Short Syllabus

BCSE421L Robotics: Kinematics, Dynamics and Motion Control (3-0-0-3)

Introduction, Spatial Descriptions and Transformations – Fundamentals, robot components, mechanics & control of mechanical manipulators, Spatial Descriptions and Transformations, Operators, Representation & Orientation; Manipulator Kinematics - Inverse Manipulator Kinematics - Velocities and Static Forces - Manipulator Dynamics - Manipulator-Mechanism Design - Motion Control Systems - Actuators, drive systems and sensors in robotics.

Course Code	Course Title	L	T	P	C
BCSE421L	Robotics: Kinematics, Dynamics and Motion Control	3	0	0	3
Pre-requisite	NIL	Syllabus Version 1.0			

Course Objectives:

1. To summarize and analyze the fundamentals of robotics.
2. To introduce students the kinematics and dynamics of robots.
3. To elucidate students the types of motion control.
4. To familiarize students with the basic techniques of designing the robots.

Course Outcomes:

After the completion of the course, student will be able to:

1. Comprehend, classify and analyze the fundamentals of robotics.
2. Analyze the inverse manipulator kinematics and dynamics.
3. Gain the knowledge about the manipulator design and mechanism.
4. Elucidate the role of actuators, drive systems and sensors in robotics.

Module:1	**Introduction, Spatial Descriptions and Transformations**	**7 hours**
Introduction: Fundamentals and robot - components, joints, degrees of freedom, coordinates. The mechanics & control of mechanical manipulators. Spatial Descriptions and Transformations: Descriptions – Positions, Orientations, and Frames, Mappings, Operators – Translations, Rotations, and Transformations, Transformation arithmetic and transform equations, transformation of free vectors, Representation & Orientation.		
Module:2	**Manipulator Kinematics**	**4 hours**
Manipulator Kinematics: Links & Connections. Actuator Space, Joint Space and Cartesian Space. Tools & Computational considerations.		
Module:3	**Inverse Manipulator Kinematics**	**5 hours**
Solvability, Algebraic and Geometric. Standard Frames, Repeatability and Accuracy. Jacobians: Velocities and Static Forces: Time varying position and orientation.		
Module:4	**Velocities and Static Forces**	**5 hours**
Linear and rotational velocity of rigid bodies. Jacobians & Singularities. Cartesian transformation of velocities and static forces.		
Module:5	**Manipulator Dynamics**	**7 hours**
Mass Distribution. Newton's and Euler's Equations. Iterative and Closed Form. Lagrangian formulation of manipulator dynamics. Manipulator Dynamics in Cartesian Space. Non-rigid body effects.		
Module:6	**Manipulator-Mechanism Design**	**7 hours**
Kinematic Configuration. Workspace measures and attributes. Redundant and closed chain structures. Actuation Schemes, Stiffness & Deflections. Position Sensing & Force Sensing.		
Module:7	**Motion Control Systems**	**7 hours**
Basic components & terminology. System Dynamics. Laplace transform and inverse Laplace transform. First and second order transfer functions. Proportional and proportional plus controllers. State space control methodology. Digital control and non-linear control systems.		
Module:8	**Contemporary issues**	**3 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. John J. Craig, "Introduction to Robotics Mechanics and Control", Pearson Education Limited 2022,
2. Saeed B. Niku, "Introduction to Robotics Analysis, Control, Applications", John Wiley & Sons Ltd 2020.

Reference Books			
1.	Nicholas Odrey, Mitchell Weiss, Mikell Groover, Roger Nagel and Ashish Dutta. “Industrial Robotics-Technology, Programming and Applications”, McGraw Hill Education; 2nd edition, 2017.		
Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).			
Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022