GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3162418
Semester VI
Robotics

Type of course: Professional Elective Course
Prerequisite: Fundamental of engineering mechanics, Sensor & Transducer, Control systems.

Rationale: Robotics is an exciting and dynamic interdisciplinary field of study like manufacturing, medicine, power electronics and entertainment. So, it is very much important to learn robotics as the synergistic integration of mechanics, electronics, controls, and computer science. This subject is intended to make student aware with basics of robot sensors, controls and transformations along with essential kinematics and dynamics. This course therefore aims to build practical skills of making different robotic structure.

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)	
3	0	2	4	70	30	30	20	150

Contents:

Sr. No	Topics content	Teaching Hours	Module Weightage
1	**Introduction:** Basics of 'robot' and 'robotics', origin of robotics, different types of robotics, Connections between robotics and Artificial intelligence, Flexible manufacturing systems, factory automation, computer-aided manufacturing, various generations of robots, Structural elements of manipulators, Degrees of freedom and number of joints, The distinction between arms and vehicles.	05	10
2	**Locomotion:** Key issues for locomotion, Legged Mobile Robots, Leg configurations and stability, Wheeled Mobile Robots, Wheeled locomotion: the design space, case studies.	05	10
3	**Geometric Configurations and Actuator for Robots:** The distinction between arms and vehicles, Degrees of freedom and number of joints, Construction and types of joints, Robot transporters and work piece positioners, Tension structures, Pneumatic actuation, Hydraulic actuation, Electric actuation, Mechanical transmission methods, Speed/Inertia reduction etc..	06	12
4	**Sensors and Intelligent Robots:** Introduction to robotic sensors, Sensor classification, characterizing sensor performance, Wheel/motor sensors, heading sensors, Ground-based beacons, Active ranging Motion/speed sensors Vision-based sensors, Representing Uncertainty, Feature Extraction.	06	12
5	**Arduino for Robotics:** Interfacing Arduino, User Control, Sensor Navigation, Orientation (Positioning), Non-Autonomous Sensors.	06	12
6	**Mobile Robot Vehicles:** Wheeled Mobile Robots, Car-Like Mobile Robots, Non-holonomic and Under-Actuated Systems, Flying Robotics.	06	12
7	**Applications of Industrial Robots:** Robots in Power Electronics applications, Machine loading, Spot welding, Arc welding, Cutting, Inspection, Types of robots for assembly, Artificial	08	16

	intelligence, Integration of industrial robots into the workplace etc.		

Suggested Reading:

1. Fundamentals of Robot Technology, An Introduction to Industrial Robots, Teleoperators and Robot Vehicles by Todd, D. J., 1st edition 1986.
2. Introduction to Autonomous Mobile Robots, Roland Siegwart, and Illah R., Nourbakhsh, The MIT Press, Cambridge, Massachusetts, London, England. 2004,
3. Arduino Robotics, John-David Warren, Josh Adams, Harald Molle,2011.

Reference Books:

1. Robotics, Vision and Control Fundamental Algorithms In MATLAB® Second Edition, Peter Corke, School of Electrical Engineering and Computer Science, Queensland University of Technology (QUT), Brisbane QLD 4000, Australia.
2. Robotics, Vision and Control: Fundamental Algorithms in MATLAB by Peter Corke, Springer pub, 1st edition, 2011.
3. Robots and manufacturing Automation by C Ray Asfahl, John Wiley, 1992.
4. Introduction to Robotics by McKerrow Phillip.John, Addison Wesley, Australia, 1991.
5. Control in Robotics and Automation: Sensor Based Integration (Engineering) B. Ghosh, T. J. Tarn, Ning Xi, Academic Press.
6. Robotics and Control by R. K. Mittal, I. J. Nagrath, Tata-Mcgraw Hill, 2003.
7. Introduction to Autonomous Mobile Robots by Ronald C. Arkin, The MIT Press Cambridge, Massachusetts London, England1998,

Course Outcome: After learning this course, the students should be able:

Sr. No.	CO statement At the end of this course, students will demonstrate the ability to	Marks % weightage	Topics covered
CO1	learn the mathematics of rigid motions, rotations, translations, velocity kinematics.	30	1,2
CO2	evaluate the various parts of mechanical and electronic system of robots.	20	3
CO3	learn about robot sensors	20	4,5
CO4	familiar with computer vision, visual servo control problems and applications in the industry	30	6,7

The following are suggested list of experiments based on theme:

1. To study different drivers for robotic arms.
2. To simulate simple robotic system using MATLAB/ MSC Adam software etc.
3. To study robot transporters and work piece positioners.
4. A software program for simple and inverse kinematics of simple robot configuration.
5. To simulate joint torque control of manipulator.
6. To model the robot dynamics using Euler-Langrangian method and to simulate the same.
7. To study feedback control/ adaptive control of robot manipulator.
8. To study speed control of stepper motor using microcontroller.
9. To study various robot applications.
10. To study about the robotic programming language like AL and AML.

Major Equipment: Robotic kits, computers, open source software, etc.

List of Open Source Software/learning website:

1. http://nptel.ac.in/courses/112101099/
2. http://nptel.ac.in/courses/112101098/