GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Mechanical Engineering

Subject Code: DI04019021

Subject Name: Robotics, Automation and 3D Modeling Practice

w.e.f. Academic Year:	2025-26
Semester:	4th
Category of the Course:	Professional Core Courses

Prerequisite:	A basic understanding of mechanical and electrical engineering principles is essential for this course. Students should be familiar with fundamental mechanisms, engineering drawings, simple circuits, motors, and sensors. Basic computer skills and prior exposure to 2D drafting, preferably using AutoCAD, will support effective learning. Knowledge of simple programming logic in languages such as C or Python is beneficial but not mandatory. A foundation in mathematics, especially geometry and coordinate systems, is helpful for robot motion and 3D modelling tasks. Above all, learners should possess curiosity and interest in robotics, automation, and digital design to fully benefit from the practical activities.
Rationale:	The field of robotics, automation, and 3D modelling is rapidly advancing and has become an essential part of modern engineering and manufacturing industries. This practical course is designed to equip students with fundamental skills and hands-on experience required to work effectively with robotic systems and digital design tools. The course introduces students to the basics of robotics, including robot types, mechanisms, degrees of freedom, and industrial applications. Emphasis is placed on safety practices, understanding robot components, and exploring the role of sensors and actuators in real-world automation systems. Students learn to program robots using point-to-point and interpolated motions, enabling them to plan paths, optimize cycle times, and troubleshoot common errors, particularly in pick-and-place applications. In parallel, the course provides comprehensive training in 3D solid modelling using AutoCAD and parametric software. Through part modelling, assembly creation, and documentation, learners gain essential competencies in digital design and product development. The inclusion of a mini-project encourages creativity and practical integration of concepts, while industrial visits offer exposure to real automation environments. Overall, this course aims to develop technically skilled graduates capable of contributing to robotics, automation, and digital manufacturing sectors.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Understand the basic concepts, types, applications, and safety practices related to robotics and automation.
02	Recognize various robot components, mechanisms, degrees of freedom, and drive systems used in industrial robots
03	Identify and use different sensors and actuators essential for robotic operations and their interfacing.
04	Develop simple robot programs, plan robot motion paths, and troubleshoot common errors in pick-and-place robots
05	Create and assemble 3D mechanical models using AutoCAD and parametric software, demonstrating basic modeling and documentation skills.

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+(PR/2)	Assessment Pattern and Marks				
				Theory		Tutorial/ Practical		Total Marks
L	T	PR	C	ESE(E)	PA(M)	PA(I)	ESE (V)	
0	0	6	3	0	0	20	30	50

Course Content:

Unit. No.	Practical Units	Hrs	Weightage in %
1	**FUNDAMENTALS OF ROBOTICS & AUTOMATION** 1.1 Definition & scope of robotics. 1.2 Types of robots (SCARA, Cartesian, Cylindrical, Articulated). 1.3 Industrial applications (welding, painting, assembly, CNC automation). 1.4 Introduction to automation levels. 1.5 Lab safety, robot working envelope, PPE requirements.	06	7
2	**ROBOT MECHANISMS & COMPONENTS** 2.1 Robot structure: base, joints, links, actuators. 2.2 Joints: linear, rotary, spherical. 2.3 DOF concept & robot workspace. 2.4 End-effectors: grippers, suction cups, tools. 2.5 Drives: servo motor, stepper motor, pneumatic drives.	12	13

3	**SENSORS & ACTUATORS** Sensor basics: analog vs digital. 3.1 Types: proximity, IR, ultrasonic, encoders, limit switches, force sensors. 3.2 Actuator types: electrical, hydraulic, pneumatic. 3.3 Signal conditioning & interfacing.	12	13
4	**ROBOT PROGRAMMING** 4.1 Robot motion types: a. Point-to-point (PTP) b. Linear/Arc interpolation c. Creating program blocks. d. Variables, loops (if supported). 4.2 Industrial applications of Peak and Place robots. 4.3 Cycle planning, gripping force, path optimization of Peak and Place Robot. 4.4 Troubleshooting robot errors of Peak and Place robots. 4.5 PLC Programming	12	13
5	**3D Solid Modeling- I (AutoCAD)** 5.1 Recall the basic 2D modeling commands of AutoCAD and sketch basic component. 5.2 Introduction to 3D Modeling in AUTOCAD 5.3 Create and modify 3D models of mechanical components using AUTOCAD. Select Mechanical Components: Each student will select three mechanical components of moderate complexity to model. 5.4 Students will submit the completed models in relevant file format.	06	7
6	**3D Solid Modeling- II (Parametric 3D Models)** 6.1 Construct and modify 3D models of mechanical components using Parametric Software. Select Mechanical Components: Each student will select five mechanical components of moderate complexity having engineering features to model. 6.2 Students will submit the completed models in relevant file format.	12	13
7	**3D Modeling- III (Part Modeling and Assembly)** 7.1 Introduction to parametric assembly environment. Use types of mates with examples. 7.2 Prepare any one simple mechanical assembly comprised of 4-5 mechanical parts having engineering features. 7.3 Students will submit the completed models in relevant file	12	13

	format individually		
8	**Mini Project** 8.1 Assign any one project which includes part modeling, assembly and documentation 8.2 Example: Cotter Knuckle Joint, Wheel Base Assembly etc. 8.3 Teacher will assign mini project in 4-5 group of students. 8.4 Students will submit the completed models in relevant file format.	12	13
9	**Industrial Visit** Students will visit any relevant Automation and Robotics Industry.	06	6
		90	**100 %**

References/Suggested Learning Resources:

(a) Books:

1. Practical Autodesk AutoCAD 2023 and AutoCAD LT 2023
2. Engineering Design with Solid Works
3. Robotics and Industrial Automation By R K Rajput
4. Industrial Automation and Robotics By A.K.Gupta S.K.Arora
5. Introduction to robotics By Prof. Subair kumar Shah
6. Fundamentals of Robotics By Prof. Dilip Kumar Pratihar
7. Fundamentals of Robot Technology By D J Todd

(b)Open-sources of the are and website:

1. https://downloads.intelitek.com/PLTW/ROBOCELL/
2. https://intelitek.com/
3. https://convergent-it.com/robot-programming-demo/
4. https://cyberbotics.com/
5. https://www.robocamp.eu/en/lessons/demo/
6. https://instrumentationtools.com/download-free-robotics-software/
7. .. https://www.kuka.com/en-in/products/robotics-systems/software/simulation-planningoptimization/kuka_sim
8. Autodesk Inventor
   - Autodesk Inventor Learning Center: https://www.youtube.com/watch?v=iCnVZrzz1VI
   - Autodesk Inventor Documentation:https://www.autodesk.com/support/technical/product/inventor
   - Autodesk Inventor Tutorials: https://www.youtube.com/watch?v=KKbwf2a53bA
9. Dassault Systems SolidWorks
   - SolidWorks Tutorials: https://www.youtube.com/watch?v=E69EqFY2qMc
   - SolidWorks Tutorials: https://www.youtube.com/watch?v=CiBwrjUeB8U

- SolidWorks Help Center: https://www.solidworks.com/support/home ……

10. PTC Creo Parametric

- PTC Learning Community: https://community.ptc.com/
- PTC Creo Parametric Tutorials:
- https://support.ptc.com/help/creo/creo_pma/r10.0/usascii/tutorials_pma/pma_tutorials.html
- PTC Creo Parametric Documentation:
- https://support.ptc.com/images/cs/articles/2018/05/1525425932uNM3/tkuse.pdf

11. Fusion 360

- Autodesk Fusion 360 Learning Centre: https://help.autodesk.com/view/fusion360/ENU/courses/
- Fusion 360 Tutorials: https://www.youtube.com/watch?v=qvrHuaHhqHI
- Fusion 360 Help Centre: https://help.autodesk.com/view/fusion360/ENU

List of Laboratory/Learning Resources Required:

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

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Computer system with latest configuration.	All
2	Laser printer - plotter of A2/A3/A4 size. (any)	All
3	Related software. (Any parametric modeling software like Pro-E, SolidEdge, SolidWorks; Autodesk Inventor, Fusion-360).	All
4	Any available software (like V-REP, RoboDK etc.)	All
5	Robotic arm-6 axis robotic arm	All
6	Sensors, Grippers and Actuators	All

Suggested Activities for Students: If any

1. Bring Actual mechanical assembly from industry/real life/scrap shop/garage/etc. (made up of at least 4 to 5 mechanical components), dismantle the same, measure dimensions and sketch it to use the same for project

2. Visit design section of different industry and observe various hardware and software, procedure, standards they are following for designing a product.

3. Encourage participation in structured competitions These events often require teams to build and program robots to solve a specific, themed challenge, using a mix of design, building, and programming skills.

Any Other:

Other than the 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 groups 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.

- Massive open online courses (MOOCs) may be used to teach various topics/subtopics.
- Guide students on addressing the issues on environment and sustainability using the knowledge of this course
- Guide students for keeping the drawings in digital form and reduce use of paper.

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