THE MAHATMA GANDHI UNIVERSITY

UNDERGRADUATE PROGRAMMES (HONOURS)

SYLLABUS

MGU-UGP (Honours)

(2024 Admission Onwards)

Faculty: Technology and Applied Sciences

Expert Committee: Electronics

Subject: Industrial Automation

Mahatma Gandhi University
Priyadarshini Hills
Kottayam – 686560, Kerala, India

Syllabus Index

Name of the Minor: **Industrial Automation**

Semester 1

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG1DSCIAM100	Interactive Robotic Systems	DSC B	4	5	3		2	

Semester: 2

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG2DSCIAM100	Intelligent automation techniques	DSC B	4	5	3		2	
MG2DSCIAM101	Automotive Systems for E-Vehicles		4	5	3		2	

Semester: 3

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG3DSCIAM200	Embedded System Programing Tools	DSC B	4	5	3		2	

Semester: 4

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG4DSCIAM200	Robotics and Automation	DSC C	4	5	3		2	

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Programme						
Course Name	Interactive Robotic Systems					
Type of Course	DSC B					
Course Code	MG1DSCIAM100					
Course Level	**100-199**					
Course Summary and Justification	This course aims to empower learners with practical skills in prototyping and constructing robotic systems. Through engaging hands-on projects, the course cultivates critical thinking and analytical reasoning, aiming to spark a genuine interest in robotics.					
Semester	1	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		3		1		75
Pre-requisites						

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains *	PO No:
1	Explain the Arduino ecosystem	U	1,2
2	Compare various sensors and actuators	U	1,2
3	Familiarize Robotic control systems	A	1,10
4	Demonstrate robotics experiments	C	1,2,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Unit	Course description	Hours	CO No:
1	1.1	Overview of Arduino Microcontroller board, Pin configuration and Ports, Basics of Arduino Programming environment, Void setup and Void loop	3	1
	1.2	Learn how to download and install the desktop-based Arduino IDE	3	1
	1.3	Basic functions: Pin Mode, Digital Write, Analog Write and PWM, Voltage divider, Analog Voltage	4	1

		Read, Serial monitor (Serial. begin, Serial print functions)		
	1.4	FOR loop and WHILE loop: syntax and uses. Connecting an LED to Arduino, Initialisation, adding delay in programs. Repeated blinking of LED using FOR and WHILE loops	5	1
2	2.1	Overview of ultrasonic sensor, Distance measurement using ultrasonic sensor	3	2
	2.2	Introduction to IR flame sensor and MQ2 smoke sensor. Familiarization of LDR	4	2
	2.3	Familiarise with servo motor, Working of a simple robotic arm using servo motor	5	2
	2.4	Familiarise with geared DC motor, DC motor driver module	3	2
3	3.1	Direction control of robotic vehicle, Motor Speed control using PWM signal, Automated obstacle detection and path diversion using IR sensors	4	3
	3.2	Obstacle detection with HCSR 04 ultrasonic sensor, RADAR mode using Ultrasonic sensor with servo motor	3	3
	3.3	Introduction to accelerometer gyroscope sensor (MPU6050) – Servo motor control with MPU6050	4	3
	3.4	Concept of self-balancing robotic systems, different techniques for self-balancing robot	4	3
4	4.1 4.2 4.3 4.4 4.5 4.6 4.7 4.8	Practical (any two) Write a program to turn on and turn off LED Write a program to create an SOS signal using LED Controlling of LED an LDR Set up a Light-controlled buzzer operation system Design a parking Indicator using ultrasonic sensor Create a smoke and fire alarm system Assemble a robocar using geared DC motors and a Driver module Design a line follower robot Project	30	4
5		Teacher specific content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Utilize a combination of lectures and hands on training to facilitate a comprehensive learning experience.
Assessment Types	**MODE OF ASSESSMENT (Internal Evaluation)** **A. Continuous Comprehensive Assessment (CCA)** **Theory: - 25 Marks** Internal Test – One MCQ based and one extended answer type Seminar Presentation – a real time application of emerging technology to be identified and present it as seminar **Practical: 15 Marks**

	Components for assessment (suggestions): A combination of quizzes, assignments, Performance, Case Study.
	B. End Semester Examination 1. Written Test (50 marks)- 1 Hour 30 Minutes (Duration of Examination) a. MCQ - 10 Marks (Answer all - 10x1=10 Marks) b. Short answer questions (4 out of 6 questions)-4x5=20 marks c. Essay questions -2 out of 4 - 2x10=20 marks 2. Practical Exam (35 marks) – 2 Hour (Duration of Examination) a. Viva b. Lab report **c.** Demonstration

References

1. Monk, Simon, and Michael McCabe. Programming Arduino: getting started with sketches. vol. 176. New York: McGraw-Hill Education, 2016.
2. Boxall, John. Arduino workshop: A Hands-On introduction with 65 projects. No starch press, 2021.
3. Shoham, Moshe. *A Textbook of Robotics 1: Basic Concepts*. Springer Science & Business Media, 2012.

Suggested readings

1. Richardd. Klafter,‖ Robotic Engineering‖'phi,1996
2. Robotics: Control, Sensing, Vision, and Intelligence" by C.S.G. Lee and K. S. Fu:
3. Arduino Cookbook by Michael Margolis, O'reilly
4. Pushkin Kachroo, Patricia Mellodge - Mobile Robotic Car Des

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Programme						
Course Name	Intelligent Automation Techniques					
Type of Course	DSC B					
Course Code	MG2DSCIAM100					
Course Level	100-199					
Course Summary and Justification	This course equips learners with the practical skills to apply AI and machine learning in solving complex electronic engineering problems					
Semester	2	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		3		1		75
Pre-requisites						

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains *	PO No:
1	Explain the concepts of Artificial Intelligence (A.I) and Machine Learning	U	1,2
2	Apply Python for machine learning applications	A	1,2
3	Organize hands-on experience in selecting appropriate classification models	A	1,2,10
4	Develop a solid understanding of Unsupervised Learning.	C	1,2,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Unit	Course description	Hours	CO No:
1	1.1	Overview OF AI and Machine Learning	2	1
	1.2	Concept of Neural networks, Machine Learning	3	1
	1.3	Types of Machine Learning Systems	3	1
	1.4	Main Challenges of Machine Learning. Application of ML: Genetics, medical treatment, Business	3	1
2	2.1	Introduction to Python, How to write code in Jupyter Notebook, Pycharm and IDLE	5	2
	2.2	Import and export data using Python (panda)	4	2
	2.3	Machine learning Lab : Extract data from database using Python	4	2
	2.4	Concept of Gradient descent algorithms	4	2
3	3.1	An overview about Machine learning- supervised , unsupervised , reinforcement	4	3

	3.2	Supervised learning Technique: K-Nearest Neighbors (KNN)	5	3
	3.3	Concept of regression analysis	4	3
	3.4	UnSupervised learning Techniques- Hierarchical Clustering	4	3
4		**Practical (Any 2)** 1. Case study about Handwritten digit recognition using KNN 2. Case study about Handwritten digit recognition using Gradient descent 3. Case study about Disease prediction 4. Case Study House Price Prediction using LINEAR REGRESSION Single Variable	30	4
5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Leverage a blended learning approach with a mix of lectures, interactive discussions, and hands-on lab sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **1. Theory: - 25 Marks** Internal Test – One MCQ based and one extended answer type Seminar Presentation – a real time application of emerging technology to be identified and present it as seminar **2. Practical: 15 Marks** Components for assessment (suggestions): A combination of quizzes, assignments , Performance ,Case Study
	B. End Semester Examination 1. Written Test (50 marks)- 1 Hour 30 Minutes (Duration of Examination) a. MCQ - 10 Marks (Answer all - 10x1=10 Marks) b. Short answer questions (4 out of 6 questions)-4x5=20 marks c. Essay questions -2 out of 4 - 2x10=20 marks 2. Practical Exam (35 marks) – 2 Hour (Duration of Examination) a. Viva b. Lab report c. Demonstration

References

1. Auelien Geron, Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, Second Edition, O'Reilly, 2019
2. Jeremy Watt, Reza Borhani, Aggelos Katsaggelos, Machine Learning Rened, 2nd Ed., Cambridge University Press.

Suggested Readings

1. Ethem Alpaydin, Introduction to Machine Learning, 3rd Ed., MIT Press.
2. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2016.
3. Michael Nielsen, Neural Networks and Deep Learning
4. Murphy, Kevin P. Machine learning: a probabilistic perspective. MIT press, 2012.

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Programme						
Course Name	Automotive Systems for E- Vehicles					
Type of Course	DSC B					
Course Code	MG2DSCIAM101					
Course Level	**100-199**					
Course Summary and Justification	This course equips learners with a deep understanding of linear integrated circuits in the context of Electric Vehicles, fostering the ability to design, optimize and apply these circuits for enhanced efficiency and performance in EV systems.					
Semester	2	Credits			4	
Content Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	**Total Hours**
		3		1		75
Pre-requisites						

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains *	PO No:
1	Demonstrate basic operational amplifier circuits	U	1,2
2	Illustrate the working of Electric Vehicle batteries	U	1,2
3	Identify the working of various motors and drivers and develop a model electric car	A	1,2
4	Construct a working model	C	1,2,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Unit	Course description	Hours	CO No:
1	1.1	Operational Amplifier basics, symbol, Pin diagram. Familiarize OpAmp ICs: single, dual and quad packages- LM324, LM741	3	1
	1.2	Open loop configuration: Infinite Open loop Gain. Working of Comparator circuit	4	1
	1.3	Working of Unity gain amplifier (Buffer), Inverting amplifier, non-inverting amplifier (Circuit and Gain formula only).	4	1
	1.4	Use of OpAmp to amplify signal from sensors. (microphone/LDR/photodiode)	4	1
2	2.1	Comparator circuit using 741 opamp, Schmitt trigger using 741, Voltage level indicator using 741	4	2

	2.2	Working of Bridge rectifiers using diodes. Capacitor filter circuit. Familiarise voltage regulator IC: 78XX	5	2
	2.3	Working of Switched Mode Power Supply (Block diagram level description)	4	2
	2.4	Introduction to Lithium-ion batteries	2	2
3	3.1	Familiarise Battery management unit (TP4056)	3	3
	3.2	An overview of Electric Vehicle charging: Charging levels, DC fast charging, Charging connectors	4	3
	3.3	Working of Brushless DC motor, Induction motor (Basic level studies only)	4	3
	3.4	Electronics speed controller for EV , monitoring of voltage and current of ESC	4	3
4	4.1	**Practical** (any five) 1. Build/simulate a comparator circuit 2. Build/Simulate of inverting and non-inverting and buffer amplifier 3. Build/simulate an OpAmp circuit to amplify output signal of a sensor (Audio sensor/LDR/Photodiode) 4. Build/simulate an unregulated power supply using Bridge rectifier IC- W10 and a capacitor. Analyse the effect of the capacitor in the output voltage. 5. Build/ simulate a regulated power supply capable of generating controllable outputs at 5V, 12V and 15V. 6. Control a DC motor using a driver module (L293D/L298N) 7. Build a battery power bank using available batteries and Battery management unit. 8. Control the speed of a brushless motor using an Electronic Speed Control module	30	3,4
5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Utilise a combination of lectures and hands-on training to facilitate a comprehensive learning experience.
	MODE OF ASSESSMENT **A. Continuous Comprehensive Assessment (CCA)** 1. Written Test (50 marks)- 1 Hour 30 Minutes (Duration of Examination) a. MCQ - 10 Marks (Answer all - 10x1=10 Marks) b. Short answer questions (4 out of 6 questions)-4x5=20 marks c. Essay questions -2 out of 4 - 2x10=20 marks 2. Practical Exam (35 marks) – 2 Hour (Duration of Examination)

	a. Viva b. Lab report c. Demonstration
	B. End Semester Examination 1. Written Test (50 marks)- 1 Hour 30 Minutes (Duration of Examination) a. MCQ - 10 Marks (Answer all - 10x1=10 Marks) b. Short answer questions (4 out of 6 questions)-4x5=20 marks c. Essay questions -2 out of 4 - 2x10=20 marks 2. Practical Exam (35 marks) – 2 Hour (Duration of Examination) a. Viva b. Lab report c. Demonstration

References

1. Larminie, James, and John Lowry. Electric vehicle technology explained. John Wiley & Sons, 2012.
2. Sedha R. S. A textbook of applied electronics. S. Chand Publishing, 2008.
3. Theraja, B. L. Fundamentals of Electrical Engineering and Electronics. S. Chand Publishing, 2006.

Suggested Readings

1. Mehta, V. K. Principles of electronics. 2000.
2. Roy, D. Choudhury. Linear integrated circuits. New Age International, 2003.
3. DMSBS, Per Enge Ph, Nick Enge MSBS, and Stephen Zoepf Ph DMSBS. Electric Vehicle Engineering. McGraw-Hill Education, 2021.
4. Electric Vehicle Engineering, Per Enge, Nick Enge, Stephen Zoepf, McGraw Hill publishers dury

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Programme						
Course Name	Embedded System Programing Tools					
Type of Course	DSC B					
Course Code	MG3DSCIAM200					
Course Level	**200-299**					
Course Summary & Justification	This course offers a fundamental understanding of Python programming and Raspberry Pi applications. Learners acquire a versatile skill set for both Python programming and Raspberry Pi interfacing.					
Semester	**3**	**Credits**			**4**	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		3		**1**		**75**
Pre-requisites						

COURSE OUTCOME (CO)

CO No.	Expected Course Outcome	Learning Domain*	PO No.
1	Demonstrate the Fundamentals of Python programming and Raspberry pi	U	2
2	Illustrate Control Structures in python and GPIO programming	U	1,2
3	Develop knowledge in GUI Programming with Tkinter	C	1,2,10
4	Build Problem-solving skills and creativity through hands-on projects and practical applications using Python for electronic systems	C	1,2,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Unit	Course description	Hours	CO No.
1	1.1	Introduction to Python - Syntax rules and conventions in Python, Structure of a Python program	3	1
	1.2	**Variables & Data types in python:** Fundamental data types - Numerical data types, string. Sequence types: list, tuple, range.	3	1
	1.3	**Operators in Python:** Arithmetic, Logical, Assignment, Comparison and bitwise operators	3	1
	1.4	Introduction to Raspberry pi-Raspberry Pi models. Port layout of Raspberry pi 4, Installation and configuration of Raspberry pi 4	6	1
2	2.1	**Control statements:** if, if-else, while loop , for loop, switch	3	2

	2.2	Basic string operations -- Len, lower, upper, split, substrings, String slices - String formatting for number system applications, Converting strings to numerical values and vice versa	4	2
	2.3	Multimedia -Importing multimedia to python (picture & sound)	4	2
	2.4	**GPIO Programming and Interfacing:** How the GPIOs work – pin numbering- Initializing I/O pins, Introduction to I/O functions - Importing functions or system libraries (GPIO libraries). Digital read, Digital write functions	4	2
3	3.1	Introduction to GUI programming - Overview of Tkinter	4	3
	3.2	Creating a basic Tkinter window - widgets: labels, buttons, entry widgets, check box – customizing widget properties	4	3,4
	3.3	Tkinter geometry managers: pack, grid, and place geometry manager	7	3,4
4	4.1	Getting started with Raspberry pi Setting up the Raspberry pi computer Thonny installation in Raspberry pi	20	4
	4.2	**Part A (Any 5 programs)** 1. Program to print Hello World! 2. Program to add two numbers with user input 3. Program to perform basic logic operations 4. Program for toggling the bits of Port B 5. Program to send values 0x00 to 0xFF to Port B 6. Program to find the sum of a given data set 7. String Input in Python 8. Program for string operations 9. Program to find largest and smallest number in an array 10. Program to display even numbers from 1-10 11. Program to display a string with number input		
	4.3	**Basic GUI applications development:**(Any One applications) 1. Basic login with GUI 2. Capturing an image using Raspberry pi camera	10	4
5		Teacher specific content		

****Practicals- Hardware & Software requirements for hands-on session:** Raspberry pi 4, Thonni IDE

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Leverage a blended learning approach with a mix of lectures, interactive discussions, and hands-on lab sessions

Assessment Types	**MODE OF ASSESSMENT (Internal Evaluation)** **A. Continuous Comprehensive Assessment (CCA)** **1. Theory: - 25 Marks** Internal Test – One MCQ based and one extended answer type Seminar Presentation – a real time application of emerging technology to be identified and present it as seminar **2. Practical: 15 Marks** Components for assessment (suggestions): A combination of quizzes, assignments , Performance ,Case Study.
	B. Semester End examination 1.Written Test (50 marks) - 1 Hour 30 minutes(Duration of Examination) a. MCQ - 10 Marks (Answer all - 10x1=10 Marks) b. Short answer questions (4 out of 6 questions)-4x5=20 marks c. Essay questions -2 out of 4 - 2x10=20 marks 2. Practical Exam (35 marks)- 2 Hour (Duration of Examination) d. Viva e. Lab report Demonstration

References

1. Lambert, Kenneth A. Fundamentals of Python: first programs. Cengage Learning, 2018.
2. Summerfield, Mark. Programming in Python 3: a complete introduction to the Python language. Addison-Wesley Professional, 2010.

Suggested Readings

1. Charles Dierbach, “Introduction to Computer Science using Python”, Wiley, 2015
2. R Nageswara Rao, Python Programming

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Programme						
Course Name	Robotics and Automation					
Type of Course	DSC C					
Course Code	MG4DSCIAM200					
Course Level	**200-299**					
Course Summary and Justification	This course provides learners with a comprehensive understanding of industrial automation, covering key components, PLC programming, robotic systems, and hands-on skills in designing automated systems.					
Semester	4	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		3		1		75
Pre-requisites	Knowledge in Basic Electronics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No.
1	Explain the principles and applications of Robotics and Automation	U	1,2
2	Apply automation techniques using PLC	A	1,2
3	Analyze and troubleshoot automation systems in real-world scenarios	An	1,2,10
4	Design and develop automated solutions for specific tasks	C	1,2,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Unit	Course description	Hours	CO No.
1	1.1	Introduction to Robotics and its Evolution **(Basics)**	2	1
	1.2	Industrial automation- Definition, Purpose, Different types, Industry Standard- Industry 4.0	2	1
	1.3	Sensors - Basic concepts of piezoelectric sensor, IR proximity sensor. PIR Sensor	6	1
	1.4	Motors - Basic concepts of Servo Motors and Stepper Motors. Actuators - Basic concepts of Electrical Actuators	5	1
	2.1	Different types of PLCs, Basic programming, basics of Ladder Logic	5	2
	2.2	Introduction to PLC -Inputs and Outputs, Types of I/O Modules	4	2
	2.3	PLC interfacing with LED and Motor	2	2
	2.4	PLC interfacing with PIR Sensors	4	2
	3.1	Control systems and their role in robotics, Example of closed loop control system - Automatic water level system	5	3

3	3.2	Components of an Automatic conveyor belt mechanism	4	3
	3.3	Robotics in industry- pick and place, spot welding	6	3
4		**Practical / Simulation** (OpenPLC Editor, i-TRiLOGI, WPLSoft, Do-more Designer, plcsimulator.online or any other). **Minimum 4 experiments** 1. Basic ON/OFF Control: Use a switch to control an output (e.g., a lamp) using PLC. 2. Toggle Operation: Implement a toggle switch to alternate between two outputs. 3. Timer Functionality: Use timers to control the ON/OFF duration of an output. 4. Latching Circuit: Create a latch/unlatch mechanism to maintain output state. 5. Logic Gates Implementation: Use PLC programming to simulate AND, OR, NOT logic functions. 6. Motor Control: Control the direction and speed of a motor using PLC. 7. Traffic Light Simulation: Simulate a traffic light system with different timing sequences. 8. Temperature Control: Control a heating or cooling system based on temperature sensor inputs. 9. Water Level Monitoring: Use sensors to monitor and control water levels in a tank. 10. Conveyor Belt Control: Control the operation and speed of a conveyor belt using PLC 11. Alarm System: Create an alarm system based on sensor inputs or specific conditions. 12. Robotic Arm Control: Basic control of a robotic arm using PLC 13. Robotic Application: Robotic arm pick-and-place tasks using PLC	30	4
5		Teacher specific content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Leverage a blended learning approach with a mix of lectures, interactive discussions, and hands-on lab sessions
Assessment Types	**MODE OF ASSESSMENT (Internal)** **A. Continuous Comprehensive Assessment (CCA)** Theory: - 25 Marks 1. Internal Test – One MCQ based and one extended answer type- 15 Marks 2. Seminar Presentation – a real time application of emerging technology to be identified and present it as seminar - 10 Marks Practical : 8 Marks 1. lab: A combination of quizzes, assignments - 2 Marks 2. Performance - 3 Marks 3. Case Study - 3 Marks
	B. Semester End examination

	1.Written Test (50 marks) a. MCQ - 10 Marks b. Short answer questions (4 out of 6 questions)-4x5=20 marks c. Essay questions -2 out of 4 - 2x10=20 marks 2. Practical Exam (17 marks) (Internal) a. Viva - 9 marks b. Lab report - 3 marks c. Demonstration - 5 marks

References

1. Merat, Frank. "Introduction to robotics: Mechanics and control." IEEE Journal on Robotics and Automation 3.2 (1987): 166-166.
2. Chakraborty, Kunal, Palash De, and Indranil Roy. Industrial applications of programmable logic controllers and scada. Anchor Academic Publishing, 2016.

Suggested Readings

1. Ghosal, Ashitava. Robotics: fundamental concepts and analysis. Oxford university press, 2006.
2. Lin, Patrick, Keith Abney, and George A. Bekey, eds. Robot ethics: the ethical and social implications of robotics. MIT press, 2014.
3. Yamamoto, Ikuo. Practical robotics and mechatronics: marine, space and medical applications. Institution of Engineering and Technology, 2016.
4. Shell, Richard. Handbook of industrial automation. CRC press, 2000.
5. Lamb, Frank. Industrial automation: hands-on. McGraw-Hill Education, 2013.
6. Jack, Hugh. Automating manufacturing systems with PLCs. Lulu. com, 2009