Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF ENGINEERING & TECHNOLOGY

Effective from Academic Batch: 2022-23

Programme: **Bachelor of Technology (Mechanical Engineering)**

Semester: **VI**

Course Code: **202090610**

Course Title: **Robotics**

Course Group: **Professional Elective Course – II**

Course Objectives: To impart widespread acquaintance of robotic system along with different configurations, their kinematics, singularity problems, dynamics, Motion planning and real field applications of them.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	0	2	4	50 / 18	50 / 17	25 / 9	25 / 9	150 / 53

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Introduction to Robotics:** Brief History, Definition, Robot Anatomy, Three laws, Classification of robots, Robot terminologies: work volume, Degree of Freedom, resolution, accuracy, repeatability, dexterity, compliance, payload capacity, speed of response etc. Wrist assembly, Joint notations, Selection criteria of any robot, Industrial applications of robot, Futuristic robotics.	06
2	**Robot drive systems, End effectors and Automation:** Types of drives: Hydraulic drives, Pneumatic and Electric drives. DC servo motors, stepper motors and AC servo motors – Salient features and applications. Comparison of all drives End effectors. Types of grippers – Mechanical Grippers, Magnetic, vacuum, pneumatic and hydraulic gripper, Selection, and design consideration of grippers.	07
3	**Robot sensor and Machine vision:** Need for sensors, types of sensors used in robotics, Classification and applications of sensors, Characteristics of sensing devices, selections of sensors, Robot vision setup (RVS), block diagram, components, working of RVS, Human vision vs. Robot vision, Applications of RVS.	03

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4	**Robot Kinematics:** Direct Kinematics, Kinematic Modelling of the Manipulator; Denavit Hartenberg (DH) Representation; Inverse Kinematic; Manipulator Workspace, Solvability of inverse kinematic models: Existence of Solution, Multiplicity of Solutions; Solution Techniques, Guidelines for Closed form Solution.	**08**
5	**Velocities & Statics :** Cross Product Operator for kinematics, Jacobians - Direct Differentiation, Basic Jacobian, Jacobian Jv / Jw, Jacobian in a Frame, Jacobian in Frame {0}, Kinematic Singularity.	**06**
6	**Robot Dynamics :** Introduction to Dynamics, Lagrangian formulation of manipulator dynamics, dynamic simulation, computational consideration.	**06**
7	**Motion Control :** Path versus Trajectory, Joint space versus Cartesian space descriptions, Point to Point Control, trajectory generation, Continuous Path Control, Force Control, hybrid position/force control system.	**06**
8	**Robot Applications:** Industrial, Material Handling, Processing, Assembly : Peg in hole, Compliance, Inspection, Surgical, Space and Military applications; Principles for robot application and application planning.	**03**
	Total	**45**

List of Practicals / Tutorials:

1	Introduction of Robotic system, various configurations and DOF calculations.
2	Basic robot Joints and its simulation using Robo Analyzer Software.
3	Direct kinematics for open/closed loop configurations analytically/simulation/coding.
4	Inverse kinematics for open/closed loop configurations analytically/simulation/coding.
5	Coding/simulation of direct kinematics for open/closed loop configurations along with workspace generation using MATLAB.
6	Formulation of DH parameters of robot configuration and its simulation using Robo Analyzer Software.
7	Lagrangian formulation of the given configuration along with its coding/ validation using simulation software.
8	Newtonian formulation of the given formulation along with its coding/ validation using simulation software.
9	Design of trajectory for a specific task as given by instructor.
10	Simulation/ performance of a trajectory planning of a robot.

Reference Books:

1	Introduction to Robotics, S K Saha, Tata McGraw Hill
2	Robotics and control, R K Mittal, I J Nagrath, Tata McGraw Hill
3	Introduction to robotics, John J Craig, Pearson/Prentice Hall
4	Introduction to Robotics: Analysis, Control, Applications , Saeed Niku, John Wiley & Sons
5	A Robot Engineering Textbook , Mohsen Shahinpoor, Harper and Row, Publisher, New York

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6	Industrial Robotics, Technology, Programming and Applications, Mikell P Groover, Tata McGraw Hill

Supplementary learning Material:	
1	NPTEL resources

Pedagogy:

- Direct classroom teaching
- Audio Visual presentations/demonstrations
- Assignments/Quiz
- Continuous assessment
- Interactive methods

Internal Evaluation:

The internal evaluation comprised of written exam (40% weightage) along with combination of various components such as Certification courses, Assignments, Mini Project, Simulation, Model making, Case study, Group activity, Seminar, Poster Presentation, Unit test, Quiz, Class Participation, Attendance, Achievements etc. where individual component weightage should not exceed 20%.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20%	30%	25%	10%	10%	5 %	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	To understand basic terminologies and anatomy of Robot.	**25**
CO-2	Learn various types of hardware used in Robot.	**20**
CO-3	To understand the use of DH Parameters for forward and Inverse Kinematics.	**25**
CO-4	Learn various approaches for dynamics of robotic system and their Motion planning.	**20**
CO-5	To understand Realtime applications of robot systems.	**10**

Curriculum Revision:	
Version:	2
Drafted on (Month-Year):	June-2022
Last Reviewed on (Month-Year):	--
Next Review on (Month-Year):	June-2025

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