
Total		**28**				70

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

Note: *This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions 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 vary slightly from above table.*

10. 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:

a) Student will visit the respective discipline industry / site and will prepare the list of mechanical engineering related equipment/machineries used by that industry / site.
b) Collect videos, animation showing working of various industrial automation systems.
c) Visit a nearby automation component shops and collect scrap components.
d) Prepare list of various components used in automation.
e) Collect videos, animation showing working of various hydro/pneumatic devices.
f) Visit a nearby industry and prepare a report on different types of material handling equipments.
g) Students will visit the industry and study different industrial automation components and submit the report.

11. 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 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 is to 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***.

f) Guide students on how to address issues on environment and sustainability

12. 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 microprojects 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 duration of the microproject should be about **14**- **16** ***(fourteen to sixteen) student engagement hours*** during the course. 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:

a) **Basic Mechanical Tools and Components:** Collect information on different Basic Mechanical Tools and Components used for robot manufacturing and automation setup from internet / industry.

b) **Gear**: Build model of different gears from cardboard.

c) **Hydraulic Device**: Collect leaflets of Hydraulic Device from market, analyze and compare specifications.

d) **Pneumatic Device**: Collect leaflets of Pneumatic Device from market, analyze and compare specifications.

e) **Pump:** Collect leaflets of pump from market and compare specifications.

f) **Industrial Automation:** Collect information on different Industrial Automation used in various industries.

g) **Material Handling Equipment:** Collect information on different material handling equipment used in power plant/ construction site/Mining industries/Process industries/heavy manufacturing industries/ship building industries/aircraft industries from the internet.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Theory of machine	R S Khurmi & J K Gupta	Eurasia Publishing House (Pvt.) Ltd. New Delhi,2020 ISBN: 9788121925242
2	Elements of workshop Technology (Vol. 1,2)	S.K. Hajra chaudhary A.K. Hajra chaudhary	Media promoters & publishers Pvt.Ltd. Mumbai,2010 ISBN:9788185099156
3	Fluid mechanics and hydraulic machines	R.K.Bansal	Laxmi publication Pvt.Ltd. New Delhi,2018 ISBN: 9788131808153
4	Material Handling equipment	N.Rundenko	Central Books Ltd,1970, ISBN: 978-0714702858

5	Thermal Engineering	R.K.Rajput	Laxmi Publication Pvt.Ltd. New Delhi,2018 ISBN:9788131808047
6	A Textbook of thermal Engineering	R. S. Khurmi & J. K. Gupta	S.chand Limited, New Delhi,2020, ISBN:9788121925730
7	Basic Mechanical Engineering	Pravin Kumar	Pearson Education ,India, 2018 ISBN: 9789386873293
8	Basic Mechanical Engineering	S. C. Sharma & M.P. Poonia	Khanna Publishing,2018 ISBN:9789386173331

14. SOFTWARE/LEARNING WEBSITES

- http:/nptel.iitm.ac.in/
- https://www.khanacademy.org/
- http://learnerstv.in/
- https://www.youtube.com/watch?v=DGST2NvATKI (Basic Mechanical tools)
- https://www.youtube.com/watch?v=eRfTZpEmnys&t=6s (Hand Tools)
- https://www.youtube.com/watch?v=RdipnvBPOKU (Power Tools)
- https://www.youtube.com/watch?v=r3f7klDFwrU (Gears)
- https://www.youtube.com/watch?v=EdiuTT7xzZg&t=144s (Power Transmission Mode)
- https://www.youtube.com/watch?v=MYhe3KSKKiU (Operations of lathe machine)
- https://www.youtube.com/watch?v=Um_g8sQ_p3Y (Manufacturing Processes)
- https://www.youtube.com/watch?v=xowQkxFXTNg (Automation)
- https://www.youtube.com/watch?v=uEhuxYXPTOE (Process Automation)
- https://www.youtube.com/watch?v=1BZpjKZ1G6c (Industrial Automation)
- https://www.youtube.com/watch?v=Um_g8sQ_p3Y (Manufacturing Processes)
- https://www.youtube.com/watch?v=BaEHVpKc-1Q (Pump)
- https://www.youtube.com/watch?v=7uI7G8csJSM (Pump)
- https://www.youtube.com/watch?v=VoUtTjtA5vE (Compressor)
- https://www.youtube.com/watch?v=M08LCcVAuUY (Material Handling equipment)

15. PO-COMPETENCY-CO MAPPING

Semester I & II	**Basics of Mechanical Engineering (Course Code: 4300017)**						
	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	**Apply basic principles of mechanical engineering in various engineering applications.**						

Course Outcomes CO							
a) Use relevant mechanical power and hand tools in real life applications.	3	1	1	3	2	1	3
CO b) Select relevant power transmission mode in simple engineering situation.	3	2	1	1	2	1	2
CO c) Identify different automation system available in different appliances/machines in day-to-day use.	3	2	1	1	2	1	2
CO d) Identify various hydro-pneumatic devices/ equipment.	2	2	1	2	1	2	2
CO e) Select material handling equipment for given situations.	2	2	1	1	2	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

Member – Board of Studies (GTU), Electrical and Allied branches

Prof. Suresh Z. Shyara, IC Engineering, AVPTI, Rajkot

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