

Semester:	6				
Course Code:	EE5600				
Course Name:	Robotics				
Credit Value:	3 (Notional hours =150)				
Pre-requisites:	EE3010				
Core/Optional	Optional				
Hourly Breakdown	Lecture	Tutorial	Practical	Assignment	Independent Learning & Assessment
	32	8	6	4	100

Course Aim: To provide understanding of representing, modelling, analysis, control design and implementation of mobile robots and industrial robots.

Intended Learning Outcomes:

On successful completion of the course, the students should be able to:

- **represent** mobile robots and industrial robots using standard tools.
- **model** mobile robots and industrial robots mathematically.
- **analyze** navigation and localization of mobile robots.
- **design** kinematic control and dynamic control for industrial robots.
- **control** mobile robots and industrial robots.

Course Content:

➤ **Position and Orientation**

Introduction to robotics; Representing Position and Orientation; Representing Pose in 2-Dimensions, Representing Pose in 3-Dimensions, Representing Orientation in 3-Dimensions, Combining Translation and Orientation.

➤ **Time and Motion**

Trajectories; Smooth One-Dimensional Trajectories, Multi-Dimensional Case, Multi-Segment Trajectories, Interpolation of Orientation in 3D, Cartesian Motion.

Time Varying Coordinate Frames; Rotating Coordinate Frame, Incremental Motion, Inertial Navigation Systems.

➤ **Mobile Robot Vehicles**

Mobility; Mobile Robot Kinematics, Car-like Mobile Robots, Moving to a Point, Following a Line, Following a Path, Moving to a Pose, Flying Robots

➤ **Navigation**

Reactive Navigation; Braitenberg Vehicles, Simple Automata

Map-Based Planning; Distance Transform, D*, Voronoi Roadmap Method, Probabilistic Roadmap Method

➤ **Localization**

Dead Reckoning; Modeling the Vehicle, Estimating Pose

Using a Map; Creating a Map; Localization and Mapping; Monte-Carlo Localization.

➤ **Robot Arm Kinematics**

Describing a Robot Arm;

Forward Kinematics; 2 to 6 DOF Robots,

Inverse Kinematics; Closed-Form Solution, Numerical Solution, Under-Actuated Manipulator, Redundant Manipulators

Trajectories; Joint-Space Motion, Cartesian Motion, Motion through a Singularity, Configuration Change

Advanced Topics; Joint Angle Offsets, Determining Denavit-Hartenberg Parameters, Modified Denavit-Hartenberg Notation

➤ **Velocity Relationships**

Manipulator Jacobian; Transforming Velocities between Coordinate Frames, Jacobian in the End-Effector Coordinate Frame, Analytical Jacobian, Jacobian Condition and Manipulability

Resolved-Rate Motion Control; Jacobian Singularity, Jacobian for under-Actuated Robot, Jacobian for over-Actuated Robot

Force Relationships; Transforming Wrenches between Frames, Transforming Wrenches to Joint Space

Inverse Kinematics using a numerical approaches

➤ **Dynamics and Control**

Equations of Motion; Gravity Term, Inertia Matrix, Coriolis Matrix, Effect of Payload, Base Force, Dynamic Manipulability

Drive Train; Friction

Manipulator joint control; Actuators, Independent joint control, Rigid-Body dynamics, Compensation, Flexible transmission dynamics;

Teaching /Learning Methods:

Lecturers, Tutorials, Practical Work, and Assignments

Assessment Strategy:

Continuous Assessment 30%	Final Assessment 70%		
Details: Assignments/Quizzes 15% Laboratory Practical classes 15%	Theory (%) 70	Practical (%)	Other (%)
<p>Recommended Reading:</p> <ul style="list-style-type: none"> ➤ Peter Corke, Robotics Vision and Control: Fundamental Algorithms in MATLAB, 2nd Edition, Springer Publications, ISBN 978-3-319-54413-7 ➤ Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Robot Modelling and Control, 1st Edition, John Wiley & Sons, Inc., ➤ Roland Siegwart, Introduction to Autonomous Mobile Robots, Intelligent Robotics and Autonomous Agents series 			