SARVAJANIK UNIVERSITY
Sarvajanik College of Engineering and Technology
Bachelor of Technology

B. Tech. Semester V

Subject Name: **Robotics and Automation** **Subject Code: BTEC15504**

Type of course: OE

Prerequisite: Digital System Design, Basic of C programming

Rationale: In near future, robots will be used widely in the fields of manufacturing, medicine, search and rescue, service, and entertainment. So, it is very much important to teach robotics as the synergistic integration of mechanics, electronics, controls, and computer science. This subject is intended to make student aware with basics of robot sensors, controls and transformations along with essential kinematics and dynamics

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.	**Introduction to Robotics:** What is Robotics?, History of Robotics, Classification of Robots, Asimov's law, Advantage and Disadvantages of Robots, Robot Components, Robot Sensing, Robot Degree of Freedom, Robot Joints, Robot Coordinates, Robot Reference Frames, Programming Modes, Robot Applications	6	15
2.	**Components and Controllers:** Sensors Classification, Contact and non-contact type sensor. Actuators: Electric, Hydraulic, Pneumatic, Grippers ,Motors selection: DC Motor, Stepper motor and servo motor., Peripheral Interfacing with microcontrollers and its programming in C and Arduino platform, Grippers interfacing with robotic controller. Open loop- closed loop, Manipulator Control and laws: P, PD, PID Controllers.	14	25
3.	**Robot Programming:** Classification of programming Languages, Generations of Robot Languages, Functions of programming, Requirements of a Robot Language, , Inverse Kinematics and Path Planning Programming.	6	20

4.	**Python for Robotics application:** Introduction to Robot Operating System (ROS) and ROS concepts, Introduction to python, python essentials, functions and classes, robot software frameworks, Robot programming using python, Robotics with python Raspberry Pi, Programming Remote Control, Working with face detection and operations.	14	25
5.	**Case Study:** Swarm Robots, Snake robots, bionic robots, Human Machine Interface for various applications, robot cell design, Artificial Intelligence in robotics.	5	15

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	20	25	10	15	15

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	S. K. Saha	Tata McGraw Hill	2007	1st
2.	Robotics and Control	R. K. Mittal, I. J. Nagrath	Tata McGraw Hill	2013	1st
3.	Learning Robotics Using Python	Learning Robotics Using Python	Packt Publishing	2015	2nd

Course Outcome:

Sr. No.	CO Statement After learning this subject students will be able to	Marks % weightage
CO-1	Summarise the fundamentals, history and components for designing robots.	20
CO-2	calculate the inverse kinematics of robots	10
CO-3	Differentiate various programming languages and environments used for robot controller program development	25
CO-4	Implement python codes for various robotics applications	25
CO-5	explain mechanical structures of industrial robots and their operational workspace characteristics	20

Mapping with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO-1	3	2	3	2	3	1	2	-	2	-	-	2
CO-2	3	2	-	-	2	2	-	-	-	-	-	-
CO-3	2	3	3	2	2	-	-	-	2	1	-	2
CO-4	2	3	3	2	2	-	-	-	2	1	-	2
CO-5	-	2	3	2	2	-	-	-	1	-	-	1

List of Practical:

1 Write a program to blink LED and DC motor control using a switch on ARDUINO IDE. Demonstrate the same on Proteus.

2 Two switches and two DC motors are connected with Arduino UNO R3. Write a code to control the 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

3 Write a program

a. To control the LED ON/OFF depending upon the light intensity falling on the Light Dependent Resistor.

b. Modify the above code for Robot Movement control to avoid Obstacle. Once an obstacle is detected, avoid collision of robot with obstacle by providing pre-programmed DC motor movement for specific direction.

4 Write a program for

a. Distance measurement and obstacle avoidance using ultrasonic sensors with LCD interfacing.

b. DC motor control depending upon distance measured by ultrasonic sensor.

5 In this lab work use an image file of ROS

a. In the virtual machine import .ova file (of 4.2 GB size) to create Ubuntu-ROS machine. Use a 4GB RAM setting for this VM. It will take approximately 11 -12 GB space of your virtual hard disk.

b. Checking installation of ROS on virtual machine. Take a screenshot of successful execution of the check, with the help of the document "ROS-Setup — Industrial Training documentation.pdf" uploaded here. Check

whether installation is successfully done or not

c. Create Catkin Workspace- Create a project workspace with the name "yourname_threedigitenroll". Take reference of the document "Create Catkin Workspace — Industrial Training documentation.pdf" uploaded here.
d. Learn how to download and create replicas of project files from github.
e. Creating Packages and Nodes - Create node printing-Running and checking Node" hello $your name having $ enrollment number". Take reference of the documents "Installing Packages — Industrial Training documentation.pdf" and "Creating Packages and Nodes — Industrial Training documentation.pdf" uploaded here.

Entire Material can also be accessed from
https://industrial-training-master.readthedocs.io/en/melodic/_source/setup/PC-Setup---ROS.html

6 Write a program to model two link robot Inverse kinematics.

a. Take the length of the first link 'l1' (read 'el one') as 'last digit of your enrollment number'. Length of second link can be assumed suitably as 'l2' read 'el two.
b. Find out different values of arm positions (x,y) for different angles (w.r.t. x-axis.)
c. Assume that Theta-1 varies between 0 to pi/2 and Theta-2 between 0 to pi.
d. Create ANFIS network using final arm positions as inputs and Theta-1 and Theta-2 as outputs.
e. Test the network and find and plot corresponding error.

7 Go to website https://www.robotigniteacademy.com/ , and create your login credentials on site.

go to https://www.robotigniteacademy.com/en/course/ros-basics-in-5-days_1_0/ to access RDS (ROS development studio) , interface and activities related to RDS. Access a small course on Learn the fundamentals of ROS to understand and be able to program robots using RDS. specifically two modules 0 - Introduction, 1 - ROS Deconstruction (accessible to you), which demonstrates ROS topic, service actions and rviz (simulation tool).

8 Write an Arduino code to

a. Transfer some data from Transmitter to receiver using Zigbee device configure at some specific baud rate and demonstrate the same on Proteus.
b. Modify the above code to control LED ON/OFF at receiver by a switch connected at transmitter device using Zigbee device configured at some specific baudrate and demonstrate the same on Proteus.
c. An ultrasonic sensor is connected with a Transmitter board. If the measured distance is less than the threshold value, control DC motor movement

connected with the receiver board. Demonstrate the entire setup using Zigbee device on Proteus.

9 To design robot system with two degree of freedom and two links using robo analyzer simulation tool.

Major Equipment:

- Arduino UNO, Sensors

List of Open Source/learning website:

- https://nptel.ac.in/courses/112108093- Robotics: Advanced Concepts and Analysis

List of Open Source Software:

- https://www.ros.org/
- https://www.arduino.cc/en/software