Government of Karnataka
DEPARTMENT OF TECHNICAL EDUCATION

Program	**Electronics & Communication Engineering**	**Semester**	**V**
Course Name	**Automation & Robotics**	**Type of Course**	**Integrated**
Course Code	**25EC53IA**	**Contact Hours**	**7 Hours/week 91 hours/Semester**
Teaching Scheme	**L:T:P :: 3:0:4**	**Credits**	**5**
CIE Marks	**50**	**SEE Marks**	**50 (Practice)**

1. Rationale:

The growth of automation & robotics has been tremendously high in recent years and the next few years are to witness great advancement in automation & robotic technology. The Robotics and Automation course focuses on the construction and operation, design automation of robotic devices, computer systems for necessary control action, feedback devices and information processing. Through project-based learning, design thinking, and inquiry learning, students will explore the technical skills needed to design and fabricate physical devices. Robotics and Automation is an interdisciplinary branch of Engineering that includes Mechanical, Electrical, Electronics, Computer Science, Sensors and Instrumentation, Industrial Automation, Artificial Intelligence and Machine learning, Nanotechnology and Machine Vision. The course provides knowledge and exposure in the field of Automation and Robotics and other related areas of automated production systems.

2. Course Outcomes: At the end of the Course, the student will be able to

CO-01	Explain and demonstrate the concept, components of Automation and its applications in Industries.
CO-02	Use Sensors, Actuators, VFD and PLC for specific applications in the automation.
CO-03	Apply the knowledge of robotic structure and its working to design and construct/simulate Robots for different applications.
CO-04	Identify the role of the sensors, actuators, AI, ROS and use it in robotic applications.

3. Course Content

WEEK	CO	PO	Theory	Practice
1	**1**	**1,2, 3,7**	➢ Automation in Production Systems, Reasons for Automating. ➢ Automation Principles and strategies. ➢ Components of Production System: Facilities and Manufacturing Support System. Case study on Benefits of converting a manual production system to Automated	Develop a Conveyor to automate parts movement. Interface Conveyor to PLC and control movement of parts. When the START button is pressed, the conveyor has to start rotating until the STOP button is pressed. Prepare a report on

			Production system.	a) Step by step procedure to develop a conveyor. b) Specifications of the actuator used. c) Selection of conveyors for different industrial applications.
2	**1**	**1,2, 3,7**	➢ Basic Elements of an Automated System: Power to accomplish the automated Process, Program of instructions, Control System ➢ Levels of Automation. ➢ Consider a use case to Demonstrate and analyze the following in the Medical Electronics /equipment manufacturing Industry. a) Improving Manufacturing Plant Efficiency b) Wastage of material c) Adapting to Technological Change	Interface Conveyor to PLC and control movement parts: Use Proximity sensor to be placed on the conveyor to detect the presence of the work piece. The conveyor has to rotate only when a work piece is available. Prepare a report on benefits if the conveyor speed can be controlled automatically.
3	**2**	**1,2, 3,7**	➢ Need for Controllers in automation: Microprocessor-based system, The Programmable Logic Controller Internal Architecture, Sourcing and sinking. ➢ PLC systems: Typical arrangement of PLC rack system, The IEC standard for PLC, Programming PLC. ➢ Use case on PLC Installation practices in a Manufacturing plant/Pharmaceutical industry/Defense and prepare a report.	Develop a PLC trainer kit and Interface toggle switches, Output LEDs to PLC. Check the working of PLC by programming it for automatic metal counting on the conveyor. Prepare a report on a) The Specifications of the PLC used. b) PIN functions of the PLC used. c) The range of industrial applications that the used PLC supports. d) List of various PLC vendors.
4	**2**	**1,2, 3,7**	➢ Role of sensors in Industrial automation, Common Measuring Devices Used in Automation. ➢ Desirable Features for Selecting Sensors Used in Automated Systems. Selection of sensors in industrial automation systems based on the given applications. ➢ Case study on application of sensors in any automated manufacturing industry.	Interface Liquid level sensor to PLC for detecting the level of liquid in a container and control the valve accordingly. Prepare a report on a) Different types of sensors used for liquid level sensing. b) Selection of liquid level sensors for different industrial applications. c) Working of the liquid level sensor used in the experiment.
5	**2**	**1,2, 3,7**	➢ Role of Actuators in industrial automation. Working and industrial applications of: Contactors and Relays, Solenoids, directional control valve. ➢ Working and industrial applications of: DC motors, AC, servo and stepper motors. ➢ Case study on the role of Actuators in	Interface Color detection sensor to PLC and separate the work pieces on the conveyor based on the color. (any two colors). (Use electric/Hydraulic/ Pneumatic actuator for parts separation) Prepare a presentation on a) The specification of the actuator

			- Automation packaging - Label scanning and - Printing	used. b) The advantages of it compared to other actuators c) The industry applications of it.
6	**2**	**1,2, 3,7**	➢ Introduction to Variable Frequency Drive (VFD), Building blocks of VFDs ➢ Specifications, types and working principles, Industrial applications of VFD ➢ Case study on application of VFD drives on speed control in the Automation Industry.	Interface PLC and VFD to change the speed of the induction Motor so that the programmable automation system is able to handle different product varieties in production: Example filling of Kissan Jam in Both Bottle (1 ltr) and sachets(100ml). Prepare a presentation on the a) Specifications of the VFD b) Induction motor used c) The types of load it supports. d) Benefits using VFD for automatic speed control e) Industry applications of it. Present the same in the class.
7	**3**	**1,2, 3,7**	➢ Introduction to Robotics: Definition of Industrial Robot, Generations of Robots. ➢ Robot Anatomy: Base, arm, wrist, end-effector. Links, joints. Joint Notation & Type of joints in robot- Linear Joint (L Joint), Orthogonal Joint (O Joint), Rotational Joint (R Joint), Twisting Joint (T Joint), Revolving Joint (V Joint) ➢ Degree of Freedom- Forward and Back, Up and Down, Left and Right, Pitch, Yaw, Roll (video demonstration of different types of Robots)	Visit nearby ITI/GTTC college and make a report on a) Types of robots. b) Work Volume c) Degree of Freedom- Forward and Back, Up and Down, Left and Right, Pitch, Yaw, Roll d) Joint Notation & Type of joints in robot- Linear Joint (L Joint), Orthogonal Joint (O Joint), Rotational Joint (R Joint), Twisting Joint (T Joint), Revolving Joint (V Joint)
8	**3**	**1,2, 3,7**	➢ Discuss Robotic Coordinate system of robots. ● Joint co-ordinate system ● Rectangular co-ordinate system ● User or object coordinate system ● Tool coordinate system. Work Volume ➢ Discuss End Effectors- Grippers, Tools Types of grippers Factors to be considered for Selecting a Gripper. ➢ Robot movement and Precision.	➢ Video demonstration on the role of Robots in automatic car assembly plants. Prepare a report on the type of robots used in the plant. ➢ Video demonstration on how the Robot pharmacist works. Prepare a report on types of sensors and actuators used in the robot.
9			➢ The need for Robotics in Automation industries. ➢ Discuss the different types of sensors used in industrial robots & their	➢ Video demonstration on the working of Driverless cars. Prepare a report on different types of sensors in it. ➢ Implement Automatic Car

	4	**1,2, 3,7**	application. ➢ Explain different Types of Actuators used in Industrial Robots.	Reverse parking alarm system by using Ultrasonic sensor and Arduino. When there is an object/obstacle, indicate it by beep sound. Beeping Interval should depend on the distance between the car and obstacle.
10	**3,4**	**1,2, 3,7**	➢ Types of Industrial Robots and their applications. ➢ Working of AGV and AMR. ➢ Case study Applications of AGVs in Unmanned systems: Defense, Medical and other Industries for material Handling.	Develop Obstacle Avoidance Robot/Line following robot using Arduino board.
11	**3,4**	**1,2, 3,7**	➢ Introduction to camera, Camera calibration. ➢ Vision Guided Robots (automated navigation guidance by vision system) ➢ Working of Turtlebot Robot.	1. Using simulation software Simulate an industry application of picking and placing an object from one place to another/ Simulate an industry application of picking the objects from the main conveyor and placing them on different conveyors based on colors using a vision sensor. 2. Make a report on the different Robotic applications using Vision Sensor.
12	**3,4**	**1,2, 3,7**	➢ Discuss and make a report on the use of Artificial Intelligence in robotics. ➢ Introduction and overview of robotic systems and their dynamics (Forward and inverse dynamics. Properties of the dynamic model. ➢ Joint space and task space control schemes (Position control, velocity control, trajectory control and force control).	1. Program a ROBO to trace a circular path, Rectangular path using any simulation software (Robo Analyser Software/ROBO studio/Gazebo / Robosoft) 2. Program a ROBO to trace elliptical and conical using any simulation software.
13	**3,4**	**1,2, 3,7**	➢ Introduction to ROS, Installation and Packages. ➢ Need for ROS. Its packages, ROS communication Tools (Topic, Services, Action) ➢ Case study on Development of various robots using ROS.	Build a Maze solving robot using real-time/ simulation software.

4. References:

Sl.No	Description
1	Automation, Production Systems, and Computer-Aided Manufacturing- Mikell P Grover, Prentice-Hall International publication.
2	Automating Manufacturing Systems with PLC by Hugh Jack.
3	Hand book of Modern Sensors" Physics, Designs and Applications- JACOB FRADEN-Springer Publications.

4	Springer Handbook of Automation by Shimon Y. Nof
5	Robotics technology and flexible automation – S.R. DEB and S.DEB.
6	R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi, 4th Reprint, 2005.
7	John J.Craig, Introduction to Robotics Mechanics and Control, Third edition, Pearson Education
8	M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.
9	B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998

5. CIE Assessment Methodologies

Sl. No	CIE Assessment	Test Week	Duration (minutes)	Max Marks	
1.	CIE-1TheoryTest	4	90	50	Average of all CIE=50 Marks
2.	CIE-2 Practice Test	7	180	50	
3	CIE-3 Theory Test	10	90	50	
4.	CIE-4 Practice Test	13	180	50	
5	CIE-5 Portfolio evaluation of all the activities through Rubrics	1-13		50	
				Total	**50 Marks**

Note: Portfolio evaluation includes average of (a) and (b)

(a) Any one suggested activity model with report and presentation evaluated for 50 Marks.

(b) Each laboratory exercise will be evaluated for a total of 50 marks. The evaluation will include the following components:

1) Written description of the experiment in the observation book.
2) Conducting the experiment and the associated learning outcomes.
3) The results obtained from the experiment.
4) Corrections and evaluations of the experiment completed in the previous class, documented in the record book.

6. SEE – Practice Assessment Methodologies

Sl. No	SEE – Practice Assessment	Duration (minutes)	Max Marks	Min marks to pass
1.	Semester End Examination-Practice	180	50	20

7. CIE Theory Test model question paper

Program	Electronics And Communication Engineering			Semester - V	
Course Name	Automation & Robotics			Test	I
Course Code	25EC53IA	Duration	90 min	Marks	50
Name of the Course Coordinator:					
Note: Answer any one full question from each section. Each full question carries equal marks.					

Q.No	Questions	Cognitive Level	Course Outcome	Marks
	Section - 1			
1	a) Discuss the different components of the Production System.	L2	1	10
	b) Describe the different levels of Automation.	L2	1	10
	c)Discuss the benefits of Programmable automation in any production industry.	L3	2	5
2	a) Summarize the Basic elements of an Automated system.	L2	1	10
	b) Use the automation principle strategies and explain the benefits of converting a manual system to an automated production system.	L2	1	10
	c) Discuss the different types of automated manufacturing system relative to production quantity and product variety.	L3	2	5
	Section – 2			
3	a) Demonstrate the desirable features of sensors used in the Automation industry.	L3	2	10
	b) Explain the working of different sensors used in potato chips production plant.	L3	2	10
	c) PLC is preferred over microcontrollers in an automation industry. Justify.	L3	2	5
4	a) Identify the need for controllers in automation and explain.	L3	2	10
	b) Demonstrate the PLC arrangement of the Rack system to be used in the milk production industry.	L3	2	10
	c) Implement the PLC installation practices in any manufacturing plant.	L3	2	5

Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, cognitive level and course outcomes.

Signature of the Course Coordinator | **Signature of the HOD** | **Signature of the IQAC Chairman**

8. CIE Practice Test model question paper

Program	**Electronics and Communication Engineering**			**Semester**	**V**
Course Name	Automation & Robotics			**Test**	**II/IV**
Course Code	**25EC53IA**	**Duration**	**180 min**	**Marks**	**50**
Name of the Course Coordinator:					

Questions	**CO**	Marks
Writing two programs and execution of any one program.	1,2,3,4	50
Scheme Of Assessment:		
Writing of Two experiment (Hardware/simulation) **Conduction/simulation of any 1** **Troubleshooting** **Result** **Viva**		**20** **10** **05** **05** **10**
Total Marks		**50**

Signature of the Course Coordinator | **Signature of the HOD** | **Signature of the IQAC Chairman**

9. Suggestive Activities

The List is an Example and not inclusive of all possible activities of the course. Students and Faculty are encouraged to choose any ONE activity that is relevant to the topic.

Sl.No.	**Suggestive Activities**
1	Design an Automatic liquid filling system.
2	Develop an automation system on Sensors and actuators.
3	Develop a Robot to separate parts moving on the conveyor based on the colour.
4	Use a color sensor to separate the parts moving on the conveyor based on the colour.
5	Use VFD for direction control of the Induction motor.
6	Integrate IOT and Automation for data monitoring.
7	Develop prototype of Self Driving Car

10. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		0-10	11-20	21-30	31-40	41-50	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	40
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	30
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	40
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	30
	Average Marks=(40+30+40+30)/4=35						**35**

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

11. SEE- Model Practice Question Paper

Program	**Electronics and Communication Engineering**		**Semester**	**V**
Course Name	**Automation & Robotics**	**Course Code 25EC53IA**	**Duration**	**180 min**
Questions			**CO**	**Marks**
Writing two programs and execution of any one program.			1,2,3.4	50
Scheme Of Assessment:				
Writing of Two experiments (Hardware/simulation) **Conduction / simulation of any 1** **Troubleshooting** **Result** **Viva**				**20** **10** **05** **05** **10**
			Total	50

1) Signature of the Examiner **2) Signature of the Examiner**

12. Equipment/software list with Specification for a batch of 30 students

Sl.No.	Particulars	Specification	Quantity
01	PLC Kits	14-20 I/O ports , 24V	15
02	PLC with Power Supply	14-20 I/O ports , 20V	15
03	Toggle Switches , Output LEDs	—----------	100 each

03	Arduino Uno (or equivalent)	At least 14 digital I/O pins, 6 analog inputs, USB interface	30
04	Ultrasonic Sensor (HCSR04)	Range: 2cm to 400cm, 5V, used for distance measurement	30
05	DC Motors	5V, used for simple rotation and speed control	30
06	Arduino IDE	Latest version, for programming Arduino boards	30
07	Computer (for Simulation and Coding)	Minimum 4GB RAM, 500GB HDD, Windows/Linux OS, with Arduino IDE and Proteus installed	30
08	Robo Analyser Software /ROBO studio/Gazebo/ Robosoft	—----------	For 30 PCs
07	VFD drive	0.5HP/1HP/2HP	5
08	Induction Motor	0.5HP/1HP/2HP	5