PARUL UNIVERSITY - Faculty of Engineering and Technology

Department of CSE – Robotics and Artificial Intelligence

SYLLABUS for 3rd Sem BTech PROGRAMME

Fundamentals of Robotics

Type of Course: BTech

Prerequisite: Engineering Mathematics, Engineering Physics, Computational thinking and structure development

Rationale: Fundamentals of Robotics introduces students to the essential concepts, such as sensors, actuators, control systems, and robot architecture. The structure of robotic systems is understood in the context of the mechanical, electronic and programming domain. This foundational knowledge is critical for understanding how robotic systems operate and can be controlled in real world case scenarios. To end the subject, we move towards the basis of robot kinematics. The Coordinate Systems, Transformations & Basic Robot Motion are few of the topics which will benefit the student into preparing necessary knowledge for studying the robotic kinematics.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/	Tut Hrs/	Lab Hrs/ Week		T	P	T	CE	P	
3	0	2	3	60	-	20	20	-	100

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Content:

Sr.	Topic	Weigh tage	Teaching Hrs.
1	**Foundational Prerequisites for Robotics**: Matrix and vector operations, Basic coordinate geometry: Cartesian plane, points, lines, and angles, Introduction to transformation matrices and rotations. Fundamental mechanics: force, torque, energy, and work. Basic kinematics: motion (linear and rotational) and equilibrium. Fundamentals of logical sequencing and algorithmic thinking What is robotics? Historical perspective and evolution Introducing basic classifications and applications of robots	20%	10
2	**Introduction & Historical Evolution of Robotics:** **Defining Robotics:** Clarify what robotics entails in modern industry and research. Establish the scope of mechanical, electrical, and computational components. **Historical Timeline:** Milestones from early automatons to modern intelligent systems. Impact of industrial and technological revolutions. **Applications and Case Studies:** Overview of industrial, healthcare, service, and research robots. Discussion on ethics and societal impact.	15%	8
3	**Robotic Components & Architecture: Mechanical Components:** Structure types: articulated, mobile, humanoid, etc. Joints and linkages—how physical motion is enabled. **Sensors & Actuators:** Types of sensors (proximity, vision, environmental) and their roles. Different actuation systems (electric, pneumatic, hydraulic).	25%	10

	Embedded Systems Overview: Basic operating principles of microcontrollers and integrated circuits. How hardware elements interconnect within a robot.		
4	**Systems & Control Fundamentals:** **Control Theory in Robotics:** Contrast open-loop versus closed-loop control. Feedback principles and the conceptual overview of PID controllers. **Embedded Control Systems:** electronic circuits and sensors integration to form a control system. Case examples of sensors feeding data to actuators.	20%	8
5	**Coordinate Systems, Transformations & Basic Robot Motion:** Coordinate Systems: Cartesian space versus joint space. Basic techniques for transitioning between coordinate systems. Rigid Body Transformations: Introduction to homogeneous transformation matrices, examples demonstrating rotations and translations. Degrees of Freedom (DOF): Concept of DOF in robots and its impact on movement capabilities. How joint configurations define a robot's ability to navigate and manipulate.	20%	9

Course outcome:

1) Gain a clear understanding of foundational mathematical, mechanical, and computational concepts necessary for robotics, including matrix operations, kinematics, and logical sequencing.
2) Develop an in-depth knowledge of robotics, including its historical evolution, fundamental classifications, and diverse applications across industries, with an awareness of ethical and societal implications.
3) Demonstrate the ability to identify and explain key components of robotic systems, such as mechanical structures, sensors, actuators, and embedded systems, and their interconnections.
4) Explore and analyze the principles of control theory, including open-loop and closed-loop systems, and learn to apply feedback mechanisms for robotic control using embedded systems.
5) Apply the concepts of coordinate systems, transformations, and degrees of freedom to analyze and describe robot movement and manipulation.

Books:

1. Introduction to Robotics By S. K. Saha | Mc Graw Hill publication
2. Fundamentals of Robotics, Analysis & Control by Schilling By Robert J., | Prentice Hall of India.
3. Introduction to Robotics, Mechanics and Control By John J. Craig, Addison Wesley.
4. Introduction to Robotics: Analysis, Systems, Applications By A. B. Niku | Prentice Hall
5. Theory of Machine By R. S. Khurmi and J. K. Gupta | S. Chand