Course Title: Introduction to Robotics	**Course Code:** 444 (CSE/SWE/CIS/ETE/EEE)	**Prerequisite Course:** Digital Electronics, Digital Logic Design, Micro-controller, Programming
Credit: 3.0	**Implicit Lab**	**Theory Hour:** 1.5 **Lab Hour:**1.5

Description:

Definition of Robot, Types of Robots (manipulator, legged robot, wheeled robot, autonomous underwater vehicles), Use of Robots, Asimov's laws of Robotics, History of Robotics, Key components of Robot, Sensors: Introduction, working principles and use of sensors (vision, force, LDR, temperature, smoke, accelerometer gyroscope, laser, titlt, compass, PIR, Infrared etc), Actuators and different actuators (DC motor, servo motor, stepper motor etc) working principles and usage, Robot programming with AD conversion and interfacing different hardware, sensors etc, Control theory of robotics; Obstacle avoidance, object tracking and motion control etc; Advance robotic control and operations.

Intended Learning Outcomes:

The module will be open to anyone having all the prerequisite courses with an interest in robotics and a desire to understand how to program robots to make them do useful tasks.

By the end of the course, student will be able to:

- Explain what robots are and what they can do;
- Knowledgeably discuss the ethical considerations of using robots to help solve societal challenges;
- Reflect on the future role and development of robotics in human society;
- Intuitively explain what does sensors and actuators do and how they can be used according to the specifications of the problem and nature of the environments;
- Write appropriate robot programs by understanding the nature of the sensors, and actuators
- Implementstate-of-the-art algorithms for solving robotic tasks;
- Describe mathematically the odometry and the control mechanism for robot manipulation;
- Apply the mathematical, algorithmic and control principles of autonomous mobile robots to implement a working robot through physical construction and software development.

Program Outcome:

- Introduction to Robotics course will strengthen the mathematical, analytical, and synthesis skills of the students which are vital for any engineering student
- This course will enable the students to build software by understanding the hardware
- This course will enrich the knowledge of sensors, actuators and processors, helping them to easily involve with embedded systems and internet of things (IOT) technologies for further study or research
- Most importantly, as a software engineer, they will not only be able to write program for software applications but also hardware applications, providing them the completeness in the field of Software Engineering.

Tools:

- Aurduino Board and other related micro-controllers

Week	Course Content	Lesson Outcomes	Teaching Learning Strategy	Assessment Strategy
Week 1	**Theory Session 1:** Definition of Robot, Types of Robots (manipulator, legged robot, wheeled robot, autonomous underwater vehicles, unmanned aerial vehicles), Use of Robots, Asimov's Laws of Robotics, History of Robotics **Lab Session 1:** Installation of Proteus ISIS software and get introduced with electronic components	Able to acquire the knowledge of introductory robotics	Lecture and Video Sharing	Quiz
Week 2	**Theory Session 2:** Key Components of a Robot, Introduction and Working Principles of Sensors (vision sensor, force sensor, light dependent resistor (LDR), temperature sensor, smoke sensor, accelerometer gyroscope, laser sensor, tilt sensor, compass) **Lab Session 2:** Simulating sensors in Proteus ISIS	Able to explain the components of robots and sensors	Lecture, Interaction and Group Discussion	Course Project Assign
Week 3	**Theory Session 3:** Introduction and Working Principles of Sensors **(**infrared transmitter-receiver, infrared sensor array, PIR sensor, sonar sensor**)** **Lab Session 3:** Simulating sensors using Micro-controller in Proteus ISIS	Able to differentiate among the sensors and understand the working principles	Lecture, Interaction and Group Discussion	Class Test 1
Week 4	**Theory Session 4:** Introduction and Working Principles of Actuators (DC motor, servo motor, stepper motor) **Lab Session 4:** Simulating actuators by reading the sensor data and taking rule-based decisions using Micro-controller in Proteus ISIS	Able to explain the difference between motors and understand the working principles	Lecture, interaction and Group Discussion	Presentation-1 on Course Project

Week 5	**Theory Session 5:** Interfacing Hardware (Motor Driver, ADC, Op-Amp) and Micro-controllers **Lab Session 5:** Hardware implementation of sensors, actuators, micro-controller, and programming the hardware	Able to understand the necessity of interface hardware and the basics of micro-controllers	Lecture, interaction and Group Discussion	Class Test 2
Week 6	**Theory Session 6:** Robot Programming (loop, register, signal, rule-based modeling) **Lab Session 6:** Manipulating the real robot for different purposes	Able to acquire the knowledge of basic micro-controller programming	Lecture, interaction and Group Discussion	
Week 7	**Theory Session 7:** Robot Programming (analog to digital conversion (ADC), interrupt, timer) **Lab Session 7:** Manipulatingthe real robot using ADC and interrupt	Able to know the usage of ADC, interrupt and timer	Lecture, interaction and Group Discussion	Presentation 2 on Course Project
Week 8	**Theory Session 8:** **Robot Programming (**Pulse Width Modulation (PWM) and motor speed control using PWM) **Lab Session 8:** Speed Control of the real-robot using PWM	Able to implement PWM for motor speed control	Lecture, interaction and Group Discussion	
Mid-term Examination				
Week 9	**Theory Session 9:** Wireless Communication (RC module and Bluetooth module interfacing with micro-controller, Teleoperation of Robot) **Lab Session 9:** Teleoperation of the real robot using RC/Bluetooth Module	Able to acquire the knowledge of wireless modules and teleoperation	Lecture, interqaction and Group Discussion	

Week 10	**Theory Session 10:** Control Theory of Robotic Systems (feedback control, PID controller) **Lab Session 10:** Manipulating the robot using PID Controller and making it autonomous	Able to understand the error-correctiontechniques using feedback	Lecture, interaction and Group Discussion	Class Test 3
Week 11	**Theory Session 11:** Control Theory of Robotic Systems (robot odometry, differential drive and navigation) **Lab Session 11:** Installation of V-Rep EDU Software and introduction to simulated robots, scripts and objects	Able to calculate the pose of a robot and navigate the robot using differential drive strategy	Lecture, interaction and Group Discussion	Presentation 3 on Course Project
Week 12	**Theory Session 12:** Obstacle avoidance/tracking for mobile robots **Lab Session 12:** Basic script writing, sensor reading and wheel velocity controlling for obstacle avoidance/tracking using V-Rep)	Able to understand the obstacle avoidance/tracking principle and write program according to sensor data	Lecture, interaction and Group Discussion	Course Project Demo
Week 13	**Theory Session 13:** Motion Planning Strategies for Static Environments, Implementation of Motion Planning Algorithms **Lab Session 13;** Simulation of the robot and implementing the motion planning algorithms	Able to acquire the knowledge of motion planning and enable the robot plan by itself	Lecture, interaction and Group Discussion	
Final Examination				

Recommended Books

Text Books:

1. **Introduction to Robotics: Analysis, Control, Applications, By Saeed B. Niku, 2nd Edition**
2. **Introduction to Autonomous Robots: Kinematics, Perception, Localization and Planning, By ENikolausCorrell, 1st Edition**
3. **Aurduino Robotics by John David Warren, Apress, 2011**