

## NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	B Tech Electronics and Instrumentation Engineering
Semester:	V
Course Code:	
Course Title:	Fundamentals of Robotics
Course Type:	Core
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 principles and working of devices and elements for robotics. (BL2)
2. select and apply various sensors and actuators for robotic systems. (BL4)
3. formulate solution algorithm related to robotic automation system. (BL5)
4. perform system level analysis and design for robotics applications. (BL6)

Unit	Contents	Teaching hours (Total 45)
<b>Unit- I</b>	<b>Introduction</b> multi-disciplinary scenario, electromechanical systems, components and modules, examples of robotics in mechatronics field.	<b>02</b>
<b>Unit-II</b>	<b>Robot sensors and perception</b> Overview of sensors, proprioceptive and exteroceptive sensors, distance sensors, all types of proximity and ranging sensor, motion and vision sensors, robot system with LIDAR and RADAR sensors, global positioning sensor for navigation, types of encoders, application-based examples of encoders used in robotic with industrial systems, other robotic sensors and its applications.	<b>08</b>
<b>Unit-III</b>	<b>Robot actuation system</b> Study of actuation systems using servo motors and servomechanism control for robotic applications, motion control techniques for legged robots, humanoid robots, and robotic arms based on servo configurations, movement generation in multi-joint robotic arms and synchronized walking in quadruped robots and humanoid robots, application-based analysis of robotic arm-based warehouse pick-and-place operation, humanoid imitation, and quadruped walking and object tracking tasks.	<b>08</b>
<b>Unit- IV</b>	<b>Mobile robotics</b> Types of holonomic and non-holonomic wheeled mobile robot, different types of drive-trains, various mobile robotic platform, kinematic model, different types of motion control for wheeled robots, flow chart and control algorithm for various mobile robot platforms, wheeled robot maneuverability techniques for navigation control, case studies of various mobile robot used in industries.	<b>10</b>

<b>Unit- V</b>	<b>Vision guided robotic automation</b> Study and use of AI cameras along with other sensors for vision-based robotic task control, object detection, object tracking, face recognition, number and tag recognition and line-following applications in robots. logic development using flowcharts and scratch-based programming language for vision-guided automation task, case studies on warehouse sorting using robotic arm with camera, autonomous object transportation and sorting system using multi-robot cooperation, implementation of adaptive cruise control in mobile robot using sensors for autonomous vehicle following and distance regulation. basics of SLAM based mapping and navigation robotic system.	<b>12</b>
<b>Unit- VI</b>	<b>Mobile robot projects</b> Obstacle avoidance using range sensors, human following robot using vision system, navigation control of autonomous vacuum cleaner bot, case study of autonomous land vehicle.	<b>05</b>

**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. Harry H. Poole, Fundamentals of Robotics Engineering, Springer Publication.
2. Roland siegwart, Introduction to autonomous mobile robot, PHI Learning Pvt Ltd.
3. Gregory dudek, Computational principle of mobile robotics, Cambridge University press.
4. Richard Grimmer, Arduino Robotic Projects, Packt Publishing Limited.

**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)**

<b>Sr.</b>	<b>Name of Experiments/Exercises</b>	<b>Hours</b>
1.	To demonstrate working of encoder sensor	(02 Hrs)
2.	To demonstrate working of range sensor	(02 Hrs)
3.	To demonstrate working of AI camera for object detection and line tracking	(02 Hrs)
4.	To learn and demonstrate working of 360-degree LIDAR for 2D plane	(02 Hrs)
5.	To implement and test adaptive cruise control (ACC) using mobile robot	(02 Hrs)
6.	To learn motion control algorithm for six wheeled mobile robots	(02 Hrs)
7.	To develop scratch-based control logic for autonomous driving demo using mobile robot	(02 Hrs)
8.	To demonstrate pick-and-place operation using AI camera for color-based object sorting	(02 Hrs)
9.	To implement warehouse object sorting using conveyor belt and AI camera integration	(02 Hrs)
10.	To demonstrate trajectory motion control for omni wheeled mobile robot	(02 Hrs)
11.	To demonstrate sensor-based navigation on Lego mobile robot platform	(02 Hrs)
12.	To implement AI camera-based interaction task for following color object or human face	(02 Hrs)