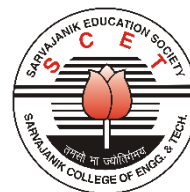




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**Sarvajani College of Engineering and Technology**  
**Bachelor of Technology**



**B. Tech. Semester VI**

**Subject Name:** Robotics and Navigation

**Subject Code:** BTEC14619

**Type of course:** PEC

**Prerequisite:** Knowledge of microprocessor/microcontroller hardware, programming concept in C, Control theory

**Rationale:** With this course, students will get aware with basics of robot sensors, controls and transformations along with essential kinematics and dynamics. It is therefore need of the day for students to learn Robotics for working in modern industry. This course therefore attempts to build required skills to understand the basic principles, design, analysis, and synthesis of robotics system.

**Teaching and Examination Scheme:**

| Teaching Scheme |   |   |   | Theory Marks |     |     | Practical Marks |     | Total |
|-----------------|---|---|---|--------------|-----|-----|-----------------|-----|-------|
| L               | T | P | C | TEE          | CA1 | CA2 | TEP             | CA3 | 150   |
| 3               | 0 | 2 | 4 | 60           | 25  | 15  | 30              | 20  |       |

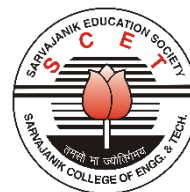
**CA1:** Continuous Assessment (assignments/projects/open book tests/closed book tests) **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

**Content:**

| Sr. no. | Topics  | Teaching Hrs. | Module % Weightage |
|---------|---|---------------|--------------------|
| 1.      | <b>Introduction to Robotics:</b> History of robots, Classification of robots, Present status and future trends. Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Mechanisms and transmission, End effectors, Grippers-different methods of gripping, Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, Cam type gripper, Magnetic grippers, Vacuum grippers, Air operated grippers; Specifications of robot | 6             | 15                 |
| 2.      | <b>Direct And Inverse Kinematics:</b> Mathematical representation of Robots - Position and orientation – Homogeneous transformation- Various joints- Representation using the DenavitHattenberg parameters -Direct kinematics-Inverse kinematics- SCARA robots- Solvability – Solution methods-Closed form solution.  | 12            | 25                 |
| 3.      | <b>Path Planning:</b> Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning   | 12            | 20                 |



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|           |  |    |    |
|-----------|--|----|----|
| <b>4.</b> | <b>Robot Programming:</b> Classification of programming Languages, ROS Basics-ROS Equation, History of ROS, Sensors and Robots Supporting ROS, ROS Architecture and Concepts, Ubuntu Linux for Robotics-Ubuntu Graphical User Interface, Shell Commands, C++ and Python for Robotic Programming- | 10 | 25 |
| <b>5.</b> | <b>Case Study:</b> Bio-Inspired Robotics, Human-Robot Interaction, Picking, Packing and Palletizing, AI for Interpreting Complex Data, Agriculture, Consumer Applications, Logistic and Transport applications, Computational Intelligence in Robotics, Multi-Robot Systems                      | 5  | 15 |

**Suggested Specification table with Marks (Theory/Practical):**

| % Distribution of Marks |         |         |         |         |         |
|-------------------------|---------|---------|---------|---------|---------|
| R Level                 | U Level | A Level | N Level | E Level | C Level |
| 10                      | 25      | 25      | 20      | 20      | 0       |

**Legends:** **R:** Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **E:** Evaluate **C:** Create and above Levels (**Revised Bloom’s Taxonomy**)

**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.

**Reference Text Books:**

| Sr. No. | Title of book /article                                    | Author(s)                      | Publisher and details like ISBN                  | Year of publication | Publication Edition |
|---------|---|--------------------------------|--|---------------------|---------------------|
| 1.      | Introduction to Robotics, Analysis, Control, Applications | S B Niku                       | Wiley Publication                                | 2015                | 2 <sup>nd</sup>     |
| 2.      | Introduction to Robotics                                  | S. K. Saha                     | Tata McGraw Hill Education Pvt. Ltd., New Delhi. | 2015                | Latest              |
| 3.      | Robotics and Control                                      | R. K. Mittal, I. J. Nagrath    | Tata McGraw-Hill Publishing Company Ltd          | 2015                | Latest              |
| 4.      | Learning Robotics Using Python                            | Learning Robotics Using Python | Packt Publishing                                 | 2015                | 2 <sup>nd</sup>     |

**Course Outcome:**



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| Sr. No. | CO Statement<br>After learning this subject students will be able to | Marks %<br>weightage |
|---------|--|----------------------|
| CO-1    | Explain and analyze components of Robot                              | 15                   |
| CO-2    | Illustrate the Kinematics and Dynamics of robotics                   | 20                   |
| CO-3    | Explain the methods in trajectory and motion planning.               | 25                   |
| CO-4    | Select appropriate microcontroller for robotic application           | 20                   |
| CO-5    | Implement various applications using programming languages           | 20                   |

**Mapping with POs:**

|      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|
| CO-1 | 3    | 2    | 3    | 2    | 3    | 1    | 2    | -    | 2    | -     | -     | 2     | 3     | 2     | 3     |
| CO-2 | 3    | 2    | 2    | 3    | 2    | -    | 1    | -    | -    | -     | 1     | 1     | 3     | 2     | 2     |
| CO-3 | 3    | 2    | -    | 3    | 2    | -    | 1    | -    | -    | -     | 1     | 1     | 3     | 2     | -     |
| CO-4 | 3    | 2    | 2    | 3    | 2    | 1    | 1    | 2    | 3    | 2     | 1     | 1     | 3     | 2     | 2     |
| CO-5 | 3    | 2    | 2    | 3    | 2    | 1    | 1    | 2    | 3    | 2     | 1     | 1     | 3     | 2     | 2     |

**List of Experiment:**

- Two switches and two DC motor are connected with Arduino UNO R3. Write a code to control DC motor depending upon the status of switches as per given table.

| Switch 2 | Switch 1 | Motor1 | Motor2 | Robot Movement |
|----------|----------|--------|--------|----------------|
| 0        | 0        | CW     | CW     | FORWARD        |
| 0        | 1        | OFF    | CW     | LEFT           |
| 1        | 0        | CW     | OFF    | RIGHT          |
| 1        | 1        | ACW    | ACW    | BACKWARD       |

- Introduction to RoboAnalyzer tool and its usage
- Write a program to model two link robot Inverse kinematics using RoboAnalyzer.
- Trajectory Planning and Creating robot joint trajectories using RoboAnalyzer tool
- Creating Virtual Robot Module in RoboAnalyzer
- Introduction to Robot operating System and Creating Packages and Nodes
- Developing Line Following Robot using ROS with Raspberry Pi
- SLAM ((Simultaneous Localization and Mapping) robot using Raspberry Pi and ROS
- Robotic Arm simulation using ROS
- Pick and Place mechanism using Robotic Arm
- Gesture controlled robot using ROS



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**Major Equipment:**

- Arduino UNO, Raspberry Pi, Power Supply, Digital multi-meter, CRO

**List of Open learning website:**

- <https://nptel.ac.in/courses/112105249>- Robotics

**List of Open Source Software:**

- Arduino IDE,