NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	B Tech Electronics and Instrumentation Engineering
Semester:	VI
Course Code:	
Course Title:	Autonomous Robot Control
Course Type:	Department Elective - II
Year of Introduction:	2025-26

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Course Learning Outcomes (CLOs):

At the end of the course, students will be able to –

1. understand the basic components of autonomous robot **(BL2)**
2. illustrate properties of robotic hardware useful in autonomous robots **(BL3)**
3. analyze deployment strategies for autonomous robots **(BL4)**
4. perform system level analysis and design for robotics applications **(BL5)**

Unit	Contents	Teaching Hours (Total 45)
Unit-I	**Introduction** Fundamental of traditional robots, anatomy and classification of robot, advancement in robots.	02
Unit-II	**Fuzzy control in robotics** Introduction to Fuzzy Logic Systems, comparison: fuzzy control vs classical control, structure of a fuzzy logic controller (FLC), fuzzification process in robotics, designing linguistic variables for robot control, rule base formation for robotic tasks, inference mechanism and decision making, defuzzification techniques for robotic outputs, fuzzy control in mobile robot navigation, fuzzy-based obstacle avoidance techniques, speed and direction control using fuzzy logic, manipulator joint control with fuzzy rules, fuzzy logic in human-robot interaction, case studies: industrial and service robots control using fuzzy.	12
Unit-III	**Introduction to autonomous land vehicles** Introduction to autonomous mobile robots, concept of various levels of vehicle autonomy, application of differential drive and omni drive robots, use of ackerman steering controlled vehicle, concept of adaptive cruise control on autonomous land vehicle, ACC system cases for vision based automated vehicle, lane keep assist feature-based control, features of advance driver assist system for robotic vehicle, case study scenario of intelligent autonomous driving vehicles.	08
Unit-IV	**AI-driven perception** LIDAR and depth camera integration, AI-based image processing for object detection, feature extraction from sensor data, semantic segmentation for environment understanding, real-time obstacle detection and avoidance, classical SLAM techniques, AI-based SLAM implementation, sensor fusion for accurate mapping, AI-assisted dynamic path replanning, handling static and dynamic obstacles.	08

Unit-V	**Autonomous driving and control** Autonomous cruise control principles, lane detection using AI models, traffic cone and road sign recognition, speed adaptation with AI inference, AI-based decision-making in traffic scenarios, adaptive path planning and speed adaptation using deep learning inference models, behaviour planning for overtaking and autonomous parking, ROS-based real-time data handling.	**10**
Unit-VI	**Adaptive control strategies** Develop an adaptive control algorithm for autonomous ground vehicles operating in dynamic environment, study real-time adjustments of steering angles, speed, and trajectory based on sensor feedback and AI-based predictions.	**05**

Self Study:

The self -study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Suggested Readings/ References:

1. Nikolaus Correll, Bradley Hayes, Adam Tow, Introduction to Autonomous Robots, CRC Press.
2. Gabe Sibley, Dylan Campbell, Derek Rose, Visual SLAM: From Theory to Practice Mobile Robots: Navigation, Control, and Remote Sensing, Springer.
3. Joe Jones, Daniel Roth, Bradley Hayes, Robot Programming: A Practical Guide to Behavior-Based Robotics, CRC press.
4. Robin R. Murphy, Introduction to AI robotics, MIT press.

Suggested List of experiments:

Laboratory work will be based on the above syllabus with a minimum 09 experiments/exercises to be incorporated. The students in a suitable group size will design and perform one experiment as a part of laboratory work.

(Only for Information)

Sr No.	Name of Experiments/Exercises	Hours
1.	To analyze motion control using distance sensor	**(02Hrs)**
2.	To demonstrate working of autonomous robotic sensor	**(02Hrs)**
3.	To demonstrate working of different range sensor	**(02Hrs)**
4.	To study feature extraction using vision sensor	**(02Hrs)**
5.	To learn and demonstrate working of 360-degree LIDAR sensor	**(02Hrs)**
6.	To demonstrate working of camera for navigation	**(02Hrs)**
7.	To determine path localization using position sensor	**(02Hrs)**
8.	To learn path planning algorithm using wheeled mobile robot	**(02Hrs)**
9.	To learn road sign recognition-based robot navigation	**(02Hrs)**
10.	To demonstrate collision avoidance for robot using camera	**(02Hrs)**
11.	To demonstrate sensor-based navigation on Jet-rover mobile robot	**(02Hrs)**
12.	To implement AI camera-based interaction task for object tracking	**(02Hrs)**