NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	B. Tech.in Electronics and Instrumentation Engineering
Semester:	V
Course Code:	3EI301ME24
Course Title:	Fundamentals of Robotics
Course Type:	Departmental Elective-I
Year of Introduction:	2024-25

L	T	Practical component				C
		LPW	PW	W	S	
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Course Learning Outcomes (CLOs):

At the end of the course, the 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 path planning and navigation **(BL5)**
4. perform system level analysis and design for robotics applications **(BL6)**

Unit	Contents	Teaching hours (Total 45)
Unit- I	**Introduction** multi-disciplinary scenario, electromechanical systems, components and modules, examples of robotics in mechatronics field.	02
Unit- II	**Robot sensors and perception** Overview of sensors, proprioceptive and exteroceptive sensors, distance sensors, heading sensor, all types of proximity and ranging sensor, motion and vision sensors, robot system with LIDAR and RADAR sensors, inertial measuring unit, purpose of sensor for localization and tracking, global positioning sensor for path planning, types of encoders, application-based examples of encoders used in robotic with industrial systems, other robotic sensors and its applications.	12
Unit- III	**Robotic actuators** Types of robot motors, working of various motors for robot application, motor drives and motor controllers for speed control, interfacing with DC geared motor, servomechanism, servo motor drive control, motor configurations with different drive-trains.	05
Unit- IV	**Mobile robotics** Types of holonomic and non-holonomic wheeled mobile robot, Different types of drive-trains, various mobile robotic platform, kinematic model, odometry based pose system, different types of motion control for wheeled robots, motion control of legged robot and humanoid robot, flow chart and control algorithm for various mobile robot application, obstacle avoidance techniques, wheeled robot maneuverability techniques for navigation control, case studies of various mobile robot used in industries.	10
Unit- V	**Navigation system in robotics** Robotics systems with control, introduction to simultaneous localization and mapping (SLAM), navigation architecture, robot programming related to navigation algorithms, feature extraction using range sensor data, robotic environment interaction, case studies of intelligent navigation algorithms, logic development using scratch codes for robotic applications.	10

Unit-VI **Mobile robot projects** **06**

Obstacle avoidance using range sensors, gesture controlled robotic vehicle, working of outdoor mobile robot, navigation control of autonomous vacuum cleaner bot, case study of autonomous land vehicle.

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.

Laboratory Work:

This shall consist of at least 10 practical based on the above syllabus.

Suggested Reading:

1. Harry H. Poole, Fundamentals of Robotics Engineering, Springer
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 Grimmett, Arduino Robotic Projects, Packt Publishing Limited

Suggested List of Experiments (not restricted to the following):
(Only for Information)

1.	To demonstrate working of encoder sensor	**(02 Hrs)**
2.	To demonstrate working of range sensor	**(02 Hrs)**
3.	To study feature extraction using range sensor data	**(02 Hrs)**
4.	To learn and demonstrate working of 360 degree LIDAR for 2D plane	**(02 Hrs)**
5.	To determine path localization using position sensor	**(02 Hrs)**
6.	To learn path planning algorithm using six wheeled mobile robot	**(02 Hrs)**
7.	To learn path planning using six-legged hexapod robot	**(02 Hrs)**
8.	To demonstrate collision avoidance for robot navigation	**(02 Hrs)**
9.	To demonstrate robot programming algorithm on mobile robot platform	**(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 demonstrate and implement SLAM algorithm on robotic platform	**(02 Hrs)**

L = Lecture, T = Tutorial, P = Practical, C = Credit

w.e.f. the academic year 2024 - 25 and onwards