Name of the Programme: M.Sc. in Artificial Intelligence
Course Code: CSI-523
Title of Course: Robotics
Number of Credits: 4 (2L-2T-0P)
Effective from AY: 2023-24

Prerequisites for the course	Linear Algebra, Set Theory, Complex Analysis, Matrices	
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.	
Theory:	**Module:1 Fundamentals** Introduction – Components, Degrees of Freedom, Joints, Coordinates, Mechanisms, Controller. **Module:2 Kinematics** Position and Orientation of Objects, Coordinate Transformation, Joint Variables and Position of End Effector, Inverse Kinematics Problem, Jacobian Matrix, Statics and Jacobian Matrices. **Module:3 Dynamics** Lagrangian and Newton-Euler Formulations, Derivation of Dynamics Equations Based on Lagrangian Formulation, Derivation of Dynamic Equations Based on Newton-Euler, Formulation, Use of Dynamics Equations and Computational Load, Identification of Manipulator Dynamics. **Module:4 Manipulability** Manipulability Ellipsoid and Manipulability Measure, Best Configurations of Robotic Mechanisms from Manipulability Viewpoint, Various Indices of Manipulability, Dynamic Manipulability. **Module:5 Position Control** Generating a Desired Trajectory, Linear Feedback Control, Two-Stage Control by Linearization and Servo Compensation, Design and Evaluation of Servo Compensation, Decoupling Control, Adaptive Control. **Module:6 Force Control** Impedance Control - Passive-Impedance Method, Active-Impedance Method-One- Degree-of- Freedom Case, Active-Impedance Method-General Case. **Module:7 Hybrid Control** Hybrid Control - Hybrid Control via Feedback Compensation, Dynamic Hybrid Control.	5 hours 5 hours 5 hours 5 hours 5 hours 3 hours 2 hours
Practicals to be discussed and implemented during the Tutorial Slots:	1. Assignment on introduction to Robot Configuration. 2. Demonstration of Robot with 2 dof, 3 dof, 4 dof etc. 3. Two assignments on programming the Robot for some simple real life applications. 4. Two assignments on programming the Robot for applications in Val II. 5. Two programming exercises for robots. 6. Two case studies of applications in industry. 7. Exercise on robotic simulation software.	3 hours 2 hours 5 hours 5 hours 5 hours 5 hours 5 hours

Pedagogy	Lectures/Practical/ Tutorials/Assignments	
References/ Readings	**Text Book(s)** 1. Tsuneo Yoshikawa, "Foundations of Robotics Analysis and Control", The MIT Press Cambridge, 1990. 2. Saeed B Niku, “Introduction to Robotics Analysis, Control, Applications”, 3rd Edition, Wiley, 2020. **Reference Books** 1. Robert J. Schilling, “Fundamentals of Robotics, Analysis and Control”, Prentice Hall India, 2003. 2. John J. Craig, “Introduction to Robotics, Mechanics and Control”, 3rd Edition, Pearson Prentice Hall, 2005.	
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 kinematics in robots. 3. Gain knowledge about the dynamics of robots. 4. Elucidate the motion control in robotics.	

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