NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	Master of Computer Application (2-Years Programme)
Course Code:	3MCAD369
Course Title:	Robotics
Course Type:	Departmental Elective
Year of Introduction:	2021-22

Credit Scheme

L	T	Practical Component				C
		LPW	PW	W	S	
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Course Learning Outcomes (CLO):

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

1. interpret mathematical concepts to model robot manipulators and mobile robots
2. deduce trade-off between different sensors, actuators and their processing algorithms
3. relate the computational challenges inherent in fundamental mobile robotic tasks
4. create the robotic environment with appropriate algorithms

Syllabus: **Total Teaching hours: 45**

Unit	Syllabus	Teaching hours
Unit-I	**Introduction:** Robotics, Robot mechanical structure, Industrial robotics, Robot modelling, Planning and control	04
Unit-II	**Robot Kinematics:** Position analysis, Differential motions and velocities, Trajectory planning	07
Unit-III	**Actuators and Sensors:** Joint actuating system, Drives, Proprioceptive sensors, Exteroceptive sensors, Sensor processing algorithms, Visual Servoing	08
Unit-IV	**Control Architecture:** Introduction, Control dynamics, Motion control, Force control	08
Unit-V	**Localization and Mapping:** Introduction to localization, Kalman filters, Monte Carlo localization, Introduction to mapping and Simultaneous Localization and Mapping (SLAM), Occupancy grid mapping, Grid-based FastSLAM, GraphSLAM	10
Unit-VI	**Path Planning and Navigation:** Classic path planning, Sample-based and probabilistic path planning, Obstacle avoidance	08

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. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani and Giuseppe Oriolo, Robotics: Modelling, Planning and Control, Springer
2. Klafter R. D., Thomas A Chmielewski and Michael Negin, Robotics Engineering: An Integrated Approach, Prentice Hall
3. Mittal and Nagrath, Robotics and Control, Tata McGraw-Hill

4. Craig John, Introduction to Robotics, Mechanics and Control, Pearson Education
5. Siegwart, R., Nourbakhsh, I. R., & Scaramuzza, D. Introduction to Autonomous Mobile Robots, MIT press
6. Nehmzow, U. Mobile Robotics: A Practical Introduction. Springer
7. Jaulin, L., Mobile Robotics, Elsevier
8. Kelly, A., Mobile Robotics: Mathematics, Models, and Methods. Cambridge University Press

Suggested List of Experiments:

Sr. No.	Title	Hours
1	To get familiarize with Gazebo tool and learn the various features of the tool for simulating various robot applications	02
2	To use Gazebo to simulate a robotic environment comprised of a building to house your future robot.	02
3	To use the Robot Operating System (ROS) to design the first mobile robot capable of moving from source to destination.	04
4	To use the Monte Carlo Localization algorithm in ROS, in conjunction with sensor data and a map of the world, to estimate a mobile robot's position so that the robot can answer the question "Where am I?"	04
5	To add the capability to identify the robot's orientation so that it answers the questions regarding it present orientation	02
6	To use a ROS SLAM package and simulated sensor data to create an agent that can both map the world around it, and localize within it.	04
7	To simulate a home service robot that can map, localize, and navigate to a specific location.	02
8	To simulate a home service robot that can sense the surrounding environment and avoid collision.	02
9	To program your robot such that it can chase a ball placed in the given visual field.	04
10	To simulate a home service robot that can transport objects, moving from one room to another autonomously.	04

Suggested Case List: -NA-