Course Code: ELE-602
Course Title: Robotics

Number of Credits: 04 **Total Hours: 60** **Total Marks: 100**
Effective from AY: 2022-23

Prerequisites for the course		
Should have knowledge of Basic electronics hardware, Mathematics, and programming.		
Objectives of Course		
This course is intended to: ● Introduce robotics and the key elements and constituents of a robot; science and technology in robots; ROS. ● Understand and explain the various elements of the robotic system. ● Study all necessary kinematics and various analysis techniques. ● Understand the robot dynamics and control theory. ● Give exposure to futuristic robotic technologies.		
Course Content		
Unit I	**Introduction**	**10 Hours**
Introduction- Brief history, types, classification and usage, growth; Robot applications- Manufacturing industry, defense, rehabilitation, medical, etc.; Laws of Robotics; Introduction to ROS		
Unit II	**Elements of robots**	**12 Hours**
Links, joints, actuators, and sensors; Position and orientation of a rigid body, Homogeneous transformations; Representation of joints, link representation using D-H parameters, Examples of D-H parameters, and link transforms; Different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor; Types of transmissions; Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge-based force-torque sensors, proximity, and distance measuring sensors, and vision sensors.		
Unit III	**Kinematics**	**07 Hours**
Direct and Inverse Kinematics; Kinematics of serial robots: Direct and inverse kinematics problems, Inverse kinematics of constrained and redundant robots, Tractrix-based approach for fixed and free robots and multi-body systems; Kinematics of parallel robots: direct and inverse kinematics problems, Mobility, Stewart-		

Gough platform, Degrees-of- freedom of parallel mechanisms and manipulators, Active and passive joints.		
Unit IV	**Velocity and static analysis**	**05 Hours**
Linear and angular velocity of links, Manipulator Jacobians for serial and parallel manipulators; Statics of serial and parallel manipulators, Statics and force transformation matrix of a GoughStewart platform, Singularity and Statics analysis.		
Unit V	**Robot Dynamics & Controls**	**10 Hours**
Robot dynamics equation; General procedure for dynamics equation forming and introduction to control; Actuator dynamics and PD, PID control for robots; Trajectory tracking control; Lyapunovs theorems; Neural network control design		
Unit VI	**Robotics Applications**	**09 Hours**
Introduction, development, and working of: UAV, Drone, Humanoid Robots & Underwater robot		
Unit VII	**Futuristic Robots**	**07 Hours**
Introductions to MEMS (micro-electro-mechanical systems), Introduction to Cognitive Robotics and Human-Robot Interaction, Robots in Space & Defense applications		
Case Studies:		
1. Development of obstacle avoidance and line following robot. 2. Implementation of ROS. 3. Simulation of robotic trajectories. 4. Drone-based image analysis.		
Pedagogy		
Lectures/Experiential Learning		
Course Outcome		

Students will:

- Gain knowledge of the basic concepts in robotics, ROS, key elements, and constituents of the robotic system.
- Learn the kinematics of serial and parallel robots and will be able to perform various analyses.
- Understand the various robotic dynamics and control designs.
- Able to understand and develop robotic systems.
- Have an update on the latest robotic research & technologies.

References/Readings

1. Ghosal, A., 'Robotics: Fundamental Concepts and Analysis', Oxford University Press, 9th reprint, 2013
2. Robert J Schilling, 'Fundamentals of Robotics', Prentice Hall India, 1st ED, 2003
3. John J Craig, 'Introduction to Robotics', Prentice Hall International, 3rd ED, 2005
4. Jitendra R. Raol, Ramakalyan Ayyagari, 'Control Systems: Classical, Modern, and AI-Based Approaches', CRC Press, 1st ED, 2019
5. Gao, Yang, 'Space Robotics and Autonomous Systems', Institution of Engineering & Technology, 2021
6. Lentin Joseph, Aleena Johny, 'Robot Operating System (ROS) for Absolute Beginners', 2nd ED, 2022

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