University School of Automation and Robotics
GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY
East Delhi Campus, Surajmal Vihar
Delhi - 110092

Paper Code: ARA 203
Subject: Introduction to Robotics

L	T/P	Credits
4	-	4

Marking Scheme

1. Teachers Continuous Evaluation: 25 Marks
2. End Term Theory Examination: 75 Marks

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks : 75**

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 15 marks.
3. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 15 marks.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required

Course Outcomes:

CO1:	Ability of students to implement the mechanisms of robot along with its grippers. Furthermore to understand kinematics of robot using DH representation
CO2:	Ability of students to utilize the differential motion and velocities of robot using jacobian.
CO3:	Ability of students to use the dynamic analysis of forces using Lagrangian and Newtonian method.
CO4:	Ability of students to implement the online and offline programming of robots.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping (Scale 1: Low, 2: Medium, 3: High

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	3	3	2	1	-	1	3	1	2
CO2	3	3	3	3	3	1	1	-	2	3	1	2
CO3	3	3	3	3	3	1	1	-	3	3	2	3
CO4	3	3	3	3	3	3	2	-	3	3	2	3

Unit I **[10]**

Fundamentals of Robot Technology: Robot definition, automation and robotics, Robot anatomy, Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission

End effectors: Mechanical and other types of grippers, Tools as end effectors, Robot and effector interface, Gripper selection and design.

Sensors and actuators used in robotics: Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots

Unit II **[10]**

Kinematics of Robots: Transformation Matrices, Inverse transformation matrices, Forward and Inverse kinematic equation for position and orientation, Denavit-Hartenberg representation of robot, inverse kinematic solution for articulated robot, Numericals.

Differential Motions and velocities: Jacobian, Differential motions of a frame, Differential motion between frames, Calculation of the Jacobian, Inverse Jacobian, Numericals.

Approved by BoS of USAR: 1/08/22

Approved by AC subcommittee: 20/08/22

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Unit III

Dynamic analysis of Force: Lagrangian and Newtonian mechanics, Dynamic equations form multiple –DOF Robots, Static force analysis of Robots, Transformation of forces and moments between coordinate frames, Numericals. **[10]**

Trajectory Planning: Basics of Trajectory planning, Joint space trajectory planning, Cartesian Space trajectories, Numericals.

Unit IV

Robot Programming languages & systems: Introduction, the three levels of robot programming, requirements of a robot programming language, problems peculiar to robot programming languages. **[10]**

Off-line programming systems: Introduction, central issues in on-line and offline programming, Programming examples.

Application of robots: Typical applications of robots in material transfer, machine loading/unloading; processing operations; assembly and inspection.

Text Books

1. Saha, S. K. (2014). *Introduction to robotics*. Tata McGraw-Hill Education.
2. Mittal, R. K., & Nagrath, I. J. (2003). *Robotics and control*. Tata McGraw-Hill.
3. Fu, K. S., Gonzalez, R., & Lee, C. G. (1987). *Robotics: Control Sensing. Vis*. Tata McGraw-Hill Education.
4. Niku, S. B. (2001). *Introduction to robotics: analysis, systems, applications* (Vol. 7). New Jersey: Prentice hall.

Reference Books

1. Spong, M. W., & Vidyasagar, M. (2008). *Robot dynamics and control*. John Wiley & Sons.
2. Choset, H., Lynch, K. M., Hutchinson, S., Kantor, G. A., & Burgard, W. (2005). *Principles of robot motion: theory, algorithms, and implementations*. MIT press.
3. Bhaumik, A. (2018). *From AI to robotics: mobile, social, and sentient robots*. CRC Press.

Approved by BoS of USAR: 1/08/22

Approved by AC: 29/08/22

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