GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering
Subject Code: 3725001
Semester – II
Subject Name: Robotics and Artificial Intelligence

Type of course: Core IV

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.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
03	0	02	04	70	30	30	20	150

Content:

Sr. No.	Content	**Total Hrs**
1	Introduction: Brief history, robot technology, Basic Terminologies, classification, and characteristics, physical configuration, structure of industrial robot, Automation.	**02**
2	Robot Grippers: Types of Grippers, Design aspect for gripper, Force analysis for various basic gripper systems including Mechanical, Hydraulic and Pneumatic systems.	**04**
3	Robot Sensors: Transducers and Sensors, Sensors in Robot, Tactile sensor, Proximity and range sensors, Sensing joint forces, Robotic vision system, Image grabbing, Image processing and analysis , Image segmentation, etc.	**06**
4	Kinematics: 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	**08**
5	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.	**04**

6	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**
7	Robot application: Material transfer, Machine loading/unloading. Processing operation, Assembly and Inspection, Feature Application.	**02**
8	Introduction of AI: Concepts and definition of AI, AI Problems, The Underlying assumption, What is an AI technique?, AI characteristics, AI versus Natural Intelligence, Applications of AI, Etc.	**02**
9	Problems, Problem Spaces, and Search: Defining the Problem as State Space Search, Production Systems, Problem Characteristics, Production Systems Characteristics, Issues in the Design of Search Programs, Advantages and Disadvantages of DFS & BFS Techniques.	**04**
10	Heuristic Search Techniques: What is heuristic?, Heuristic Function, Importance of Heuristic Function, Introduction to Search Techniques: Generate – and – Test, Hill Climbing, Best-First Search, Problem reduction, Constraint – Satisfaction, Means- Ends Analysis.	**04**
11	Associated Topics in Robotics:- 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.	**03**

Suggested Specification table with Marks (Theory):

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

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference 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, obotics Control, Sensing, Vision and Intelligence, McGraw Hill, 2008.
4. D. Richard, Klafter, and A. Thomas, Chmielewski, Michael Negin, Robotics Engineering-An Integrated Approach, Prentice-Hall of India Pvt. Ltd., 2009.
5. A. Ghosal, Robotics Fundamental Concepts and Analysis, Oxford University Press India, 2006.

6. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw -Hill, 2009.
7. M. P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey, Industrial Robotics Technology, Programming and Applications, McGraw Hill, Int. 2008.
8. Timothy Jordanides et al, Expert Systems and Robotics, Springer –Verlag, New York, 2007.
9. S. K. Saha, Introduction to Robotics, Tata Mcgraw Hill Education Private Limited, 2008.
10. J. J. Craig, Introduction to Robotics: Mechanics and Control, 3/e, Pearson Education, 2009
11. Patrick H. Winston, Artificial Intelligence, 3rd Edition, Pearson.
12. Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.
13. Dan W. Paterson, Introduction to Artificial Intelligence and Expert System, PHI.
14. Ephraim Turban Jay E. Aronson, Decision Support Systems and Intelligent Systems PHI.
15. Elaine Rich, Kevin Knight, Artificial Intelligence, 2nd Edition, Tata MeGraw-Hill.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Appreciate the significance of robot in industry also design and make the robot for particular industrial problem.	20
CO-2	Acquire skills in understanding robot language its programming and task planning and problem solving.	30
CO-3	Develop skills in understanding various sensors, robot peripherals and their use & deployment in manufacturing system.	30
CO-4	Develop skills in identifying areas in manufacturing where robotics can be deployed for enhancing productivity	20

Term Work:
The term work shall be based on the topics mentioned above.

List of Experiments:

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. To develop the programs for:
   (1) Water Jug Problem,
   (2) Knights Tour,
   (3) Crypto Arithmetic Problems &
   (4) Implementing Searching algorithm.

Major Equipment:

These experiments can be performed using

1. CAD Softwares like Pro-E, CATIA, UniGraphics, etc.
2. Robocell Design softawares 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.

List of Open Source Software/learning 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.