GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Subject Code: ME02000871

Subject Name : Robotics and Automation

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	Nil
Rationale:	It is much tough to meet the global challenges especially in the field of automation and manufacturing to make impact in the global market. Robot intelligence is the most important & recent research area for the R&D in global competence to remain ahead. This course allows the student to have few concepts of basic knowledge of Robot kinematics, peripherals, programming & languages and intelligence keeping the manufacturing in centre.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
1	Classify and configure Industrial robot.
2	Develop kinematics and dynamics of Industrial Robot.
3	Examine robot cell design, programming for robot and economic aspects.
4	Dissect Automation and hardware for process control
5	Interpret automated production line.

Teaching and Examination Scheme:

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)	
3	0	2	4	70	30	30	20	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Robotics:**	08	20

	Brief history, robot technology, Basic Terminologies, classification, and characteristics, physical configuration, structure of industrial robot, Automation. Robot Drives, Grippers, Sensors, Actuators and Controls: Drives: Functions of Drive system, General types of fluids, Pump, Hydraulic and Pneumatic systems, Electrical drives, DC motors and transfer functions, AC motors, piezoelectric Actuators, Stepper motors, Drive Mechanisms. Grippers: Types of Grippers, Design aspect for gripper, Force analysis for various basic gripper systems including Mechanical, Robot Sensors: Robot Transducers and Sensors, Tactile sensor, Proximity and range sensors, Sensing joint forces, Robotic vision system, Image grabbing, Image processing and analysis, Image segmentation, etc. Design and control of sensor Integrated Dexterous robot hand.		
2.	**Kinematics and Dynamics of Robotics**: Transformation matrices and their arithmetic, link and joint description, Denavit Hartenberg parameters, frame assignment to links, direct kinematics. Dynamics: Introduction to Dynamics, Trajectory generations, Manipulator Mechanism Design.	06	14
3.	**Robot Cell Design:** Robot work cell design and control, Safety in Robotics, Robot cell layouts, Multiple Robots and machine interference, Robots cycle time analysis, Industrial application of robots.	06	14
4.	**Robot Programming:** Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SINGNAL AND DELAY commands, Branching capabilities and Limitations. Robot languages: Textual robot languages, Generation, Robot language structures, Elements in function.	06	12
5.	**Robotics application and advances:** Material transfer, Machine loading/unloading. Processing operation, Assembly and Inspection, Feature Application. Economical aspects for robot design, Safety for robot and associated mass, New Trends and recent updates in robotics, International Scenario for implementing robots in Industrial and other sectors. Future scope for robotization.	06	12
6.	**Automation:**	03	08

	Definition, Benefits of Automation, Types of automation, Typical Features and examples; Reasons for automating, Automation strategies, Automated flow lines, General forms of Workflow, Criteria for selection, Methods of work part transport, Transfer Mechanisms.		
7	**Hardware Components and Process Control:** Sensors, Actuators. Analogue to digital convertors, Digital to Analogue convertors, Input/Output devices for discrete data. Control system: Continuous and Discrete control, Computer process control: Logic control, Sequencing. Ladder logic diagrams, Programmable Logical control, Application of computer technology. Automatic identification and data capture: Bar code technology, RFID, AIDC technology.	06	14
8	**Automated Production Line:** System configuration, Work part transfer mechanism, Storage buffer and control, Application, and analysis of transfer lines. Automated Assembly Systems: Assembly System Configuration, Quantitative analysis of Assembly systems.	04	06
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	**10**	**25**	**20**	**25**	**10**

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

References/Suggested Learning Resources:

(a) Books:

1. Introduction to Robotics Analysis, Systems, Applications by Saeed B Niku PHI.
2. Fundamentals of Robotics Analysis and Control, Robert J Schilling, PHI.
3. K.S. Fu, R. C. Gonzalez and C.S.G. Lee, Robotics Control, Sensing, Vision and Intelligence, McGraw Hill, 2008.
4. M.P. Groover – "Automation, production systems and computer-integrated manufacturing"; Prentice-Hall of India Pvt. Ltd, New Delhi, 1989.
5. G. Boothroyd, C. Poli and L.E. Murch – "Automatic Assembly"; Marcel Dekker Inc., New York and Basel, 1982.
6. G. Boothroyd – "Assembly Automation and Product Design", Second Edition, Taylor & Francis, First Indian Edition – 2010

7. D. Richard, Klafter, and A. Thomas, Chmielewski, Michael Negin, Robotics Engineering-An Integrated Approach, Prentice-Hall of India Pvt. Ltd., 2009.
8. A. Ghosal, Robotics Fundamental Concepts and Analysis, Oxford University Press India, 2006.
9. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw -Hill, 2009.
10. M. P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey, Industrial Robotics Technology, Programming and Applications, McGraw Hill, Int. 2008.

(b) Open-source software and website:

1. Development of program for forward kinematics, Inward kinematics and trajectory planning for any small-scale industrial robot in nearby Industry/your own workshop.
2. Robot cell design using simulation software environment for any real-life application.
3. Development of mobile robot for applications like Material handling, Inspection, Pick and Place operations using sensors and basic robot peripherals.

Suggested Course Practical List:

Suggested list of experiments but not restricted to

1. Application of solid Modeling & Mechanism simulation using CAD software
2. Design of Robot cell using simulation software
3. To develop program for forward kinematics, inverse kinematics using various codes
4. Development of Composite Rotation Matrix.
5. Develop and arm matrix for Adept-1 SCARA robot.
6. Inverse Kinematics for Adept-I SCARA Robot.
7. Robot programming for Industrial application (Case study)

List of Laboratory/Learning Resources Required:

These experiments can be performed using

1. CAD Software like Pro-E, CATIA, UniGraphics, etc.
2. Robocell Design software available online
3. Programming using MATLAB, PROLOG.
4. Use of Control-X simulation Control of X-Y Position Table manually and thru Programming.
5. Use of Control-X simulation Control of Conveyor manually and thru Programming. Programming using sensors and conveyor.
6. Use of Control-X simulation Program for bottling plant experiment using Conveyer and Pneumatics
7. Use of P-Simulator design a pneumatic circuit using a double acting cylinder and 5/2 Air Spring Valve to open the main gate of a factory which can be controlled by a security personnel from the security room.

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