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| **Course Code** | **18RO2002** | **Duration** | **3hrs** |
| **Course Name** | **INTRODUCTION TO MECHANICAL SYSTEMS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define isolated system. | | CO1 | R | 1 |
| 2. | Describe zeroth law of thermodynamics. | | CO1 | U | 1 |
| 3. | Estimate the displacement work of a system. | | CO2 | U | 1 |
| 4. | Determine Charles law. | | CO2 | R | 1 |
| 5. | Sketch p-v diagram of an otto cycle. | | CO3 | A | 1 |
| 6. | State the importance of spark plug. | | CO3 | R | 1 |
| 7. | Discuss the significance of of conservation of energy. | | CO4 | U | 1 |
| 8. | Define Hydrodynamic pressure. | | CO4 | R | 1 |
| 9. | Determine the number of centroids for an object. | | CO5 | R | 1 |
| 10. | Explain the term kinematics. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Give examples of closed system. | | CO1 | U | 3 |
| 12. | Differentiate between specific heat and latent heat. | | CO2 | An | 3 |
| 13. | Explain the function of cam shaft mechanism. | | CO3 | A | 3 |
| 14. | Determine the Bernoulli’s equation. | | CO4 | U | 3 |
| 15. | Sketch a force couple system. | | CO5 | A | 3 |
| 16. | Explain impulse momentum equation. | | CO6 | A | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Analyze different types of thermodynamic equilibriums. | CO1 | An | 8 |
|  | b. | Differentiate between path and point functions. | CO1 | U | 4 |
|  |  |  |  |  |  |
| 18. | a. | Determine the constant volume process of a gas with a neat sketch | CO2 | An | 8 |
|  | b. | Two bulbs of different volumes are separated by a valve. The valve between the 2.00 L bulb, in which the gas pressure is 1.00 atm, and the 3.00 L bulb, in which the gas pressure is 1.50 atm, is opened. What is the final pressure in the two bulbs, the temperature being constant and the same in both bulbs? | CO2 | U | 4 |
|  |  |  |  |  |  |
| 19. | a. | Illustrate the processes in a spark ignition engine with a neat sketch. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. | a. | Describe the Bernoullies equation. | CO4 | U | 4 |
|  | b. | Find the volume of the water displaced and the position of the center of buoyancy for a wooden block of width 2.5m and of depth 1.5m, when it floats horizontally in the water. The density of the wooden block is 650 kg/m3 and its length 6m. | CO4 | An | 8 |
|  |  |  |  |  |  |
| 21. | a. | Four forces act on bolt A as shown. Determine the resultant of the forces on the bolt.  C:\Users\Admin\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Picture4.png | CO5 | E | 12 |
|  |  |  |  |  |  |
| 22. | a. | Distinguish between four-stroke spark ignition engine and a four-stroke compression ignition engine. | CO3 | A | 8 |
|  | b. | Construct the free-body diagram of the following figure  [Solved] (b) Draw the following Free Body Diagram (FBD) : ' (c) A ... | CO5 | A | 4 |
|  |  |  |  |  |  |
| 23. | a. | Explain the three modes of heat transfer in a system. | CO3 | U | 6 |
|  | b. | Estimate the hydrostatic forces acting on the immersed plane surface. | CO4 | An | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | 2 weights are connected by a string and move along the rough horizontal plane under the action of force 40 N, applied to the first weight as in the figure. The coefficient of friction between the sliding surfaces of weights and the plane is 0.3. Determine the acceleration of weights in tension in the string using D’Alembert’s principle. | CO6 | E | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Recall the fundamentals of systems |
| CO2 | State the laws of thermodynamics |
| CO3 | Describe the air standard cycles and their significance |
| CO4 | Discuss about the principles of fluid mechanics |
| CO5 | Construct free body diagrams to analyze static equilibrium |
| CO6 | Apply the knowledge of Dynamics in Mechanical System Design |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 8 |  | 8 |  |  | 17 |
| CO2 | 1 | 5 |  | 11 |  |  | 17 |
| CO3 | 1 | 6 | 24 |  |  |  | 31 |
| CO4 | 1 | 8 | 4 | 14 |  |  | 27 |
| CO5 | 1 |  | 3 |  | 12 |  | 16 |
| CO6 |  | 1 | 3 |  | 12 |  | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **18RO2005** | **Duration** | **3hrs** |
| **Course Name** | **SENSOR SIGNAL CONDITIONING CIRCUITS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define input offset current. | | CO1 | A | 1 |
| 2. | Draw the diagram for voltage follower circuit. | | CO1 | A | 1 |
| 3. | List the features of an instrumentation amplifier | | CO2 | R | 1 |
| 4. | Mention the applications of a comparator circuit. | | CO2 | A | 1 |
| 5. | Active filters are preferred over passive filters? Why? | | CO3 | R | 1 |
| 6. | Draw the circuit diagram for a clamper circuit? | | CO3 | U | 1 |
| 7. | Name the states present in the monostable multivibrator circuit | | CO4 | R | 1 |
| 8. | Choose the frequency and duty cycle for a 555 timer astable multivibrator with R1=10Kohm, R2= 5K ohm and C-0.01 µF. | | CO4 | R | 1 |
| 9. | Name the types of digital to analog converter. | | CO5 | R | 1 |
| 10. | Draw a sample and hold circuit diagram? | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | What causes slew rate? | | CO1 |  | 3 |
| 12. | Sketch the basic circuit using op amp to perform the mathematical operation of differentiator and explain? | | CO2 | A | 3 |
| 13. | Draw the circuit diagram for a square wave generator. | | CO3 | U | 3 |
| 14. | Define lock in range and capture range? | | CO4 | R | 3 |
| 15. | Draw the block diagram for Phase Locked Loop (PLL)? | | CO5 | R | 3 |
| 16. | Define resolution and conversion time of DAC? | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Discuss the DC characteristics of an operational amplifier. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. |  | Sketch the instrumentation amplifier whose gain is controlled by adjustable gain and explain its working concept. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | Design a second order Butterworth active Low Pass Filter with a upper cut of frequency of 2kHz | CO2 | An | 12 |
|  |  |  |  |  |  |
| 20. |  | What is a precision rectifier? With circuit schematic explain the working principle of full wave rectifier. | CO3 | R | 12 |
|  |  |  |  |  |  |
| 21. |  | With a neat diagram explain the astable multivibrator using IC 555 timer and derive an expression for the frequency of oscillation with relevant waveforms. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 22. |  | Explain the applications of Phase Locked Loop (PLL) for Amplitude Modulation (AM) detection, Frequency Shift Key(FSK) demodulation. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 23. | a. | With a neat block diagram explain the working of weighed resistor method using digital to analog converter (DAC) and state its merits and demerits? | CO5 | U | 6 |
|  | b. | With a neat block diagram explain the flash type analog to digital converter (ADC) and state its merits and demerits. | CO5 | U | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | With a neat diagram explain the grounding and shielding effects in strain gauge, and thermocouple sensors. | CO6 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Define the characteristics of operational amplifiers. |
| CO2 | Describe the linear applications of op-amp. |
| CO3 | Design circuits for non-linear applications of op-amp. |
| CO4 | Apply the knowledge of special ICs like IC 555 to design circuits. |
| CO5 | Discuss about the types of ADCs and DACs. |
| CO6 | Analyze the parameters to be considered for interfacing. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | - | - | 16 | 1 | - |  | 17 |
| CO2 | 1 | - | 16 | 12 | - | - | 29 |
| CO3 | 13 | 16 | - | - |  | - | 29 |
| CO4 | 5 |  | - | 12 | - | - | 17 |
| CO5 | 4 | 12 | - | - | - | - | 16 |
| CO6 | 3 | 1 | 12 | - | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **18RO2008** | **Duration** | **3hrs** |
| **Course Name** | **ROBOT KINEMATICS AND DYNAMICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | Specify the meaning of the term “Degree of Freedom” of a robot. | | | CO1 | R | 1 |
| 2. | Name the part of a robot that is used to hold an object or a tool. | | | CO1 | R | 1 |
| 3. | Identify the type of transformation represented by “T” in the Fig. 1. below.    Fig. 1. | | | CO2 | U | 1 |
| 4. | Mention the characteristics of a holonomic robot. | | | CO2 | R | 1 |
| 5. | List the factors that determine the work space of a robot. | | | CO3 | R | 1 |
| 6. | Give the significance of perspective transformation related to robot vision. | | | CO3 | U | 1 |
| 7. | Outline the concept of resolved motion rate control. | | | CO4 | U | 1 |
| 8. | Relate the Coupling Inertia between joints with the equations of motion of a robot. | | | CO4 | U | 1 |
| 9. | Comment on the usage of Lagrange function for robot dynamic analysis. | | | CO5 | U | 1 |
| 10. | Describe Slew Motion of a robot. | | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | State Asimov’s Laws of Robotics. | | | CO1 | R | 3 |
| 12. | Find the resultant position of the vector P = 3i + 2j + 5k, when it is rotated by an angle of 600 about the z axis of the reference frame. | | | CO2 | A | 3 |
| 13. | Compare the illumination techniques used in robot vision systems. | | | CO3 | An | 3 |
| 14. | Differentiate Boundary Singularity and Interior Singularity conditions of a robot manipulator. | | | CO4 | An | 3 |
| 15. | Derive the force-acceleration relationship of the cart spring system shown in Fig.2. using Newtonian Mechanics.    Fig.2 | | | CO5 | U | 3 |
| 16. | Highlight the difference between non-normalized and normalized movements of a 1 DoF robot in joint space description. | | | CO6 | An | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q. No 24 is Compulsory)** | | | | | | |
| 17. | | a. | With relevant diagrams and explanations, classify robots based on the path control techniques and the manipulator configuration. | CO1 | U | 8 |
|  | | b. | A cartesian coordinate robot has a prismatic joint with a range of 30 inches. It is specified that the robot has a control resolution of 0.010 inches. Determine the number of bits that the robot’s control memory should possess in order to attain this level of precision. | CO1 | A | 4 |
|  | |  |  |  |  |  |
| 18. | | a. | For the point 3i + 7j + 5k, perform the following operations.   1. Rotate 300 about X axis and then translate 6 units along Y axis. 2. Translate 6 units along Y axis and then translate 300 about X axis. | CO2 | A | 8 |
|  | | b. | Describe the four kinematic parameters that are used to derive the arm equation of a robot. | CO2 | U | 4 |
|  | |  |  |  |  |  |
| 19. | |  | Elaborate the procedure to perform the kinematic analysis of a robot work cell. | CO3 | U | 12 |
|  | |  |  |  |  |  |
| 20. | |  | Illustrate the use of Jacobians for Differential Kinematic analysis. Hence, determine the Jacobian of a 2 DoF planar manipulator. | CO4 | U | 12 |
|  | |  |  |  |  |  |
| 21. | |  | Using the Lagrange Method, derive the equations of motion of the 2 DoF manipulator shown in Fig. 3.    Fig. 3 | CO5 | A | 12 |
|  | |  |  |  |  |  |
| 22. | | a. | It is required to design a robot that can pick up an object of arbitrary shape from a table and place it inside a box. What is the minimum number of degrees of freedom required? Sketch the possible arm configurations. | CO3 | A | 6 |
|  | | b. | Specify the primary functions of vision system in robotic applications. Elaborate the significance of each function with relevant illustrations and examples. | CO3 | U | 6 |
|  | |  |  |  |  |  |
| 23. | | a. | Write the general form of Homogeneous Transformation Matrix and indicate the significance of each component. | CO2 | U | 4 |
|  | | b. | A frame B has a reference coordinate frame *xyz* and moving frame *uvw.* Itwas rotated about the *x* axis by 900, then it was translated about the *w* axis by 3 inches before it was rotated about the *z* axis by 900. Finally, it was translated about the *v* axis by 5 inches.  (i) Write an equation that describes the motions.  (ii) Find the final location of a point p(1,5,4)T attached to the frame relative to the reference frame. | CO2 | A | 8 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. | | a. | Compare Joint Space and Cartesian Space description of trajectory planning. | CO6 | An | 4 |
|  | | b. | It is desired to have the first joint of a 6-axis robot go from an initial angle of 500 to a final angle of 800 in 3 seconds. Calculate the coefficients for a third-order polynomial joint-space trajectory. Determine the joint angles, velocities, and accelerations at 1 and 3 seconds. It is assumed that the robot starts from rest and stops at its destination. | CO6 | A | 8 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Select and classify various robotic systems |
| CO2 | Utilize kinematics analysis of robotic manipulators |
| CO3 | Perform Workspace analysis of a Robotic System |
| CO4 | Describe the Differential Motion and Statics of robotic manipulators |
| CO5 | Describe the construction of robotic manipulators and analyze dynamics and force of robotic manipulators |
| CO6 | Plan off-line Robot trajectories to meet desired End-Effector tasks |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 5 | 8 | 4 |  |  |  | 17 |
| CO2 | 1 | 9 | 19 |  |  |  | 29 |
| CO3 | 1 | 19 | 6 | 3 |  |  | 29 |
| CO4 |  | 14 |  | 3 |  |  | 17 |
| CO5 |  | 4 | 12 |  |  |  | 16 |
| CO6 | 1 |  | 8 | 7 |  |  | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **18RO2009** | **Duration** | **3hrs** |
| **Course Name** | **VISION SYSTEMS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Enumerate the various membranes of human vision system. | | CO1 | R | 1 |
| 2. | Identify the shutter preferred for capturing the image of a moving object. | | CO1 | R | 1 |
| 3. | Recall the logarithmic gray level transformation for image enhancement technique. | | CO2 | R | 1 |
| 4. | Define sharpening in spatial domain image enhancement technique. | | CO2 | R | 1 |
| 5. | Define histogram of an image. | | CO3 | R | 1 |
| 6. | Name the techniques involved in region-based segmentation. | | CO3 | R | 1 |
| 7. | Recall the fundamental machine vision approaches to human object recognition. | | CO4 | R | 1 |
| 8. | Define the term “pattern class” in the object recognition algorithm. | | CO4 | R | 1 |
| 9. | Show the basic layout of parallel stereo imaging. | | CO5 | R | 1 |
| 10. | Relate the laser scan measurements to polar scan matching. | | CO5 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Summarize the range of subjective brightness adaptation and discrimination for vision system. | | CO1 | U | 3 |
| 12. | Interpret the significance of histogram equalization. | | CO2 | U | 3 |
| 13. | Identify the key parameters by which the boundary descriptors are analyzed. | | CO3 | U | 3 |
| 14. | List the components that are linked to object recognition challenges. | | CO4 | R | 3 |
| 15. | Determine the intrinsic and extrinsic characteristics of the camera. | | CO5 | A | 3 |
| 16. | Enumerate the key features of the meta-operating system for a robot. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Explain the components of a general-purpose image processing system with the help of a neat block diagram. | CO1 | U | 10 |
|  | b. | Differentiate the rods cells and the cone cells in human vision system. | CO1 | U | 2 |
|  |  |  |  |  |  |
| 18. |  | Explain in detail the smoothing and sharpening filters in frequency domain to enhance a digital image. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Define segmentation. | CO3 | R | 2 |
|  | b. | Enumerate the types of image segmentation techniques and summarize its applications in digital image processing. | CO3 | U | 10 |
|  |  |  |  |  |  |
| 20. |  | Discuss in detail the fundamental machine vision approaches to recognize the object in an image. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21 |  | Describe the tasks performed using k-means clustering algorithm in detail. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 22. | a. | Define the term “Edges”. | CO3 | R | 2 |
|  | b. | Discuss the Edge linking and boundary detection using the Hough transform. | CO3 | U | 10 |
|  |  |  |  |  |  |
| 23. | a. | Trace the photometric image formation model with a neat sketch. | CO1 | U | 5 |
|  | b. | Discuss in brief the CCD color camera sensors. | CO1 | U | 7 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Enumerate the simulators and visualization tools used for robots in ROS. | CO6 | R | 4 |
|  | b. | Explain briefly the use of the cv bridge package in the ROS to OpenCV image conversion. | CO6 | U | 8 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Describe the basic components of specific visual system. |
| CO2 | Discuss the effect of low-level vision algorithms. |
| CO3 | Explain the use of high-level vision algorithms for specific purpose. |
| CO4 | Assess the identification of objects using a specified technique. |
| CO5 | Explain the applications of vision and tracking algorithms. |
| CO6 | Discuss the basics of ROS and OpenCV for Robotic vision. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 27 | - | - | - | - | 29 |
| CO2 | 2 | 15 | - | - | - | - | 17 |
| CO3 | 3 | 27 | - | - | - | - | 30 |
| CO4 | 5 | 12 | - | - | - | - | 17 |
| CO5 | 3 | 10 | 3 | - | - | - | 16 |
| CO6 | 3 | 12 | - | - | - | - | 15 |
|  | | | | | | | **124** |

**Graphical user interface, application

Description automatically generated with medium confidence**

**SUPPLEMENTARY EXAMINATION – JUNE 2023**

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| --- | --- | --- | --- |
| **Course Code** | **18RO2009** | **Duration** | **3hrs** |
| **Course Name** | **VISION SYSTEMS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | List the key features of the illumination technique in machine vision system. | | CO1 | R | 1 |
| 2. | Define Weber ratio. | | CO1 | R | 1 |
| 3. | Recognize the role of a digitizer in digital image processing. | | CO2 | R | 1 |
| 4. | Express the dimensions of the digital representation of an image. | | CO2 | U | 1 |
| 5. | Identify the technique that is used to separate a foreground object from its background. | | CO3 | U | 1 |
| 6. | List the steps used in object recognition model. | | CO3 | R | 1 |
| 7. | Define the term ‘feature’ in the object recognition technique. | | CO4 | R | 1 |
| 8. | Recall the fundamental machine vision approaches to human object recognition. | | CO4 | R | 1 |
| 9. | Show the basic layout of parallel stereo imaging. | | CO5 | R | 1 |
| 10. | Recall the ROS library used to interface ROS and OpenCV. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Differentiate the rods cells and the cone cells in human vision system. | | CO1 | U | 3 |
| 12. | Summarize the characteristics of sampling and quantization in a digital image. | | CO2 | U | 3 |
| 13. | Discuss the basic morphological operators for extracting image components with examples. | | CO3 | U | 3 |
| 14. | Justify the necessity of using an alignment technique in object recognition. | | CO4 | U | 3 |
| 15. | Explain the calibration procedure for cameras. | | CO5 | U | 3 |
| 16. | Enumerate the three pillars of computer vision in the ROS community. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Describe the digital image in a 2D discrete space and interpret the relationship between pixels with suitable examples. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 18. | a. | Explain the edge detection operators used in image processing applications. | CO2 | U | 8 |
|  | b. | Interpret the need for grayscale in digital image processing. | CO2 | U | 4 |
|  |  |  |  |  |  |
| 19. | a. | Explain in detail the concepts of boundary descriptors in object recognition. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. | a. | Discuss the modelling of objects in an image by combining two images to recognize the object efficiently. | CO4 | U | 5 |
|  | b. | Explain the object recognition technique in high-level digital image processing system with the help of a neat diagram. | CO4 | U | 7 |
|  |  |  |  |  |  |
| 21. | a. | Describe the mapping of sonar data using neat sketches. | CO5 | U | 4 |
|  | b. | Illustrate the applications of digital image processing in sensor readings for a vision system with an example. | CO5 | U | 8 |
|  |  |  |  |  |  |
| 22. | a. | Discuss the functions of human eye and label its anatomical parts with a suitable diagram. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 23. | a. | Apply the histogram equalization for the gray levels of an 8 X 8 image given below and plot the histogram of the original and the processed image.   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Gray levels | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | No. of pixels | 4 | 5 | 12 | 10 | 4 | 11 | 8 | 9 | | CO2 | A | 10 |
|  | b. | Enumerate the importance of histogram equalization. | CO2 | U | 2 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain in detail the Gazebo and Stage simulators to run the robots to venture into the real-world. | CO6 | U | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Describe the basic components of specific visual system |
| CO2 | Discuss the effect of low-level vision algorithms |
| CO3 | Explain the use of high-level vision algorithms for specific purpose |
| CO4 | Assess the identification of objects using a specified technique |
| CO5 | Explain the applications of vision and tracking algorithms |
| CO6 | Discuss the basics of ROS and OpenCV for Robotic vision |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 27 | - | - | - | - | 29 |
| CO2 | 1 | 28 | - | - | - | - | 29 |
| CO3 | 1 | 16 | - | - | - | - | 17 |
| CO4 | 2 | 15 | - | - | - | - | 17 |
| CO5 | 1 | 15 | - | - | - | - | 16 |
| CO6 | 4 | 12 | - | - | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **18RO2010** | **Duration** | **3hrs** |
| **Course Name** | **PROGRAMMABLE LOGIC CONTROLLERS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Relays are part of \_\_\_\_\_\_\_\_\_\_\_\_\_ layer in automation pyramid. | | CO1 | U | 1 |
| 2. | When a relay is energized, there is an electrical path through the \_\_\_\_\_\_\_. | | CO1 | R | 1 |
| 3. | List a few OEM for PLC. | | CO2 | R | 1 |
| 4. | Thermocouple, RTD, and limit switches can be connected to \_\_\_\_\_\_\_\_\_\_\_ module. | | CO2 | A | 1 |
| 5. | Draw a ladder diagram for NAND gate. | | CO3 | A | 1 |
| 6. | Give the function of enable bit of the timers. | | CO3 | R | 1 |
| 7. | Give the jump function that executes a subroutine. | | CO4 | R | 1 |
| 8. | Mention the need for bit set function. | | CO4 | U | 1 |
| 9. | Give the communication protocol used for HMI. | | CO5 | U | 1 |
| 10. | Mention the technologies used for touch panels. | | CO5 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Give the history of automation. | | CO1 | R | 3 |
| 12. | Define Scan Cycle. | | CO2 | U | 3 |
| 13. | Draw the ladder for the following Boolean diagram. | | CO3 | A | 3 |
| 14. | List the basic COMPARE functions. | | CO4 | R | 3 |
| 15. | Give the functions of an operator display. | | CO5 | U | 3 |
| 16. | Give the frame format for Field bus. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Elaborate on Automation Pyramid with its implication on modern industries. | CO1 | U | 8 |
|  | b. | List the conditions for developing a PLC program. | CO1 | R | 4 |
|  |  |  |  |  |  |
| 18. |  | With a neat block diagram, explain the architecture of Programmable Logic Controllers. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Develop a ladder for the following:  A two way hydraulic cylinder has two solenoids controlling it. Energizing one solenoid causes the cylinder to extend and energizing the other solenoid causes it to retract. A limit switch at each end indicates full retraction or full extension. Use two start – stop controls, one for each direction. Construct a control system with interlocks | CO4 | A | 8 |
|  | b. | Evaluate the functions of counters in PLC with suitable examples. | CO3 | U | 4 |
|  |  |  |  |  |  |
| 20. | a. | Illustrate the benefits of Skip and MCR functions in PLC ladder programming. | CO4 | U | 6 |
|  | b. | Develop a program for washing machine using sequencer funcation. | CO4 | C | 6 |
|  |  |  |  |  |  |
| 21. | a. | Elaborate on the Panel PC and its importance in industries. | CO5 | A | 8 |
|  | b. | Give the difference between Panel PC and HMI. | CO5 | A | 4 |
|  |  |  |  |  |  |
| 22. | a. | Develop an Instruction List for the following program.  Turns on a timer T1 when a switch SW1 is closed.  TimerT1 is automatically reset by an input switch SW1.  Counter C1 counts the number of times the timer goes to 10 sec.  A second input switch SW2 at a count of 5 automatically resets   the counter.  Latches on a light L1 at the count of 5. | CO4 | A | 8 |
|  | b. | Discuss the sequential function charts as an alternative for Ladder diagram. | CO4 | U | 6 |
|  |  |  |  |  |  |
| 23. | a. | Develop a ladder for the following:  Conveyor is supposed to have exactly 45 parts on it. You have three indicating lights to indicate the conveyor count status: less than 45, yellow; exactly 45, green: and more than 45, red. The count of parts on the conveyor is set at 45 each morning by an actual count of parts. There are two sensors on the conveyor. One is actuated by parts entering the conveyor, and the other is actuated by parts leaving. | CO4 | A | 9 |
|  | b. | Write a program that will turn a light on when a count reaches 20. The light is then to go off when a count of 30 is reached. | CO3 | A | 5 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain detail about IEEE 802.3 MAC sub-layer. | CO6 | U | 6 |
|  | b. | List the steps for troubleshooting and maintaining a PLC. | CO6 | U | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Identify and understand the automation concepts for Industries. |
| CO2 | Apply PLC architecture knowledge to select PLC for specific problems. |
| CO3 | Use PLC Ladder diagram for simple applications |
| CO4 | Design real time application using PLC. |
| CO5 | Create prototype for the real time application Using PLC, with HMI. |
| CO6 | Recognize the faults and identify the protocol to be used for the applications |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 8 | 9 |  |  |  |  | 17 |
| CO2 | 1 | 15 | 1 |  |  |  | 17 |
| CO3 | 1 | 4 | 9 |  |  |  | 14 |
| CO4 | 4 | 13 | 21 |  |  | 6 | 44 |
| CO5 | 1 | 4 | 12 |  |  |  | 17 |
| CO6 | 3 | 12 |  |  |  |  | 15 |
|  | | | | | | | **124** |



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| **Course Code** | **18RO2011** | **Duration** | **3hrs** |
| **Course Name** | **AUTOMATION SYSTEM DESIGN** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | | |
| 1. | Sketch the integration of hardware and software systems. | | CO1 | | U | 1 |
| 2. | Suggest few examples for integrated design process. | | CO1 | | R | 1 |
| 3. | Define load cycle. | | CO2 | | U | 1 |
| 4. | Name the law which is related to inertia. | | CO2 | | R | 1 |
| 5. | Define precision. | | CO3 | | R | 1 |
| 6. | List few applications of guideways. | | CO3 | | R | 1 |
| 7. | Identify the industries which has material handling units. | | CO4 | | R | 1 |
| 8. | Brief about the differences between AGV and ASR. | | CO4 | | U | 1 |
| 9. | Mention the friction factor of conveyor belts. | | CO5 | | R | 1 |
| 10. | Define automation. | | CO6 | | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | | |
| 11. | How mechatronic design is superior over conventional design? | | CO1 | | R | 3 |
| 12. | Brief the issues arising in integration of system for automating an industrial process. | | CO2 | | A | 3 |
| 13. | Outline the function of bearings. | | CO3 | | U | 3 |
| 14. | Tabulate the characteristics that influence the design of material handling systems. | | CO4 | | R | 3 |
| 15. | Select the factors involved in the determination of angle of inclination. | | CO5 | | U | 3 |
| 16. | List the application areas of CIROS. | | CO6 | | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | | |
| 17. | a. | Summarize the building blocks of automation system with suitable sketch. | CO1 | U | | 6 |
|  | b. | Elaborate on the modules involved in the design of mechatronic system. | CO1 | U | | 6 |
|  |  |  |  |  | |  |
| 18. | a. | Emphasize on the torque speed relationship in DC motors. | CO2 | R | | 6 |
|  | b. | Demonstrate on the selection of motor for designing automation system with the help of flowchart. | CO2 | U | | 6 |
|  |  |  |  |  | |  |
| 19. | a. | Justify the significance of motion guides in moving an element along a pre determined path. Brief on the types of motion guides | CO3 | U | | 6 |
|  | b. | Interpret the design features and physical specifications to be considered on selecting precision motion components. | CO3 | A | | 6 |
|  |  |  |  |  | |  |
| 20. | a. | Classify the grippers. Specify the criteria for selection of grippers. | CO4 | A | | 6 |
|  | b. | Present the principles of material handling, | CO4 | U | | 6 |
|  |  |  |  |  | |  |
| 21. | a. | Examine the importance of belt conveyor with a neat sketch. Mention the components involved in the design of the belt conveyor. | CO5 | R | | 6 |
|  | b. | Determine the horse power of the conveyor shaft. | CO5 | U | | 6 |
|  |  |  |  |  | |  |
| 22. | a. | Interpret the operation of machine tending robot. | CO6 | U | | 6 |
|  | b. | Justify the influence of automation on nation’s economy. | CO6 | R | | 6 |
|  |  |  |  |  | |  |
| 23. | a. | Classify suspended idlers. Justify the best one among them. | CO5 | A | | 6 |
|  | b. | Examine the process of identifying and addressing the troubles caused by belt conveyors. | CO5 | A | | 6 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. | a. | Assess the role of HMI and drives in automating an industrial process. | CO2 | | R | 6 |
|  | b. | Classify the types of industrial automation based on the types of motor loads. | CO2 | | R | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | CO1 Specify the automation elements and requirements. |
| CO2 | Select the appropriate precision motion components based on the application. |
| CO3 | Analyze the motion control with more precise arrangements. |
| CO4 | Describe the basic design considerations of material handling equipment. |
| CO5 | Design and select a belt conveyor for real world applications. |
| CO6 | Analyze the integrating automation components. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 4 | 13 | - | - | - | - | 17 |
| CO2 | 19 | 7 | 3 | - | - | - | 29 |
| CO3 | 2 | 9 | 6 | - | - | - | 17 |
| CO4 | 4 | 7 | 6 | - | - | - | 17 |
| CO5 | 7 | 9 | 12 | - | - | - | 28 |
| CO6 | 6 | 10- | - | - | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **18RO2013** | **Duration** | **3hrs** |
| **Course Name** | **TOTALLY INTEGRATED AUTOMATION** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | | |
| 1. | Point out the necessity in automating an industrial process. | | CO1 | | U | 1 |
| 2. | Identify the areas which are integrated in TIA. | | CO1 | | R | 1 |
| 3. | What does a tag represent in SCADA application? | | CO2 | | U | 1 |
| 4. | Identify the modules through which communication takes place in SCADA. | | CO2 | | U | 1 |
| 5. | Expand DDE. | | CO3 | | R | 1 |
| 6. | Name the unit in SCADA which assists in sending messages. | | CO3 | | R | 1 |
| 7. | Highlight the importance of LCU in DCS. | | CO4 | | R | 1 |
| 8. | Mention the types of DCS display. | | CO5 | | U | 1 |
| 9. | What do you mean by plant layout? | | CO6 | | R | 1 |
| 10. | Share an example of functional layout. | | CO6 | | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | | |
| 11. | List the advantages of TIA. | | CO1 | | R | 3 |
| 12. | List the key criteria to be in practice in SCADA reporting. | | CO2 | | U | 3 |
| 13. | Specify the objective of OPC in process control. | | CO3 | | U | 3 |
| 14. | Evolve the development of DCS. | | CO4 | | R | 3 |
| 15. | How is general purpose computer programmed in DCS? | | CO5 | | U | 3 |
| 16. | Brief about the development of plant layout. | | CO6 | | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | | |
| 17. | a. | Enumerate on the characteristics which distinguishes PAC from PLC. | CO1 | U | | 6 |
|  | b. | Summarize the role of industrial automation in the current industry scenario. | CO1 | U | | 6 |
|  |  |  |  |  | |  |
| 18. | a. | Comment on how SCADA is superior to DCS. | CO2 | R | | 6 |
|  | b. | Interpret the process behind writing SCADA script. | CO2 | U | | 6 |
|  |  |  |  |  | |  |
| 19. | a. | Examine the differences between open and proprietary protocols. | CO3 | U | | 6 |
|  | b. | Judge the importance of protocols in interfacing PLC with SCADA. | CO3 | A | | 6 |
|  |  |  |  |  | |  |
| 20. | a. | Sketch the DCS architecture and relate the importance of control functions. | CO4 | A | | 6 |
|  | b. | Examine the role of redundancy in SCADA systems. | CO4 | U | | 6 |
|  |  |  |  |  | |  |
| 21. | a. | Assess the types of operator interfaces. | CO5 | R | | 6 |
|  | b. | Examine the importance of engineering interface in DCS. | CO5 | U | | 6 |
|  |  |  |  |  | |  |
| 22. | a. | Highlight the parameters in the selection of power and automation cables. | CO6 | U | | 6 |
|  | b. | Illustrate with suitable examples the steps involved in industrial plant design. | CO6 | R | | 6 |
|  |  |  |  |  | |  |
| 23. | a. | Outline the design of process sequencing in and industry with suitable examples. | CO2 | A | | 6 |
|  | b. | Write a VB script for displaying the output content of message window in dialog window. | CO2 | A | | 6 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. | a. | Interpret the type of HMI in easing communication between men and machine. | CO6 | | R | 6 |
|  | b. | Articulate the components of TIA with suitable sketch. | CO6 | | R | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Outline the selection, and application of various TIA control elements. |
| CO2 | Discuss the configuration of SCADA functionalities with Tags, Screens, and Trends. |
| CO3 | Compare various communication protocols for automation system. |
| CO4 | Identify and differentiate various sub systems of DCS. |
| CO5 | Describe various functions of Interfaces in DCS. |
| CO6 | Analyze and design an appropriate system for the industrial application. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 16 | 13 | - | - | - | - | 29 |
| CO2 | 12 | 5 | 12 | - | - | - | 29 |
| CO3 | 2 | 9 | 6 | - | - | - | 17 |
| CO4 | 4 | 6 | 6 | - | - | - | 16 |
| CO5 | 6 | 10 | - | - | - | - | 16 |
| CO6 | 19 | 10 | - | - | - | - | 17 |
|  | | | | | | | **124** |

**Graphical user interface, application

Description automatically generated with medium confidence**

**SUPPLEMENTARY EXAMINATION – JUNE 2023**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **18RO2013** | **Duration** | **3hrs** |
| **Course Name** | **TOTALLY INTEGRATED AUTOMATION** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Horizontal integration means networking between individual machines, items of equipment or production units. (Say True or False). | | CO1 | An | 1 |
| 2. | TIA ensures consistent data management, worldwide standards and uniform interfaces – from the field level to the corporate management level. (Say True or False). | | CO1 | U | 1 |
| 3. | Mention two main categories of SCADA architecture. | | CO2 | R | 1 |
| 4. | The fourth generation SCADA systems were developed or designed in the year \_\_\_\_\_\_ | | CO2 | R | 1 |
| 5. | Define a Tag. | | CO3 | R | 1 |
| 6. | Name two different reports which can be created by using WinCC | | CO3 | U | 1 |
| 7. | Write the year in which DCS was introduced. | | CO4 | R | 1 |
| 8. | Mention the Programming languages used for DCS. | | CO5 | U | 1 |
| 9. | Write the simulation software used for Plant Simulation. | | CO6 | R | 1 |
| 10. | In which of the layout, the machines are arranged together at one place. | | CO6 | A | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | List out the advantages of industrial automation. | | CO1 | U | 3 |
| 12. | Discuss the feature of Totally Integrated Automation. | | CO2 | A | 3 |
| 13. | State the functionalities of SCADA. | | CO3 | U | 3 |
| 14. | Write down the features of OPC | | CO4 | U | 3 |
| 15. | List out the major components of DCS. | | CO5 | R | 3 |
| 16. | Write the advantages and disadvantages of product layout. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Write down the necessity of HMI. Explain the types of HMI in detail. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. | a. | Explain various types of SCADA systems with relevant diagrams in detail. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Describe the procedure to integrate VB scripts in HMI Screen with suitable example. | CO2 | An | 12 |
|  |  |  |  |  |  |
| 20. | a. | Describe the step by step procedure to interface PLC with HMI. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 21. | a. | Name two different reports which can be created by using WinCC. Explain each in with suitable example. | CO3 | A | 6 |
|  | b. | Explain the functions of Trends with relevant example. | CO3 | A | 6 |
|  |  |  |  |  |  |
| 22. | a. | Describe the Task architecture of DCS in detail. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 23. | a. | Write down in detail about Operator interface and engineering interface in DCS with relevant diagrams | CO5 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Describe the principles of plant layout. | CO6 | U | 6 |
|  | b. | Explain any one model of plant location | CO6 | U | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Outline the selection, and application of various TIA control elements |
| CO2 | Discuss the configuration of SCADA functionalities with Tags, Screens and Trends |
| CO3 | Compare various communication protocols for automation system |
| CO4 | Identify and differentiate various sub systems of DCS |
| CO5 | Describe various functions of Interfaces in DCS. |
| CO6 | Analyze and design an appropriate system for the industrial applications. |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 |  | 4 | 12 | 1 |  |  | 17 |
| CO2 | 2 | 12 | 15 |  |  |  | 29 |
| CO3 | 1 | 4 | 24 |  |  |  | 29 |
| CO4 | 1 | 15 |  |  |  |  | 16 |
| CO5 | 3 | 1 | 12 |  |  |  | 16 |
| CO6 | 1 | 16 |  |  |  |  | 17 |
|  | | | | | | | **124** |



|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **18RO2015** | **Duration** | **3hrs** |
| **Course Name** | **FIELD AND SERVICE ROBOTICS** | **Max. Marks** | **100** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Give an application of Service Robot. | | CO1 | R | 1 |
| 2. | List the essential features of Autonomous mobile robot. | | CO1 | U | 1 |
| 3. | Express the Classification of AMR systems with respect to the field of application. | | CO1 | R | 1 |
| 4. | Write about the DOF in Mobile Robot. | | CO2 | U | 1 |
| 5. | List the Markov’s assumption. | | CO2 | U | 1 |
| 6. | Mention the three types of error in mobile robot localization. | | CO3 | R | 1 |
| 7. | List the state estimation algorithms. | | CO4 | R | 1 |
| 8. | Mention the use of A\* Algorithm. | | CO5 | R | 1 |
| 9. | Give the DOF of Humanoids. | | CO6 | An | 1 |
| 10. | List the medical applications of Tactile sensor. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Define Mobility. | | CO1 | R | 3 |
| 12. | List the wheel configurations for rolling vehicles. | | CO2 | U | 3 |
| 13. | Define SLAM. | | CO3 | R | 3 |
| 14. | Mention the framework in Bayes Filter. | | CO4 | U | 3 |
| 15. | Distinguish Grid and Sector Map. | | CO5 | R | 3 |
| 16. | Define sound sensor. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Explain the classification of service robot based on their application areas. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 18. |  | Summarize the Mobile Robot Maneuverability and Workspace. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | Draw the general schematic diagram of mobile robot localization. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. |  | Explain the Kinematic Models and Constraints representing the robot position. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | Explain the Kalman filter algorithm with a suitable example. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 22. |  | Describe in detail on the Grid Maps with neat sketch. | CO3 | R | 12 |
|  |  |  |  |  |  |
| 23. |  | Distinguish in detail the Cell Decomposition approaches in Mobile Robot Path Planning. | CO5 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Summarize in detail on tactile sensing, sound and vision sensors in Humanoids. | CO6 | R | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Describe the applications and current trend in field and service robot. |
| CO2 | Explain about the kinematic modeling of mobile robots. |
| CO3 | Identify, formulate and solve algorithm related to localization, obstacle avoidance, and mapping |
| CO4 | Apply and program robot for reactive concepts for robot interaction with human, between machines and among robots. |
| CO5 | Analyze the concepts of balancing legged robots and interaction interface concepts for humanoid robot. |
| CO6 | Implement path planning algorithms inside a field/service robot for navigation. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 5 | 13 | - | - | - | - | 17 |
| CO2 | - | 5 | 24 | - | - | - | 30 |
| CO3 | 16 | 12 | - | - | - | - | 28 |
| CO4 | 4 | - | - | 12 | - | - | 16 |
| CO5 | 4 | 12 |  | - | - | - | 16 |
| CO6 | 16 | - | - | 1 | - | - | 17 |
|  | | | | | | | **124** |



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| **Course Code** | **19RO1001** | **Duration** | **3hrs** |
| **Course Name** | **MATERIAL SCIENCE** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | The most common and familiar composite material is -----------------. | | CO1 | R | 1 |
| 2. | The atoms of some elements having two or more different atomic weights are called -----------------. | | CO1 | U | 1 |
| 3. | Diffusion refers to the ---------------------- in solids. | | CO2 | U | 1 |
| 4. | The stable form of iron has a --------------- crystal structure at room temperature. | | CO2 | R | 1 |
| 5. | ------------------ is a property of ferromagnetic materials which causes them to expand or contract in response to a magnetic field. | | CO3 | R | 1 |
| 6. | The electron gun is responsible for the ------------------------. | | CO3 | U | 1 |
| 7. | ---------------- is the natural tendency of a material to gradually move or  permanently deform as a result of mechanical stress or strain. | | CO4 | U | 1 |
| 8. | ---------------- is the phenomenon by which a ductile metal becomes harder and stronger as it is plastic deformed. | | CO4 | R | 1 |
| 9. | The measure of the degree to which material can be magnetized is known as -------------------. | | CO5 | R | 1 |
| 10. | The man-made synthetic materials that replicate the natural biological objects in our daily life are termed as -----------------------. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | What are the 3 main classifications of materials? | | CO1 | A | 3 |
| 12. | State Fick’s first law. | | CO2 | R | 3 |
| 13. | List the main components of an electron gun. | | CO3 | A | 3 |
| 14. | Write a short note on deformation by twinning. | | CO4 | A | 3 |
| 15. | Describe the Nabarro-Herring creep. | | CO5 | An | 3 |
| 16. | List the uses of Photonic crystals. | | CO6 | A | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. | a. | Explain the Face-centered cubic crystal structure found in common metals. | CO1 | An | 6 |
|  | b. | Write short notes on the effect of crystallinity on polymer properties? | CO1 | A | 6 |
| 18. | a. | Describe the development of Microstructure in Iron-Carbon Alloys with a neat diagram. | CO2 | An | 6 |
|  | b. | Discuss in detail about the Bainite transformation in Steel. | CO2 | An | 6 |
| 19. | a. | Explain the working principle and construction of Electron Beam Machining with a neat sketch. | CO3 | A | 6 |
|  | b. | Point out the real-time applications of Magnetostrictive materials. | CO3 | A | 6 |
| 20. | a. | Illustrate the Rockwell hardness test method used to measure the permanent depth of indentation produced by a force/load on an indenter with a neat sketch. | CO4 | A | 6 |
|  | b. | Discuss in detail the creep mechanism and the typical constant load creep behavior of metals with a schematic representation of the creep curve. | CO4 | An | 6 |
| 21. | a. | Analyze the hysteresis curve of ferromagnetic materials using domain theory. | CO5 | An | 6 |
|  | b. | List the types Ferroelectric materials and write their advantages with few applications | CO5 | A | 6 |
| 22. | a. | Explain nanophase materials and list their types with applications. | CO6 | A | 6 |
|  | b. | Define composite materials and explain the different types of composites with their applications. | CO6 | A | 6 |
| 23. | a. | Illustrate the motion of electron perpendicular to a uniform magnetic field. | CO3 | An | 6 |
|  | b. | Determine the manner in which the shell states are filled (electronic configuration) with electrons by Pauli exclusion principle. | CO1 | An | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Discuss in detail any one of the method to fabricate composite materials. | CO6 | An | 6 |
|  | b. | Write short notes on Multiferroic materials. | CO6 | A | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the various phase diagrams and their applications. |
| CO2 | Explain the applications of Ferrous alloys. |
| CO3 | Discuss about the electrical properties of materials. |
| CO4 | Summarize the mechanical properties of materials and their measurement. |
| CO5 | Differentiate magnetic, dielectric and superconducting properties of materials. |
| CO6 | Describe the application of modern engineering materials. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 1 | 9 | 12 | - | - | 23 |
| CO2 | 4 | 1 | - | 12 | - | - | 17 |
| CO3 | 1 | 1 | 15 | 6 | - | - | 23 |
| CO4 | 1 | 1 | 9 | 6 | - | - | 17 |
| CO5 | 1 | - | 6 | 9 | - | - | 16 |
| CO6 | 1 | - | 21 | 6 | - | - | 28 |
|  | | | | | | | **124** |

**Graphical user interface, application

Description automatically generated with medium confidence**

**SUPPLEMENTARY EXAMINATION – JUNE 2023**

|  |  |  |  |
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| **Course Code** | **19RO1001** | **Duration :** | **3hrs** |
| **Course Name** | **MATERIAL SCIENCE** | **Max. Marks :** | **100** |

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| **Q. No.** | **Questions** | | | | | | **CO** | | **BL** | | | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | | | | | | | |
| 1. | Identify a secondary bond? | | | | | | CO1 | | R | | | 1 |
| 2. | The atomic number of four elements P, Q, R, S are 8, 10,11 and 17 respectively. Identify the two elements which can react to form ionic compounds? | | | | | | CO1 | | An | | | 1 |
| 3. | Identify the XY line in the given phase diagram? | | |  | | | CO2 | | U | | | 1 |
| 4. | Identify the boundary line between (liquid) and (liquid+solid) regions. | | | | | | CO2 | | An | | | 1 |
| 5. | Explain about conductors. | | | | | | CO3 | | R | | | 1 |
| 6. | List out the use of electron ballistics. | | | | | | CO3 | | An | | | 1 |
| 7. | Define creep and creep strength. | | | | | | CO4 | | E | | | 1 |
| 8. | Define Interstitial solid solution. | | | | | | CO4 | | An | | | 1 |
| 9. | List out two examples of ferroelectric materials. | | | | | | CO5 | | R | | | 1 |
| 10. | Explain superconductors and its types. | | | | | | CO5 | | A | | | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | | | | | | | |
| 11. | | Explain atomic bonding and its types. Explain about three types of primary bonds available in solids. | | | CO1 | | An | | | 3 | | |
| 12. | | Distinguish between brittle and ductile materials with suitable examples. | | | CO2 | | R | | | 3 | | |
| 13. | | Explain about electron theory of metals. | | | CO3 | | A | | | 3 | | |
| 14. | | Elaborate and explain the principle of Vickers hardness test. | | | CO4 | | An | | | 3 | | |
| 15. | | Explain about Ferrite materials and its types. | | | CO5 | | A | | | 3 | | |
| 16. | | Describe about biomimetic materials. | | | CO6 | | U | | | 3 | | |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.no 17 to 23)** | | | | | | | | | | | | |
| 17. | | a. | Define phase diagram and its importance. Describe 1-2-1 rule and lever rule in phase diagram. Draw the Iron-Carbon phase diagram and explain about its different points. | | | CO1 | | An | | | 12 | |
|  | |  |  | | |  | |  | | |  | |
| 18. | | a. | Elaborate the ferrous metals, its types, properties, and uses.  List out six examples of non-ferrous metals.Write the difference between ferrous and non-ferrous metals. | | | CO2 | | A | | | 12 | |
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| 19. | a. | Classify the materials based on their electrical properties. | CO3 | E | 5 |
|  | b. | Explain about band theory in solids. Describe the difference between valence band, conduction band and forbidden band. | CO3 | E | 7 |
|  |  |  |  |  |  |
| 20. | a. | Define strength, toughness, hardness, malleability, and ductility? | CO4 | R | 5 |
| b. | Explain Strengthening mechanisms of materials and four types of strengthening mechanisms of materials. | CO4 | An | 7 |
|  |  |  |  |  |  |
| 21. |  | Describe ferromagnetism. Explain domain theory of magnetism with suitable sketches. Distinguish between hard magnetic materials and soft magnetic materials. | CO5 | E | 12 |
|  |  |  |  |  |  |
| 22. |  | Describe about phase transformation and derive its expressions. Define nucleation rate, and growth rate. | CO2 | An | 12 |
|  |  |  |  |  |  |
| 23. |  | Define the meaning of hardness? List out the types of hardness. Explain about Rockwell hardness test and Brinell hardness test. | CO4 | R | 12 |
|  |  | **Compulsory:** | | | |
| 24. | a. | Describe about liquid crystals and also explain about thermotropic liquid crystals. | CO6 | U | 4 |
| b. | Elaborate ferroic materials with its classifications. Distinguish the difference between ferroelectric and Ferroelastic materials. Note down at least six applications of ferroic materials. | CO6 | An | 8 |

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the various phase diagrams and their applications |
| CO2 | Explain the applications of Ferrous alloys |
| CO3 | Discuss about the electrical properties of materials |
| CO4 | Summarize the mechanical properties of materials and theirmeasurement |
| CO5 | Differentiate magnetic, dielectric and superconducting properties ofmaterials |
| CO6 | Describe the application of modern engineering materials |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 12 | - | 4 | - | - | 17 |
| CO2 | 3 | 1 | 12 | 13 | - | - | 29 |
| CO3 | 8 | - | 3 | 1 | 5 | - | 17 |
| CO4 | 17 | 7 | - | 4 | 1 | - | 29 |
| CO5 | 1 | - | 4 | - | 12 | - | 17 |
| CO6 | - | 7 | - | 8 | - | - | 15 |
|  | | | | | | | **124** |



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| **Course Code** | **19RO1002** | **Duration** | **3hrs** |
| **Course Name** | **ENGINEERING PRACTICES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Give the name of the tool used for holding the carpentry work piece. | | CO1 | R | 1 |
| 2. | A tool which is used for cutting the work piece is called \_\_\_\_\_\_\_\_\_\_ | | CO1 | R | 1 |
| 3. | Name one type of domestic wiring. | | CO2 | R | 1 |
| 4. | The Fuse is used for \_\_\_\_\_\_\_\_\_\_\_\_. | | CO2 | R | 1 |
| 5. | Expand CRO. | | CO3 | R | 1 |
| 6. | The instrument which produces a signal of desired wavelength and type is called as \_\_\_\_\_\_\_\_\_\_\_\_\_. | | CO3 | R | 1 |
| 7. | Name a type of DC motor. | | CO4 | R | 1 |
| 8. | If the torque of a motor is high then \_\_\_\_\_\_\_\_\_\_ load can be applied. | | CO4 | U | 1 |
| 9. | Expand PCB. | | CO5 | R | 1 |
| 10. | \_\_\_\_\_\_\_\_\_ is used for cleaning the masked PCB. | | CO5 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | How do you make a rectangular planning in carpentry? | | CO1 | U | 3 |
| 12. | State the principle of a motor. | | CO2 | U | 3 |
| 13. | A square wave has high-dut cycle of 90%. Give significance with the diagram. | | CO3 | R | 3 |
| 14. | List different types of AC and DC motors. | | CO4 | U | 3 |
| 15. | Justify the increment in pad width in a PCB design. | | CO5 | R | 3 |
| 16. | Give steps for punching a hole in an object using TINKER CAD. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Explain the procedure of measuring a potential and the current associated with it including neat diagrams. Give insights on the experimental setup also with method of tabulation and inferences. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 18. |  | List different types of domestic wiring and explain any two in details with circuit diagrams. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | Discuss briefly the characteristics of a function generator with neat diagrams. | CO3 | An | 6 |
|  |  | Discuss the Cathode Ray Oscilloscope and justify the need for visualization of a signal in real-time with practical procedures. | CO3 | U | 6 |
|  |  |  |  |  |  |
| 20. |  | Elaborate on the step-by-step PCB designing procedure of an AND/OR gate with a suitable diagram. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | Discuss in detail the PCB fabrication process and also give insights into the various etching methods available in today’s market. | CO5 | An | 12 |
|  |  |  |  |  |  |
| 22. | a. | Explain the practical procedure to measure a given signal and elaborate on how a signal’s characteristics are measured. | CO3 | A | 8 |
|  | b. | Give insights on Blender Software. | CO6 | A | 4 |
|  |  |  |  |  |  |
| 23. |  | Give detailed procedure for troubleshooting a DC Motor with necessary diagrams. | CO4 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Give detailed procedure for creating the following 3-D models using TINKER CAD/Blender Software   1. Prosthetic Limb 2. DNA 3. Kidney | CO6 | An | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Assemble mechanical devices and equipment by applying basic carpentry. |
| CO2 | Design simple electric circuits and apply different types of wiring. |
| CO3 | Identify the operation and handling of measuring instruments. |
| CO4 | Perform troubleshooting of electric motors. |
| CO5 | Fabricate PCB boards for specific applications. |
| CO6 | Create and fabricate 3-D models. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 3 | - | - | - | - | 5 |
| CO2 | 2 | 3 | 12 | - | - | - | 17 |
| CO3 | 5 | 6 | 20 | 6 | - | - | 37 |
| CO4 | 1 | 4 | 12 | - | - | - | 17 |
| CO5 | 5 | - | 12 | 12 | - | - | 29 |
| CO6 | 3 | - | 4 | 12 | - | - | 19 |
|  | | | | | | | **124** |



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| **Course Code** | **19RO2001** | **Duration** | **3hrs** |
| **Course Name** | **THEORY AND PROGRAMMING OF CNC MACHINES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | G-code in part program is known as\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_word. | | CO1 | U | 1 |
| 2. | The purpose of a ball screw in a CNC lathe machine is \_\_\_\_\_\_\_\_\_\_\_. | | CO1 | U | 1 |
| 3. | Define PLC according to National Electrical Manufacturing Association. | | CO2 | R | 1 |
| 4. | List two few merits of using PLC controllers. | | CO2 | R | 1 |
| 5. | Define the frictional force. | | CO3 | U | 1 |
| 6. | State the main difference between relay and contactor. | | CO4 | R | 1 |
| 7. | Draw the circuit for circuit breaker. | | CO4 | U | 1 |
| 8. | DNC stands for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. | | CO5 | R | 1 |
| 9. | The use of G00 code is \_\_\_\_\_\_\_\_\_\_\_\_\_. | | CO5 | U | 1 |
| 10. | Define is machining cost? | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Compare CNC over NC machine tools with their advantages and disadvantages. | | CO1 | A | 3 |
| 12. | State the functions of controllers of CNC machines. | | CO2 | U | 3 |
| 13. | Tabulate the differences between AC and DC motors. | | CO3 | An | 3 |
| 14. | Discuss the differences between circuit breakers and Isolators. | | CO4 | An | 3 |
| 15. | Draw and explain one block of NC program which can be read by MCU. | | CO5 | A | 3 |
| 16. | Discuss briefly the factors influencing the selection of CNC machines. | | CO6 | An | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. | a. | Describe the merits, demerits and applications of a CNC machine tool. | CO1 | U | 6 |
|  | b. | Illustrate the working of CNC lathe with a neat diagram. | CO1 | A | 6 |
|  |  |  |  |  |  |
| 18. | a. | Elaborate the important features and the principle of operation of a CNC machine tool. | CO2 | An | 6 |
|  | b. | Discuss the principle of operation of an automatic tool changer. | CO2 | U | 6 |
|  |  |  |  |  |  |
| 19. | a. | Describe the working principle of DC servo motor with neat diagram with one industrial application. | CO3 | A | 8 |
|  | b. | Classify various stepper motors and discuss the working of PM type stepper motor. | CO3 | A | 4 |
|  |  |  |  |  |  |
| 20. | a. | Illustrate the following with neat sketches: MCB, MCCB, RCCB, ELCB. | CO4 | U | 8 |
|  | b. | Discuss the control relays used in a CNC machine, explain it’s working with a neat sketch? | CO4 | A | 4 |
|  |  |  |  |  |  |
| 21. | a. | Illustrate G84 Threaded Canned Cycle. | CO5 | An | 2 |
|  | b. | For the following part geometry:   1. Define the points in absolute and incremental coordinate systems. 2. Write the part program for the geometry. | CO5 | E | 10 |
|  |  |  |  |  |  |
| 22. | a. | List out main objectives of preventive maintenance of CNC machines. | CO6 | R | 4 |
|  | b. | Discuss the practical aspects to consider during the introduction of CNC. | CO6 | An | 4 |
|  | c. | State the benefits of accurately designed and installed electrical systems. | CO6 | A | 4 |
|  |  |  |  |  |  |
| 23. | a. | Define the production cost and the costs involved in carrying out a machining operation. | CO6 | U | 6 |
|  | b. | Describe the prominent factors involved in the economics of CNC machine tools. | CO6 | A | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Describe the working of rotary encoders in CNC machines with neat diagram. | CO4 | An | 4 |
|  | b. | Illustrate the working of Capacitive and Inductive type proximity sensors with neat sketches. | CO4 | An | 8 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
|  | The Student will be able to |
| CO1 | Classify the types of CNC machines and read their electrical circuit diagram. |
| CO2 | Select the parameters for optimum performance and read the PLC ladder diagram with reference to the PLC I/Os. |
| CO3 | Perform the sizing of servomotors and do drive optimization. |
| CO4 | Design electrical power, and control circuits for a CNC machine and interface various sensors to CNC/PLC. |
| CO5 | Develop CNC programs for lathes, select the right tools, take offsets and do machining of a component. |
| CO6 | Estimate the machine hour rate of a CNC machine and do the regular and preventive maintenance. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 0 | 8 | 9 |  |  |  | 17 |
| CO2 | 2 | 9 |  | 6 |  |  | 17 |
| CO3 |  | 1 | 12 | 3 |  |  | 16 |
| CO4 | 1 | 9 | 4 | 15 |  |  | 29 |
| CO5 | 1 | 1 | 3 | 2 | 10 |  | 17 |
| CO6 | 5 | 6 | 10 | 7 |  |  | 28 |
|  | | | | | | | **124** |



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| **Course Code** | **19RO2002** | **Duration** | **3hrs** |
| **Course Name** | **AUTONOMOUS VEHICLES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define Breaking Valve Actuator. | | CO1 | R | 1 |
| 2. | Mention the first autonomous vehicle parts. | | CO1 | R | 1 |
| 3. | List the Entertainment Services in Car. | | CO2 | U | 1 |
| 4. | Define ADAS. | | CO2 | U | 1 |
| 5. | Write the PID Controller Equation. | | CO6 | A | 1 |
| 6. | List the two types of Night Vision Technology. | | CO3 | R | 1 |
| 7. | Define Driverless Car. | | CO4 | U | 1 |
| 8. | List the autonomous car manufacturer in India. | | CO5 | R | 1 |
| 9. | Write the security issue in AV. | | CO6 | An | 1 |
| 10. | Mention the present automation level of Autonomous car in India. | | CO5 | A | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | List the Infotainment system in car. | | CO1 | R | 3 |
| 12. | Differentiate RADAR and LIDAR. | | CO2 | R | 3 |
| 13. | Write the Components of Machine Vision System. | | CO3 | U | 3 |
| 14. | Define IVC. | | CO4 | U | 3 |
| 15. | List the applications of Connected Car Technology. | | CO4 | R | 3 |
| 16. | Write the various controllers used in vehicle actuation. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Describe the working of LIDAR with an Adaptive Cruise Control Interfaces. | CO2 | R | 12 |
|  |  |  |  |  |  |
| 18. |  | Explain the different types of Chassis with neat sketch. | CO1 | R | 12 |
|  |  |  |  |  |  |
| 19. |  | Illustrate the new features in the Connected car technology with DSRC. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 20. |  | Summarize the various levels of automation in AV with a suitable example. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 21. |  | Explain the different methods used in advanced driver assistance systems to maximize the driver safety. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 22. |  | Describe in detail on PID Controller design in AV. | CO6 | An | 12 |
|  |  |  |  |  |  |
| 23. |  | Summarize the Neural network architectures with its method to classify the Image. | CO3 | R | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Describe the challenges in AV in the aspects of technical, security and legal issues. | CO6 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Describe the evolution of Automotive Electronics and the operation of ECUs. |
| CO2 | Compare the different type of sensing mechanisms involved in Autonomous Vehicles. |
| CO3 | Discuss about the use of computer vision and learning algorithms in vehicles. |
| CO4 | Summarize the aspects of connectivity fundamentals existing in a driverless car. |
| CO5 | Identify the different levels of automation involved in an Autonomous Vehicle. |
| CO6 | Outline the various controllers employed in vehicle actuation. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 17 | - | - | - | - | - | 17 |
| CO2 | 15 | 14 | - | - | - | - | 29 |
| CO3 | 13 | 3 | - | - | - | - | 16 |
| CO4 | 3 | 4 | 12 | - | - | - | 19 |
| CO5 | 1 | 12 | 1 | - | - | - | 14 |
| CO6 | 3 | - | 13 | 13 | - | - | 29 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **19RO2005** | **Duration** | **3hrs** |
| **Course Name** | **INDUSTRIAL ROBOTICS AND MATERIAL HANDLING SYSTEMS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | The word Robot comes from \_\_\_\_\_\_\_\_\_\_. | | CO1 | R | 1 |
| 2. | Write the establishment year of the first mobile Robot. | | CO1 | R | 1 |
| 3. | Describe any one type of robot interface method. | | CO2 | R | 1 |
| 4. | Write the frequently used colour scale for image segmentation. | | CO2 | U | 1 |
| 5. | Describe the average size of the paint droplet. | | CO3 | U | 1 |
| 6. | Write the temperature range of the welding. | | CO3 | R | 1 |
| 7. | List the disadvantages of vacuum Grippers. | | CO4 | R | 1 |
| 8. | List the prominent uses of industrial robots. | | CO5 | R | 1 |
| 9. | Summarize the types of barcodes. | | CO6 | U | 1 |
| 10. | Write the stacking load height of the unit load ASRS. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Illustrate in-line robot work cell. | | CO1 | U | 3 |
| 12. | List the different types of optical aids used in visual inspection. | | CO2 | R | 3 |
| 13. | State the importance of Micro class remotely operated underwater vehicles (ROV). | | CO3 | R | 3 |
| 14. | Define degrees of freedom. | | CO4 | R | 3 |
| 15. | Write short notes on Robot controller features. | | CO5 | U | 3 |
| 16. | Discuss industrial monorails. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Discuss in detail the various types of industrial robots. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 18. |  | Discuss the detailed procedure of Robotic vision systems. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. |  | Write the detailed procedure of Robotic cleaning. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. |  | Classify the different types of grippers. Discuss them in detail. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. |  | Explain the various influencing factors for selecting a robot. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 22. |  | Describe Robotic vision systems; discuss the detailed process of Robotic vision systems. | CO2 | R | 12 |
|  |  |  |  |  |  |
| 23. |  | Analyze the various underwater applications of Robots. | CO3 | An | 12 |
|  |  |  |  |  |  |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Explain automated guided vehicle systems. | CO6 | U | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Differentiate the various types of Industrial Robots and their architecture. |
| CO2 | Apply the concepts of image processing for robotic inspection systems. |
| CO3 | Analyze the applications of robots in various industrial application. |
| CO4 | Design and fabricate simple grippers for pick and place application. |
| CO5 | Identify the right Robot for a given industrial application. |
| CO6 | Select the right material handling system for a given application |

|  |  |  |  |  |  |  |  |
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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 15 | - | - | - | - | 17 |
| CO2 | 16 | 13 |  | - | - | - | 29 |
| CO3 | 3 | 2 | 12 | 12 | - | - | 29 |
| CO4 | 4 | 12 | - | - | - | - | 16 |
| CO5 | 1 | 15 | - | - | - | - | 16 |
| CO6 | - | 16 | 1 | - | - | - | 17 |
|  | | | | | | | **124** |



|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **19RO2007** | **Duration** | **3hrs** |
| **Course Name** | **COGNITIVE ROBOTICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Name the factors that affect visual perception. | | CO1 | R | 1 |
| 2. | List any two soft computing tools. | | CO1 | R | 1 |
| 3. | What is traverse boundary? | | CO2 | U | 1 |
| 4. | Identify the software used for robot simulation. | | CO2 | R | 1 |
| 5. | What are probabilistic roadmaps? | | CO3 | R | 1 |
| 6. | Recall the usage of Voronoi diagram in cognitive robotics. | | CO3 | R | 1 |
| 7. | Identify the primary challenge of implementing SLAM in landmark worlds. | | CO4 | A | 1 |
| 8. | Relate the importance of graph-based optimization techniques. | | CO4 | U | 1 |
| 9. | What is the role of sensors in robot programming? | | CO5 | R | 1 |
| 10. | Interpret the purpose of the Sonar Display. | | CO5 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Differentiate: top-down and bottom-up processing in visual perception. | | CO1 | An | 3 |
| 12. | Outline the advantages of robot simulation. | | CO2 | U | 3 |
| 13. | Explain how probabilistic roadmaps helps in improving robot path planning. | | CO3 | U | 3 |
| 14. | Summarize the limitations of extended Kalman filter. | | CO4 | U | 3 |
| 15. | Distinguish between: Autonomous and Tele-Operated Robots. | | CO5 | An | 3 |
| 16. | Examine how building perception helps robots navigate in complex environments. | | CO6 | An | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Explain the process of visual perception, including the different stages and the role of the brain in this process. | CO1 | U | 6 |
|  | b. | Discuss the relationship between attention and memory in the model of cognition. | CO1 | A | 6 |
|  |  |  |  |  |  |
| 18. | a. | Elaborate the process of constructing a 2D world map. | CO2 | A | 6 |
|  | b. | Summarize the data structure used in map building with its advantages and disadvantages. | CO2 | U | 6 |
|  |  |  |  |  |  |
| 19. |  | Interpret the limitations and challenges of robot path planning, including issues related to computational complexity, real-time performance, and uncertainty. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. |  | Compare and contrast the different paradigms used in SLAM, including their advantages and disadvantages. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 21. |  | Illustrate with example various components of an autonomous navigation robot. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 22. |  | Discuss the role of robot simulation in map building and how it is used to test and validate the map algorithm. | CO2 | C | 12 |
|  |  |  |  |  |  |
| 23. |  | Explain the process of constructing a visibility graph and how it is used in robot path planning. | CO3 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Elaborate the role of building perception in robot navigation and control, and discuss the algorithms used to implement this function. | CO6 | C | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Discuss about the basics of robot cognition and perception. |
| CO2 | Illustrate the different methods of map building and the robot simulation and execution of a program. |
| CO3 | Analyze the various path planning techniques by briefing about the robot’s environment and |
| CO4 | explaining about the programs used. |
| CO5 | Develop knowledge about simultaneous localization and mapping based techniques and paradigms. |
| CO6 | Elaborate the various robot programming packages for display,tele-operation and other applications. |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 6 | 6 | 3 |  |  | 17 |
| CO2 | 1 | 10 | 6 |  |  | 12 | 29 |
| CO3 | 2 | 27 |  |  |  |  | 29 |
| CO4 |  | 4 | 1 | 12 |  |  | 17 |
| CO5 | 1 | 13 |  | 3 |  |  | 17 |
| CO6 |  |  |  | 3 |  | 12 | 15 |
|  | | | | | | | **124** |

**Graphical user interface, application

Description automatically generated with medium confidence**

**SUPPLEMENTARY EXAMINATION – JUNE 2023**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **19RO2009** | **Duration** | **3hrs** |
| **Course Name** | **MEDICAL ROBOTICS** | **Max. Marks** | **100** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Expand UAV. | | CO1 | R | 1 |
| 2. | List any two important features of medical robots. | | CO1 | R | 1 |
| 3. | Define degrees of freedom. | | CO2 | R | 1 |
| 4. | Interpret the term gait. | | CO2 | R | 1 |
| 5. | Mention any two methods for localization in neurosurgery. | | CO3 | R | 1 |
| 6. | Give the other name of LINAC system in radiosurgery. | | CO3 | R | 1 |
| 7. | Mention the full form of TMR. | | CO4 | R | 1 |
| 8. | Interpret the term OCT. | | CO4 | R | 1 |
| 9. | Expand ADA. | | CO5 | R | 1 |
| 10. | Indicate any one pediatric exoskeleton. | | CO5 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Write short notes on the features of medical robots. | | CO1 | U | 3 |
| 12. | State the applications of the optical technology-based position sensors. | | CO2 | U | 3 |
| 13. | Sketch the schematic diagram of human heart. | | CO3 | U | 3 |
| 14. | Illustrate the concept of fibres in endoscopy. | | CO4 | U | 3 |
| 15. | List out the advantages of the robotic surgery. | | CO5 | U | 3 |
| 16. | State the concept of objectives tree method. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. | a. | Explain the concept of navigation in robots. | CO1 | U | 6 |
|  | b. | Illustrate the concept of prosthetics in healthcare with necessary example. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | Illustrate the features of rehabilitation robots in detail. | CO1 | U | 6 |
|  | b. | Analyze the importance of robotics in the field of healthcare. | CO1 | AN | 6 |
|  |  |  |  |  |  |
| 19. | a. | Describe the working of mechanical based position sensors used for robotic surgery. | CO2 | U | 6 |
|  | b. | Describe the application of vision based robotic surgery. | CO2 | U | 6 |
|  |  |  |  |  |  |
| 20. | a. | Illustrate the concept and the steps involved in radiosurgery. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 21. | a. | Discuss the construction and working of deep brain stimulation. | CO4 | U | 8 |
|  | b. | Explain the concept of cochlear implant in detail. | CO4 | U | 4 |
|  |  |  |  |  |  |
| 22. | a. | Describe the procedure involved in orthopedic surgery. | CO4 | U | 6 |
|  | b. | Explain any one application of assistive robot used in the operation theatre. | CO5 | U | 6 |
|  |  |  |  |  |  |
| 23. | a. | Demonstrate the procedure involved in urological surgery. | CO3 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Illustrate the examples of medical robots and their requirements for the various field of applications. | CO6 | U | 6 |
|  | b. | Describe the importance of actuators used in the design of medical robots. | CO6 | U | 6 |

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Describe the types of medical robots and the concepts of navigation and motion replication |
| CO2 | Discuss about the sensors used for localization and tracking |
| CO3 | Summarize the applications of surgical robotics |
| CO4 | Outline the concepts in Rehabilitation of limbs and brain machine interface |
| CO5 | Classify the types of assistive robots |
| CO6 | Analyze the design characteristics, methodology and technological choices for medical robots |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 2 | 27 |  | 6 |  |  | 29 |
| CO2 | 2 | 15 |  |  |  |  | 17 |
| CO3 | 2 | 27 |  |  |  |  | 29 |
| CO4 | 2 | 21 |  |  |  |  | 23 |
| CO5 | 2 | 9 |  |  |  |  | 11 |
| CO6 |  | 15 |  |  |  |  | 15 |
|  | | | | | | | **124** |



|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **19RO2009** | **Duration** | **3hrs** |
| **Course Name** | **MEDICAL ROBOTICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | List out any 2 types of medical robots. | | CO1 | U | 1 |
| 2. | State the meaning of degrees of freedom. | | CO1 | U | 1 |
| 3. | Interpret the term GPS. | | CO2 | U | 1 |
| 4. | Define gait. | | CO2 | U | 1 |
| 5. | Mention the other name of gamma knife system in radiosurgery. | | CO3 | U | 1 |
| 6. | Identify the long instrument inserted into a small skin incision. | | CO3 | U | 1 |
| 7. | Define physiotherapy. | | CO4 | U | 1 |
| 8. | Expand EMG. | | CO4 | U | 1 |
| 9. | Mention the name of the self balancing wheelchair robot. | | CO5 | U | 1 |
| 10. | Indicate any two benefits of assistive robots. | | CO5 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Mention the benefits of medical robots. | | CO1 | R | 3 |
| 12. | Write short notes on calypso-varian system. | | CO2 | R | 3 |
| 13. | Describe about the metal frame constructed by Scientist Lars Leksell. | | CO3 | R | 3 |
| 14. | Briefly describe the working of the tendon-drive hand system which is the basic rehabilitation device | | CO4 | R | 3 |
| 15. | Give details on the benefits of robotic surgery. | | CO5 | R | 3 |
| 16. | Discuss the kinematic and dynamic specifications followed in endoscopic surgery. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. | a. | Describe the various generation medical robots in detail. | CO1 | U | 6 |
|  | b. | Illustrate the application of motion replication in detail. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | Describe the working of any 2 position sensors in detail. | CO2 | U | 6 |
|  | b. | Analyze the importance of location and tracking in the robotic surgery. | CO2 | AN | 6 |
|  |  |  |  |  |  |
| 19. |  | With required diagrams, explain the working of cardiac system and illustrate the steps involved in cardiac surgery. | CO3 | R | 12 |
|  |  |  |  |  |  |
| 20. | a. | Explain the steps involved in radiosurgery and explain the types of radiosurgeries in detail. | CO4 | U | 8 |
|  | b. | Describe the importance of rehabilitation robots for elders. | CO4 | U | 4 |
|  |  |  |  |  |  |
| 21. | a. | Demonstrate the working of rehabilitation robots for limbs with necessary diagrams. | CO4 | U | 8 |
|  | b. | Describe any one application of assistive robots. | CO5 | U | 4 |
|  |  |  |  |  |  |
| 22. |  | With necessary diagrams, explain the construction and working of brain machine interfaces using electrodes and EMG data. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 23. |  | Illustrate the construction and working of walk assistive robots in detail with necessary diagrams. | CO5 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Describe the analysis of the medical surgical gestures of the various field of applications. | CO6 | U | 6 |
|  | b. | Illustrate the importance of sensors in the design of medical robots. | CO6 | U | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Describe the types of medical robots and the concepts of navigation and motion replication. |
| CO2 | Discuss about the sensors used for localization and tracking. |
| CO3 | Summarize the applications of surgical robotics. |
| CO4 | Outline the concepts in Rehabilitation of limbs and brain machine interface. |
| CO5 | Classify the types of assistive robots. |
| CO6 | Analyze the design characteristics, methodology and technological choices for medical robots. |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 3 | 14 |  |  |  |  | 17 |
| CO2 | 3 | 8 |  | 6 |  |  | 17 |
| CO3 | 15 | 2 |  |  |  |  | 17 |
| CO4 | 3 | 34 |  |  |  |  | 37 |
| CO5 | 3 | 18 |  |  |  |  | 21 |
| CO6 | 3 | 12 |  |  |  |  | 15 |
|  | | | | | | | **124** |



**SUPPLEMENTARY EXAMINATION – JUNE 2023**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **19RO2010** | **Duration** | **3hrs** |
| **Course Name** | **MACHINE LEARNING FOR ROBOTICS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | What do you mean by a well–posed learning problem? | | CO1 | U | 1 |
| 2. | State Bayes Theorem? | | CO1 | R | 1 |
| 3. | What is gini index? | | CO2 | R | 1 |
| 4. | Why is the KNN Algorithm known as Lazy Learner? | | CO2 | R | 1 |
| 5. | How a decision tree can be pruned? | | CO3 | U | 1 |
| 6. | Name the Kernel functions used in SVM. | | CO3 | R | 1 |
| 7. | List the different types of clustering. | | CO4 | U | 1 |
| 8. | Can PCA be used to reduce the dimensionality of a highly nonlinear dataset? | | CO4 | R | 1 |
| 9. | Define the R squared statistical measure of regression model. | | CO5 | U | 1 |
| 10. | Point out the significance of various activation functions with  Mathematical equations. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Write the performance metrics formulas for accuracy, sensitivity and specificity? | | CO1 | An | 3 |
| 12. | Compare linear regression with logistic regression | | CO2 | U | 3 |
| 13. | Explain the steps involved in Naïve Bayesian Classifier | | CO3 | A | 3 |
| 14. | Outline the similarities and differences between divisive clustering and agglomerative(AGNES) clustering.. | | CO4 | U | 3 |
| 15. | What is a Perceptron? Explain the working of a perceptron with a neat diagram. | | CO5 | U | 3 |
| 16. | Draw the network for single layer ANN and Multilayer ANN? | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Define machine learning. Mention its application in various fields. | CO1 | U | 8 |
|  | b. | Distinguish between supervised learning and Unsupervised learning. Illustrate with an example. | CO1 | U | 4 |
|  |  |  |  |  |  |
| 18. | a. | The decision on whether tennis can be played or not is based on the following features: Outlook E {Sunny, Overcast, Rain}, Temperature E {Hot, Mild, Cool}, Humidity E {High, Normal} and Wind E {Weak, Strong}. The training data is given in the table. Which attribute will be the root of the decision tree and how much is the information gain due to Outlook{Sunny, Overcast, Rain},Temperature{Hot, Mild, Cool}, Humidity{High, Normal} and Wind attributes {High, Normal}.   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **Day** | **Outlook** | **Temperature** | **Humidity** | **Wind** | **Play Tennis** | | 1 | Sunny | Hot | High | Weak | No | | 2 | Sunny | Hot | High | Strong | No | | 3 | Overcast | Hot | High | Weak | Yes | | 4 | Rain | Mild | High | Weak | Yes | | 5 | Rain | Cool | Normal | Weak | Yes | | 6 | Rain | Cool | Normal | Strong | No | | 7 | Overcast | Cool | Normal | Strong | Yes | | 8 | Sunny | Mild | High | Weak | No | | 9 | Sunny | Cool | Normal | Weak | Yes | | 10 | Rain | Mild | Normal | Weak | Yes | | 11 | Sunny | Mild | Normal | Strong | Yes | | 12 | Overcast | Mild | High | Strong | Yes | | 13 | Overcast | Hot | Normal | Weak | Yes | | 14 | Rain | Mild | High | Strong | No | | CO2 | An | 12 |
|  |  |  |  |  |  |
| 19. | a. | Describe k-nearest neighbor algorithm with an example and explain why is it called instance based learning? | CO4 | U | 12 |
|  |  |  |  |  |  |
| 20. | a. | What is Principal component analysis? With the help of an example, how the dimensionality reduction can be done using Principal component analysis with the necessary steps.. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. | a. | With neat diagrams, illustrate the electrical operations and chemical operations within the human brain. Also, outline the significances of human brain in comparison to the computer | CO5 | U | 12 |
|  |  |  |  |  |  |
| 22. | a. | Infer the role of the following in support vector machine: hyper plane, support vectors, distance margin and kernels. Justify support vector machine is better than linear classifiers. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 23. | a. | Assume, you want to cluster 8 observations A1(2, 10), A2(2, 5), A3(8, 4), A4(5, 8), A5(7, 5), A6(6, 4), A7(1, 2), A8(4, 9) into 3 clusters A1(2, 10), A4(5, 8) and A7(1, 2) using K-Means clustering algorithm. What will be the cluster centroids if you want to proceed after first iteration? | CO4 | An | 12 |
|  |  |  |  |  |  |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Discuss the application of the neural network which is used for learning to steer an autonomous vehicle? | CO6 | An | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | **COURSE OUTCOMES** | | | | | | | |
| CO1 | | Discuss about the concepts of machine learning | | | | | | | |
| CO2 | | Describe the types of trees and bias | | | | | | | |
| CO3 | | Outline the supervised learning methods with various case studies | | | | | | | |
| CO4 | | Compare the learning methodologies and dimensionality concepts | | | | | | | |
| CO5 | | Summarize the applications of neural networks in robotic applications. | | | | | | | |
| CO6 | | Illustrate the applications of machine learning using case studies. | | | | | | | |
| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | | | |
| **CO / P** | | **R** | **U** | **A** | **An** | **E** | **C** | **Total** | |
| CO1 | | 1 | 13 |  | 3 |  |  | 17 | |
| CO2 | | 2 | 3 |  | 12 |  |  | 17 | |
| CO3 | | 1 | 25 |  | 3 |  |  | 29 | |
| CO4 | | 1 | 4 | 12 | 12 |  |  | 29 | |
| CO5 | |  | 16 |  |  |  |  | 16 | |
| CO6 | |  | 4 |  | 12 |  |  | 16 | |
|  | | | | | | | | **124** | |



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| **Course Code** | **19RO2010** | **Duration** | **3hrs** |
| **Course Name** | **MACHINE LEARNING FOR ROBOTICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | What do you mean by a well–posed learning problem? | | CO1 | U | 1 |
| 2. | State Bayes Theorem? | | CO1 | R | 1 |
| 3. | What are tree based classifiers? | | CO2 | R | 1 |
| 4. | Why is the KNN Algorithm known as Lazy Learner? | | CO2 | R | 1 |
| 5. | How can a decision tree be pruned? | | CO3 | U | 1 |
| 6. | Consider the two data points x=(1,2) and y=(2,3). Apply the RBF kernel and find the value of RBF kernel for these points. | | CO3 | R | 1 |
| 7. | List the different methods of Hierarchical Clustering | | CO4 | U | 1 |
| 8. | Can PCA be used to reduce the dimensionality of a highly nonlinear dataset? | | CO4 | R | 1 |
| 9. | Draw the network for single layer ANN and multilayer ANN. | | CO5 | U | 1 |
| 10. | Point out the significance of various activation functions with  Mathematical equations. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Construct a confusion matrix and calculate the performance metrics for the following experiment. For the classification of images into normal subject and EEG subject, a total number of 120 images were used, in which 60 images represent the normal subject and 60 images represent the EEG subject. Upon the classification using ANN, 50 true normal subject images were classified as normal subject and 45 true EEG subject images were classified as EEG subject. | | CO1 | An | 3 |
| 12. | Compare K-mean clustering with KNN algorithm. | | CO2 | U | 3 |
| 13. | Interpret the Logistic regression equations. | | CO3 | An | 3 |
| 14. | Compare and contrast agglomerative and divisive hierarchical clustering. | | CO4 | U | 3 |
| 15. | What is a Perceptron? Explain the working of a perceptron with a neat diagram. | | CO5 | U | 3 |
| 16. | Explain the bias variance tradeoff with an example. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. |  | Discuss in detail the parametric based approaches used in classification and regression. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. |  | The decision on whether tennis can be played or not is based on the following features: Outlook E {Sunny, Overcast, Rain}, Temperature E {Hot, Mild, Cool}, Humidity E {High, Normal} and Wind E {Weak, Strong}. The training data is given in the table. Which attribute will be the root of the decision tree and how much is the information gain due to Outlook{Sunny, Overcast, Rain},Temperature{Hot, Mild, Cool}, Humidity{High, Normal} and Wind attributes {High, Normal}.   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **Day** | **Outlook** | **Temperature** | **Humidity** | **Wind** | **Play Tennis** | | 1 | Sunny | Hot | High | Weak | No | | 2 | Sunny | Hot | High | Strong | No | | 3 | Overcast | Hot | High | Weak | Yes | | 4 | Rain | Mild | High | Weak | Yes | | 5 | Rain | Cool | Normal | Weak | Yes | | 6 | Rain | Cool | Normal | Strong | No | | 7 | Overcast | Cool | Normal | Strong | Yes | | 8 | Sunny | Mild | High | Weak | No | | 9 | Sunny | Cool | Normal | Weak | Yes | | 10 | Rain | Mild | Normal | Weak | Yes | | 11 | Sunny | Mild | Normal | Strong | Yes | | 12 | Overcast | Mild | High | Strong | Yes | | 13 | Overcast | Hot | Normal | Weak | Yes | | 14 | Rain | Mild | High | Strong | No | | CO2 | An | 12 |
|  |  |  |  |  |  |
| 19. |  | The following example gives data about the stolen vehicles. Using Naïve Bayesian classifier classify the new data.(Red, SUV, Domestic).   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | S. No | Color | Type | | Origin | Stolen | | 1 | Red | Sports | Domestic | | Yes | | 2 | Red | Sports | Domestic | | No | | 3 | Red | Sports | Domestic | | Yes | | 4 | Yellow | Sports | Domestic | | No | | 5 | Yellow | Sports | Imported | | Yes | | 6 | Yellow | SUV | Imported | | No | | 7 | Yellow | SUV | Imported | | Yes | | 8 | Yellow | SUV | Domestic | | No | | 9 | Red | SUV | Imported | | No | | 10 | Red | Sports | Imported | | Yes | | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. |  | Consider the two dimensional patterns (2, 1), (3, 5), (4, 3), (5, 6), (6, 7), (7, 8), (8,9). Compute the principal component using PCA Algorithm. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | Draw the model and explain the algorithm for back propagation. Derive the necessary equations to derive the propagation error. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 22. |  | Infer the role of the following in support vector machine: hyper plane, support vectors, distance margin and kernels. Justify support vector machine is better than linear classifiers. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 23. |  | Assume, you want to cluster 8 observations A1(2, 10), A2(2, 5), A3(8, 4), A4(5, 8), A5(7, 5), A6(6, 4), A7(1, 2), A8(4, 9) into 3 clusters A1(2, 10), A4(5, 8) and A7(1, 2) using K-Means clustering algorithm. What will be the cluster centroids if you want to proceed after second iteration? | CO4 | An | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Illustrate the real time application of convolution neural network used in Line following Robot. | CO6 | An | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Discuss about the concepts of machine learning. |
| CO2 | Describe the types of trees and bias. |
| CO3 | Outline the supervised learning methods with various case studies. |
| CO4 | Compare the learning methodologies and dimensionality concepts. |
| CO5 | Summarize the applications of neural networks in robotic applications. |
| CO6 | Illustrate the applications of machine learning using case studies. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 1 | 12 | 3 |  |  | 17 |
| CO2 | 2 | 3 |  | 12 |  |  | 17 |
| CO3 | 1 | 25 |  | 3 |  |  | 29 |
| CO4 | 1 | 4 | 12 | 12 |  |  | 29 |
| CO5 |  | 16 |  |  |  |  | 16 |
| CO6 |  | 4 |  | 12 |  |  | 16 |
|  | | | | | | | **124** |

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| **Course Code** | **19RO2012** | **Duration** | **3hrs** |
| **Course Name** | **ARTIFICIAL INTELLIGENCE IN ROBOTICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | List any two artificial intelligent systems used in our daily-routine. | | CO1 | R | 1 |
| 2. | Define the stochastic environment for an agent. | | CO1 | R | 1 |
| 3. | Recall leaf node in a search tree. | | CO2 | R | 1 |
| 4. | Define the term unary constraint. | | CO2 | R | 1 |
| 5. | Indicate the appropriate technique used for creating a representation of planning in AI. | | CO3 | U | 1 |
| 6. | Identify the admissible heuristic estimate for state-space search. | | CO3 | U | 1 |
| 7. | Enumerate the advantages of Bayesian view of learning. | | CO4 | R | 1 |
| 8. | Identify the goal of reinforcement learning. | | CO4 | R | 1 |
| 9. | Recall prior probability of an event. | | CO5 | R | 1 |
| 10. | Show the significance of cognition. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Describe the simple reflex agent with a suitable block diagram. | | CO1 | U | 3 |
| 12. | Enumerate the various informed and uninformed search strategies. | | CO2 | R | 3 |
| 13. | Describe the partial-order plan for the shoes and socks problem. | | CO3 | U | 3 |
| 14. | List the applications of natural language processing. | | CO4 | R | 3 |
| 15. | Justify the need of probabilistic reasoning in AI. | | CO5 | U | 3 |
| 16. | Summarize the ethics of computing. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Describe the components of basic artificial neuron with a suitable diagram. | CO1 | U | 4 |
|  | b. | Tabulate the PEAS description of the task environment for the medical diagnosis system, part-picking robot and an automated taxi driver. | CO1 | R | 8 |
|  |  |  |  |  |  |
| 18. | a. | Discuss in detail the syntax and semantics of first order logic. | CO2 | U | 6 |
|  | b. | Illustrate the crypt arithmetic problem in constraint satisfaction programming with suitable examples. | CO2 | U | 6 |
|  |  |  |  |  |  |
| 19. |  | Discuss the forward state-space search and backward state-space search planning algorithm. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. |  | Explain the ‘surprise candy’ problem and predict the flavor of the next piece of candy using statistical learning methods. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. | a. | Describe in detail the Markov decision process with suitable examples. | CO5 | U | 8 |
|  | b. | Enumerate the applications of Hidden Markov Model in real-time scenario. | CO5 | R | 4 |
|  |  |  |  |  |  |
| 22. |  | Explain in detail the Hill climbing algorithm with suitable examples and enumerate the challenges in the algorithm. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 23. |  | Illustrate the concepts of reinforcement learning with a suitable example. | CO4 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Discuss the path planning of a robot in detail. | CO6 | U | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Identify problems that are amenable to solution by AI methods. |
| CO2 | Identify appropriate AI methods to solve a given problem. |
| CO3 | Formalize a given problem in the language/framework of different AI methods. |
| CO4 | Summarize the learning methods adopted in AI. |
| CO5 | Design and perform an empirical evaluation of different algorithms on a problem formalization. |
| CO6 | Illustrate the applications of AI in Robotic Applications. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 10 | 7 | - | - | - | - | 17 |
| CO2 | 5 | 24 | - | - | - | - | 29 |
| CO3 | 5 | 12 | - | - | - | - | 17 |
| CO4 | 5 | 12 | 12 | - | - | - | 29 |
| CO5 | 5 | 11 | - | - | - | - | 16 |
| CO6 | 16 | - | - | - | - | - | 16 |
|  | | | | | | | **124** |

**Graphical user interface, application

Description automatically generated with medium confidence**

**SUPPLEMENTARY EXAMINATION – JUNE 2023**

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| --- | --- | --- | --- |
| **Course Code** | **19RO2012** | **Duration** | **3hrs** |
| **Course Name** | **ARTIFICIAL INTELLIGENCE IN ROBOTICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define the term “rational agent.” | | CO1 | R | 1 |
| 2. | Recall the structure of an agent. | | CO1 | R | 1 |
| 3. | List the parameters used to define a problem. | | CO2 | R | 1 |
| 4. | Define binary constraint in a CSP network. | | CO2 | R | 1 |
| 5. | Interpret the admissible heuristic estimate for state-space search. | | CO3 | U | 1 |
| 6. | Identify the appropriate technique used for creating a representation of planning in AI. | | CO3 | R | 1 |
| 7. | Express the need of probablistic reasoning in AI. | | CO4 | U | 1 |
| 8. | Recall the types of reinforcement learning. | | CO4 | R | 1 |
| 9. | Define posterior probability of an event. | | CO5 | R | 1 |
| 10. | Indicate the importance of cognition. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Enumerate the components of basic artificial neuron with suitable diagram. | | CO1 | R | 3 |
| 12. | Summarize the terms and connective symbols with their meanings used in propositional logic-based knowledge representation. | | CO2 | U | 3 |
| 13. | Describe the total-order plan for the shoes and socks problem. | | CO3 | U | 3 |
| 14. | List the types of learning methods adopted in AI and brief them. | | CO4 | R | 3 |
| 15. | Interpret the causes of uncertainty by an agent to occur in the real world. | | CO5 | U | 3 |
| 16. | Explain the process of robotic perception with a neat diagram. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Discuss in detail the state-of-the-art of Artificial intelligence in robotics. | CO1 | U | 10 |
|  | b. | Recall the standard definition for the term “Artificial Intelligence”. | CO1 | R | 2 |
|  |  |  |  |  |  |
| 18. | a. | Explain in detail the A\* search and AO\* search algorithm for problem solving with a suitable example. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Discuss the partial order planning graph giving suitable example. | CO3 | U | 5 |
|  | b. | Explain the problem formulation and the algorithm for progression state-space search. | CO3 | U | 7 |
|  |  |  |  |  |  |
| 20. | a. | Illustrate the concepts of reinforcement learning with a suitable example. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. | a. | Explain in detail the Markov decision process with suitable examples. | CO5 | U | 8 |
|  | b. | List the applications of Hidden Markov Model in real-time scenario. | CO5 | R | 4 |
|  |  |  |  |  |  |
| 22. | a. | Discuss in detail the model-based reflex agent and utility-based agent. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 23. | a. | Summarize the drawbacks of minimax algorithm and explain the Alpha-Beta pruning method to overcome these limitations. | CO2 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain in detail the ethics and risks of artificial intelligence in robotics | CO6 | U | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Identify problems that are amenable to solution by AI methods. |
| CO2 | Identify appropriate AI methods to solve a given problem. |
| CO3 | Formalize a given problem in the language/framework of different AI methods. |
| CO4 | Summarize the learning methods adopted in AI. |
| CO5 | Design and perform an empirical evaluation of different algorithms on a problem formalization. |
| CO6 | Illustrate the applications of AI in Robotic Applications. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 7 | 12 | - | - | - | - | 29 |
| CO2 | 2 | 27 | - | - | - | - | 29 |
| CO3 | 1 | 16 | - | - | - | - | 17 |
| CO4 | 4 | 13 | - | - | - | - | 17 |
| CO5 | 5 | 11 | - | - | - | - | 16 |
| CO6 | - | 16 | - | - | - | - | 16 |
|  | | | | | | | **124** |

**Graphical user interface, application

Description automatically generated with medium confidence**

**SUPPLEMENTARY EXAMINATION – JUNE 2023**

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| **Course Code** | **19RO2013** | **Duration** | **3hrs** |
| **Course Name** | **INDUSTRIAL ENERGY MANAGEMENT SYSTEM** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | | **CO** | **BL** | | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | | |
| 1. | Write the unit of calorific value. | | | CO1 | R | | 1 |
| 2. | Write the error ranges of the Volume meter. | | | CO1 | An | | 1 |
| 3. | Define hydraulic efficiency. | | | CO2 | A | | 1 |
| 4. | Mention the high voltage range of electric energy. | | | CO2 | R | | 1 |
| 5. | Mention the high-pressure range of natural gas for industrial applications. | | | CO3 | R | | 1 |
| 6. | State the velocity range of steam in industries. | | | CO3 | U | | 1 |
| 7. | Write the efficiency range of the centrifugal fan. | | | CO4 | R | | 1 |
| 8. | List the two types of dynamic compressors. | | | CO4 | U | | 1 |
| 9. | Describe the energy recovery rate from Biomass. | | | CO5 | An | | 1 |
| 10. | Write the range of industrial-boiler plant efficiency. | | | CO6 | An | | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | | |
| 11. | List the objectives of energy management. | | | CO1 | | U | 3 |
| 12. | Write the sources of wind energy. | | | CO2 | | R | 3 |
| 13. | Discuss electric distribution losses. | | | CO3 | | An | 3 |
| 14. | Define fan efficiency. | | | CO4 | | An | 3 |
| 15. | List the three main ways of waste management. | | | CO5 | | U | 3 |
| 16. | Mention the main functions of computers in energy management systems. | | | CO6 | | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | | | |
| 17. | | a. | Explain the different types of renewable and non-renewable energy sources and also mention the merits and demerits. | CO1 | | U | 12 |
|  | |  |  |  | |  |  |
| 18. | | a. | Explain water tube and fire tube boilers with neat sketches. | CO2 | | U | 12 |
|  | |  |  |  | |  |  |
| 19. | | a. | What is a cogeneration system? Discuss the plant combined cycle cogeneration steam system. | CO3 | | R | 12 |
|  | |  |  |  | |  |  |
| 20. | | a. | Discuss the different types of Air compressors with suitable sketches. | CO4 | | An | 12 |
|  | |  |  |  | |  |  |
| 21. | | a. | Explain the detailed process of waste management; also discuss the merits of waste management. | CO5 | | U | 12 |
|  | |  |  |  | |  |  |
| 22. | | a. | Discuss the production process of hydraulic energy with suitable sketches. | CO2 | | A | 12 |
|  | |  |  |  | |  |  |
| 23. | | a. | Explain in detail about various types of industrial fans with neat sketches. | CO4 | | U | 12 |
| **COMPULSORY QUESTION** | | | | | | | |
| 24. | | a. | Discuss the detailed working procedure of computerized energy and waste management systems. | CO6 | | An | 12 |

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|  | **COURSE OUTCOMES** |
| CO1 | Discuss the need for industrial energy balance |
| CO2 | Describe the functioning of utility plants and renewable energy sources |
| CO3 | Compare the various distribution systems. |
| CO4 | Explain the functioning of equipment used in energy management. |
| CO5 | Summarize the concept of energy recovery from waste and the need of automation. |
| CO6 | Discuss about the use of computers in Energy Management. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 15 | - | 1 | - | - | 17 |
| CO2 | 4 | 12 | 13 | - | - | - | 29 |
| CO3 | 13 | 1 | - | 3 | - | - | 17 |
| CO4 | 1 | 13 | - | 15 | - | - | 29 |
| CO5 | - | 15 | - | 1 | - | - | 16 |
| CO6 | 3 | - | - | 13 | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **19RO2013** | **Duration** | **3hrs** |
| **Course Name** | **INDUSTRIAL ENERGY MANAGEMENT SYSTEM** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Write the unit of calorific value. | | CO1 | R | 1 |
| 2. | Indicate the percentage of energy used by industries. | | CO1 | U | 1 |
| 3. | Define hydraulic efficiency. | | CO2 | A | 1 |
| 4. | State the minimum wind speed required to operate the windmill. | | CO2 | U | 1 |
| 5. | Write the reason for electric distribution losses. | | CO3 | An | 1 |
| 6. | Write the expressions for the active power | | CO3 | R | 1 |
| 7. | List the two types of dynamic compressors. | | CO4 | U | 1 |
| 8. | Write the efficiency range of the centrifugal fan. | | CO4 | R | 1 |
| 9. | Write the energy recovery rate from Industrial solid waste. | | CO5 | U | 1 |
| 10. | Describe the range of efficiency improvements due to a computerized energy management system. | | CO6 | An | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | List some of the objectives of energy management. | | CO1 | U | 3 |
| 12. | Write short notes on efficient energy use. | | CO2 | R | 3 |
| 13. | List the general principles of energy conservation. | | CO3 | A | 3 |
| 14. | Define fan efficiency. | | CO4 | An | 3 |
| 15. | List the three main ways of waste management. | | CO5 | U | 3 |
| 16. | Mention the main functions of computers in energy management systems. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. |  | Explain the different types of renewable and non-renewable energy sources also mention the merits and demerits. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 18. |  | Illustrate the energy storage systems in detail. | CO2 | R | 12 |
|  |  |  |  |  |  |
| 19. |  | Discuss the plant combined cycle cogeneration steam system | CO3 | An | 12 |
|  |  |  |  |  |  |
| 20. |  | Explain the various types of Industrial pumps with neat sketches. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | Define waste management, discuss the detailed process of waste management | CO5 | An | 12 |
|  |  |  |  |  |  |
| 22. |  | Explain the importance of hydraulic energy; discuss the production process of hydraulic energy with suitable sketches. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | Explain the various types of fans with neat sketches. | CO4 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Explain in detail energy and waste management by computerized systems with suitable sketches. | CO6 | An | 12 |

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|  | **COURSE OUTCOMES** |
| CO1 | Discuss the need for industrial energy balance. |
| CO2 | Describe the functioning of utility plants and renewable energy sources. |
| CO3 | Compare the various distribution systems. |
| CO4 | Explain the functioning of equipment used in energy management. |
| CO5 | Summarize the concept of energy recovery from waste and the need of automation. |
| CO6 | Discuss about the use of computers in Energy Management. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 16 | - | - | - | - | 17 |
| CO2 | 15 | 1 | 13 | - | - | - | 29 |
| CO3 | 1 | - | 3 | 13 | - | - | 17 |
| CO4 | 1 | 13 | 12 | 3 | - | - | 29 |
| CO5 | - | 4 | - | 12 | - | - | 16 |
| CO6 | 3 | - | - | 13 | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **19RO2014** | **Duration** | **3hrs** |
| **Course Name** | **ROBOTICS AND AUTOMATION IN FOOD INDUSTRY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define set point in a process control loop. | | CO1 | R | 1 |
| 2. | Enumerate the unit operations involved in snack-food manufacturing plants. | | CO1 | R | 1 |
| 3. | Indicate the variables to be measured in a food process control system. | | CO2 | U | 1 |
| 4. | Recall window-pixel operation in shape analysis to recognize objects. | | CO2 | R | 1 |
| 5. | Quote the specific purpose of deep penetrating needle gripper. | | CO3 | R | 1 |
| 6. | Enumerate the types of pins used in pinning/penetration grippers. | | CO3 | R | 1 |
| 7. | Show the wireless star network topology on a single-hop communication. | | CO4 | U | 1 |
| 8. | Define smart dust. | | CO4 | R | 1 |
| 9. | Recall the advantage of extremum-seeking framework of fed-batch bioprocess. | | CO5 | R | 1 |
| 10. | Identify the role of chilling and freezing tunnel in a chilling system. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | List the design specifications of a pick and place food sector robot. | | CO1 | R | 3 |
| 12. | Summarize the challenges when SCADA is employed in the food processing industry. | | CO2 | U | 3 |
| 13. | Differentiate the term ‘hard gripping’ and ‘soft gripping’. | | CO3 | U | 3 |
| 14. | Show the fuzzy symbolic approach applied in biscuit baking. | | CO4 | U | 3 |
| 15. | Describe the preservation processes to increase the product life in food industry. | | CO5 | R | 3 |
| 16. | Differentiate the requirements for robotic handling and the manual handling of seafood products. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Discuss in detail the elements of a process control loop. | CO1 | U | 5 |
|  | b. | Summarize the process control systems and structure in the food industry with a PID controller. | CO1 | U | 7 |
|  |  |  |  |  |  |
| 18. | a. | Explain the salient features required to implement SCADA network for baking process in food industry. | CO2 | A | 8 |
|  | b. | Enumerate the benefits and challenges of SCADA for the food processing industry. | CO2 | U | 4 |
|  |  |  |  |  |  |
| 19. | a. | Discuss in detail the gripping physics applied for the robotic arm to move the object. | CO3 | U | 8 |
|  | b. | Enumerate the general design parameters to be considered while selecting the appropriate gripping mechanism. | CO3 | U | 4 |
|  |  |  |  |  |  |
| 20. |  | Explain the role of wireless sensor network in agriculture and food production. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. | a. | Explain the design of PID controllers for fed-batch processes with the help of a neat sketch. | CO5 | U | 7 |
|  | b. | Discuss the methods for the control of bioconversion in a fed-batch reactor. | CO5 | U | 5 |
|  |  |  |  |  |  |
| 22. |  | Discuss in detail the food process instrumentation with special considerations in design technology. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 23. |  | With the help of a schematic diagram, explain the advanced neural network-based controllers in the continuous snack-food frying process. | CO1 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Explain in detail the automation and robotics for bulk sorting in the food industry. | CO6 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Specify the characteristics of robots used in food industry. |
| CO2 | Identify the applications of sensors in food industry. |
| CO3 | Describe about the different types of gripper mechanisms. |
| CO4 | Describe the use of sensor networks and quality control in food sector. |
| CO5 | Discuss about the advanced methods for control of food process. |
| CO6 | Summarize the applications of automation and robotics in food industry. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 5 | 12 | 12 | - | - | - | 29 |
| CO2 | 1 | 20 | 8 | - | - | - | 29 |
| CO3 | 2 | 17 | - | - | - | - | 19 |
| CO4 | 1 | 16 | - | - | - | - | 17 |
| CO5 | 4 | 12 | - | - | - | - | 16 |
| CO6 | 4 | 12 | - | - | - | - | 16 |
|  | | | | | | | **124** |

**Graphical user interface, application

Description automatically generated with medium confidence**

**SUPPLEMENTARY EXAMINATION – JUNE 2023**

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| **Course Code** | **19RO2014** | **Duration** | **3hrs** |
| **Course Name** | **ROBOTICS AND AUTOMATION IN FOOD INDUSTRY** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Enumerate the operations involved in the manufacturing of snack-food frying. | | CO1 | R | 1 |
| 2. | Define closed-loop process control systems. | | CO1 | R | 1 |
| 3. | Recall window-pixel operation in shape analysis to recognize objects. | | CO2 | R | 1 |
| 4. | List a few sensors for temperature monitoring and control that will ensure the quality of the end product. | | CO2 | R | 1 |
| 5. | Define freeze pads. | | CO3 | R | 1 |
| 6. | Enumerate the main classes of multi-finger grippers to withstand normal force to hold the object. | | CO3 | R | 1 |
| 7. | Show the wireless mesh network topology with multi node routing capablity. | | CO4 | U | 1 |
| 8. | Define smart dust. | | CO4 | R | 1 |
| 9. | Recall the separation processes used in food industry. | | CO5 | R | 1 |
| 10. | Identify the role of image processor in an optical sorting machine. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Show the feedback closed-loop control scheme with a PID controller. | | CO1 | U | 3 |
| 12. | Enumerate the applications of sensors used for automated food process control system. | | CO2 | R | 3 |
| 13. | List the main categories of contamination to consider while selecting a gripper in terms of hygiene. | | CO3 | R | 3 |
| 14. | Summarize the advantages of fuzzy logic system over Boolean logic system. | | CO4 | U | 3 |
| 15. | Describe the real-time optimization using various controllers for fed-batch processes. | | CO5 | U | 3 |
| 16. | Compare the requirements for robotic handling and the manual handling of seafood products. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Explain the advanced neural network-based controllers in the continuous snack-food frying process with the help of a schematic diagram. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. | a. | Illustrate the food process instrumentation with special considerations in design technology. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Discuss in detail the variants of gripping principle used in the concept of pinching and enclosing grippers. | CO3 | U | 8 |
|  | b. | Interpret the gripping physics for force transfer through the pinching and enclosing grippers for the food products. | CO3 | U | 4 |
|  |  |  |  |  |  |
| 20. | a. | Illustrate the evaluation of crusting degree of a sausage using image analysis and fuzzy logic based intelligent control systems. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. | a. | Explain the methods for the control of bioconversion in a fed-batch reactor. | CO5 | A | 5 |
|  | b. | With the help of a neat sketch, discuss the design of PID controllers for fed-batch processes. | CO5 | U | 7 |
|  |  |  |  |  |  |
| 22. | a. | Discuss the sensors used for measuring the variables that influence the food industry. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 23. | a. | Explain in detail the elements of a process control loop. | CO1 | U | 5 |
|  | b. | Describe the process control systems and structure in the food industry with a PID controller. | CO1 | U | 7 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Discuss the automatic control of food chilling and freezing to maintain product quality and safety. | CO6 | U | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Specify the characteristics of robots used in food industry. |
| CO2 | Identify the applications of sensors in food industry. |
| CO3 | Describe about the different types of gripper mechanisms |
| CO4 | Describe the use of sensor networks and quality control in food sector |
| CO5 | Discuss about the advanced methods for control of food process. |
| CO6 | Summarize the applications of automation and robotics in food industry. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 15 | 12 | - | - | - | 29 |
| CO2 | 5 | 24 | - | - | - | - | 29 |
| CO3 | 5 | 12 | - | - | - | - | 17 |
| CO4 | 1 | 16 | - | - | - | - | 17 |
| CO5 | 1 | 10 | 5 | - | - | - | 16 |
| CO6 | - | 4 | 12 | - | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **19RO2015** | **Duration** | **3hrs** |
| **Course Name** | **NEURAL NETWORKS AND FUZZY SYSTEMS** | **Max. Marks** | **100** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | What is the role of Soma in biological neuron? | | CO1 | R | 1 |
| 2. | Hebbian Learning Rule is a --------- type of learning rule. | | CO1 | R | 1 |
| 3. | Mention the applications of Artificial Neural Network. | | CO2 | R | 1 |
| 4. | A 4-input neuron has weights 2, 3, 4 and 5. The transfer function is linear with the constant of proportionality being equal to 2. The inputs are 4, 10, 5 and 20 respectively. The output will be:----------. | | CO2 | A | 1 |
| 5. | Can we use CNN to perform Dimensionality Reduction? | | CO3 | U | 1 |
| 6. | What is Stride? What is the effect of high Stride on the feature map? | | CO3 | U | 1 |
| 7. | Write De Morgan’s Law. | | CO4 | R | 1 |
| 8. | List the operations in fuzzy sets. | | CO4 | R | 1 |
| 9. | Define the core of a membership function. | | CO5 | R | 1 |
| 10. | Mention the applications of Fuzzy logic control system. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Why activation function is used in artificial neuron? Explain different activation functions? | | CO1 | U | 3 |
| 12. | With a neat sketch, differentiate the multilayer feed forward network and recurrent neural network? | | CO2 | U | 3 |
| 13. | An input image has been converted into a matrix of size 12 X 12 along with a filter of size 3 X 3 with a Stride of 1. Determine the size of the convoluted matrix. | | CO3 | A | 3 |
| 14. | List the properties of fuzzy relations. | | CO4 | R | 3 |
| 15. | State the max product composition of two fuzzy relations R1 & R2? | | CO5 | A | 3 |
| 16. | Draw the basic block diagram for a fuzzy logic control system. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Compare the biological neural network with an artificial neural network. | CO1 | U | 6 |
|  | b. | Differentiate the types of supervised learning and unsupervised learning with an example for each learning methods. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | State and prove bidirectional-associative memory energy theorem. | CO2 | U | 6 |
|  | b. | Explain the steps involved in a MADALINE learning algorithm. | CO2 | A | 6 |
|  |  |  |  |  |  |
| 19. |  | Draw and explain the architecture of Convolution Neural Network (CNN). | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. |  | Consider a set P= {P1, P2, P3, P4} of four varieties of paddy plants , set D={ D1, D2, D3, D4}of the various diseases affecting the plants and S={ S1, S2, S3, S4} be the common symptoms of the diseases. Let R be a relation on P\*D and S be the relation on D\*S. Find RoS for the given problem. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | Classify the various defuzzification techniques. Explain each of them in detail. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 22. | a. | Discuss the role of mean square error in delta learning rule. Explain the impact of continuous activation function in it. | CO2 | U | 6 |
|  | b. | Illustrate the Hebbian learning with binary function for a simple network. With the initial weight vector needs to be trained using the set of three input vectors as below for an arbitrary choice of learning constant c = 1. Assume first that bipolar binary neurons are used, and thus f(net) = sgn (net). . Find the net value and the W2 weights for the given problem. | CO1 | A | 6 |
|  |  |  |  |  |  |
| 23. | a. | Find the fuzzy Cartesian product (R) between the Fuzzy set A~ represents the ambient temperature and fuzzy set B∼ represents the near-optimum pressure for a certain heat exchanger, and the Cartesian product might represent the conditions (temperature–pressure pairs) of the exchanger that are associated with “efficient” operations. | CO4 | A | 6 |
|  | b. | Describe Mc-Culloch Pitt’s neuronal model. Design a network using this model to realize a OR gate. | CO1 | U | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Design and develop a Greg-Viot fuzzy cruise controller using fuzzy logic control model. Formulate necessary membership functions and required fuzzy rules for the application. | CO6 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Classify the types of neural networks. |
| CO2 | Discuss about the applications of neural networks. |
| CO3 | Describe the concepts of deep learning and convolutional neural networks. |
| CO4 | Compare fundamentals of classical logic and fuzzy logic concepts. |
| CO5 | Characterize the fuzzy membership functions. |
| CO6 | Summarize the applications of fuzzy logic controllers. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 4 | 19 | 6 |  |  |  | 29 |
| CO2 | 1 | 15 | 7 |  |  |  | 23 |
| CO3 |  | 14 | 3 |  |  |  | 17 |
| CO4 | 5 |  | 18 |  |  |  | 23 |
| CO5 | 1 | 12 | 3 |  |  |  | 16 |
| CO6 | 1 | 3 | 12 |  |  |  | 16 |
|  | | | | | | | **124** |

**Graphical user interface, application

Description automatically generated with medium confidence**

**SUPPLEMENTARY EXAMINATION – JUNE 2023**

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| --- | --- | --- | --- |
| **Course Code** | **19RO2015** | **Duration** | **3hrs** |
| **Course Name** | **NEURAL NETWORKS AND FUZZY SYSTEMS** | **Max. Marks** | **100** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | The function of the dendrite is to act as a --------------- | | CO1 | R | 1 |
| 2. | Why do linearly separable problem require two layers? | | CO1 | R | 1 |
| 3. | What is the role of axon in biological neuron? | | CO2 | R | 1 |
| 4. | List the methods used in single layer neural networks? | | CO2 | R | 1 |
| 5. | What is Padding in CNN? | | CO3 | R | 1 |
| 6. | Name the activation functions used in CNN. | | CO3 | R | 1 |
| 7. | Write De Morgan’s Law. | | CO4 | R | 1 |
| 8. | Give the formula for Fuzzy tolerance and equivalence equations | | CO4 | R | 1 |
| 9. | What do you meant by membership function? | | CO5 | R | 1 |
| 10. | Mention the applications of Fuzzy logic control system. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Comparison of ANN with Conventional AI methods | | CO1 | U | 3 |
| 12. | With a neat sketch differentiate the multilayer feed forward network and recurrent neural network? | | CO2 | U | 3 |
| 13. | State the significance of the RELU activation function in Convolution Neural network and the types of Pooling layers used in CNN Architecture. | | CO3 | R | 3 |
| 14. | List the properties of fuzzy relations | | CO4 | R | 3 |
| 15. | State the max product composition of two fuzzy relations R1 & R2? | | CO5 | A | 3 |
| 16. | Draw the basic block diagram for a fuzzy logic control system. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Compare the biological neural network with an artificial neural network | CO1 | U | 6 |
|  | b. | Describe Mc-Culloch Pitt’s neuronal model. Design a network using this model to realize a NAND gate. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | What are the steps involved in an ADALINE learning algorithm | CO2 | R | 6 |
|  | b. | Illustrate with an example about the types of associative memory network | CO2 | A | 6 |
|  |  |  |  |  |  |
| 19. | a. | With the help of a neat diagram, explain the architecture of Convolution Neural Network (CNN). | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. | a. | X = {x1, x2}, Y = {y1, y2}, and Z = {z1, z2, z3}*.*Consider the following fuzzy relations:  Relation R  Relation S  Find the resulting relation, T which relates elements of universe X to elements of universe Z, i.e., defined on Cartesian space X × Z   * Using **Max-Min** composition and * Using **Max-Product** composition | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. | a. | Compare fuzzification with defuzzification. Explain different types of Defuzzification methods. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | Illustrates the perceptron learning rule of the network. The set of input training vectors and the initial weight vector w1 are given in the problem. The learning constant is assumed to be c = 0.1. The teacher's desired responses for xl , x2, x3 are dl = - 1, d2 = - 1, and d3 = 1, respectively. Find the net value and the W2 weights for the given problem. | CO2 | A | 6 |
|  | b. | Why activation function is used in artificial neuron? Explain different activation functions? | CO1 | R | 6 |
|  |  |  |  |  |  |
| 23. | a. | Find the fuzzy Cartesian product (R) between the Fuzzy set A~ represents the ambient temperature and fuzzy set B∼ represents the near-optimum pressure for a certain heat exchanger, and the Cartesian product might represent the conditions (temperature–pressure pairs) of the exchanger that are associated with “efficient” operations. | CO4 | A | 6 |
|  | b. | Differentiate the types of supervised learning and unsupervised learning with an example for each learning methods | CO1 | U | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Design and develop a Greg-Viot fuzzy cruise controller using fuzzy logic control model. Formulate necessary membership functions and required fuzzy rules for the application. | CO6 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Classify the types of neural networks. |
| CO2 | Discuss about the applications of neural networks |
| CO3 | Describe the concepts of deep learning and convolutional neural networks |
| CO4 | Compare fundamentals of classical logic and fuzzy logic concepts. |
| CO5 | Characterize the fuzzy membership functions. |
| CO6 | Summarize the applications of fuzzy logic controllers. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 8 | 21 |  |  |  |  | 29 |
| CO2 | 2 | 9 | 12 |  |  |  | 23 |
| CO3 | 5 | 12 |  |  |  |  | 17 |
| CO4 | 5 | 18 |  |  |  |  | 23 |
| CO5 | 1 |  | 15 |  |  |  | 16 |
| CO6 | 1 | 3 | 12 |  |  |  | 16 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **19RO2016** | **Duration** | **3hrs** |
| **Course Name** | **MICROCONTROLLERS FOR ROBOTICS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **Course Outcome** | | **Bloom’s Level** | | | **Marks** | |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | | | | |
| 1. | List any two features of 8051 | | CO1 | | R | | | 1 | |
| 2. | List the importance of Address Latch Enable (ALE) in 8051 | | CO1 | | R | | | 1 | |
| 3. | Find the 8051 instruction used to get the ones complement of a numbers | | CO2 | | R | | | 1 | |
| 4. | Identify the addressing modes for the following 8051 instructions  MOV A, #10 | | CO2 | | R | | | 1 | |
| 5. | Show the status of carry and parity flag after executing the following instruction  MOV A,#9C ADD A,#64H | | CO3 | | U | | | 1 | |
| 6. | Define Zigbee protocol | | CO3 | | R | | | 1 | |
| 7. | Determine the resolution of 8-bit ADC if the full-scale voltage is 10V | | CO4 | | U | | | 1 | |
| 8. | Name the slowest type of Analog to Digital Converter. | | CO4 | | R | | | 1 | |
| 9. | Mention the type of mode used for exception handling in ARM Cortex M4 | | CO5 | | U | | | 1 | |
| 10. | Illustrate an example for input device. | | CO6 | | U | | | 1 | |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | | | | |
| 11. | Examine the output at the address 4200 after executing the following program  MOV A, #0B  RRC  MOV DPTR, #4200  MOVX @DPTR,A | | CO1 | | | An | | 3 | |
| 12. | Classify different instruction set of 8051 | | CO2 | | | U | | 3 | |
| 13. | Distinguish between assembler and compiler | | CO3 | | | An | | 3 | |
| 14. | Outline the importance of Sample and Hold circuit in ADC | | CO4 | | | U | | 3 | |
| 15. | Determine the time taken by one machine cycle if crystal frequency is 12 MHz? | | CO5 | | | An | | 3 | |
| 16. | Interpret the steps followed in interfacing ultrasonic sensor with 8051 | | CO6 | | | U | | 3 | |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | | | | | |
| 17. | a. | Build a circuit which interfaces memory with 8051 microcontroller in order to fetch a data 40h from memory. | | CO1 | | | A | | 6 | |
|  | b. | Explain the characteristics of embedded system. | | CO1 | | | U | | 6 | |
|  |  |  | |  | | |  | |  | |
| 18. | a. | Develop an assembly language program to find the largest number in an array of 10 numbers | | CO2 | | | A | | 6 | |
|  | b. | Illustrate with example, different branch instructions in 8051. | | CO2 | | | U | | 6 | |
|  |  |  | |  | | |  | |  | |
| 19. | a. | Differentiate synchronous and asynchronous communication. | | CO3 | | | U | | 6 | |
|  | b. | Discuss timer/counter operations in 8051 with different modes | | CO3 | | | An | | 6 | |
|  |  |  | |  | | |  | |  | |
| 20. | a. | Examine the drawback of weighted binary DAC with R-2R ladder DAC | | CO4 | | | An | | 6 | |
|  | b. | Summarize the functional blocks of ARM 9 Processor | | CO4 | | | U | | 6 | |
|  |  |  | |  | | |  | |  | |
| 21. | a. | Outline the features of ARM Cortex M4 | | CO5 | | | U | | 6 | |
|  | b. | Classify the addressing modes for the following instructions in 8051.  MOV DPTR, #4300  MOV A, R5  MOV @R1, 80H  MOVC A,@DPTR  SWAP A  MOV R2, 45H | | CO5 | | | An | | 6 | |
|  |  |  | |  | | |  | |  | |
| 22. | a. | Summarize 3 stage pipelining in ARM 9 Processor | | CO4 | | | U | | 6 | |
|  | b. | Distinguish between Von Neumann and Harvard architecture | | CO2 | | | An | | 6 | |
|  |  |  | |  | | |  | |  | |
| 23. | a. | With block diagram, explain the architecture of 8051 | | CO1 | | | U | | 8 | |
|  | b. | Distinguish between 8 bit and 32 bit microcontroller | | CO1 | | | An | | 4 | |
| **COMPULSORY QUESTION** | | | | | | | | | |
| 24. | a. | Develop an 8051 interfacing circuit which rotates DC motor in clockwise direction | | CO6 | | | A | | 6 | |
|  | b. | Develop an 8051 interfacing circuit which rotates stepper motor in clockwise direction. | | CO6 | | | A | | 6 | |

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the architecture of 8051 controllers |
| CO2 | Classify different types of instruction set and addressing modes 3 |
| CO3 | Express their knowledge in designing a system using 8051 |
| CO4 | Discuss the general features of RISC architecture |
| CO5 | Summarize the specific features of cortex controller |
| CO6 | Develop interfacing program with controller |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 2 | 12 | 6 | 9 |  |  | 29 |
| CO2 | 1 | 10 | 6 | 6 |  |  | 23 |
| CO3 | 1 | 1 | 6 | 9 |  |  | 17 |
| CO4 | 1 | 16 |  | 6 |  |  | 23 |
| CO5 |  | 7 |  | 9 |  |  | 16 |
| CO6 |  | 4 | 12 | - |  |  | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **18RO1003** | **Duration :** | **3hrs** |
| **Course Name** | **FUNDAMENTALS OF PYTHON PROGRAMMING FOR ROBOTICS** | **Max. Marks :** | **100** |

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| **Q. No.** | **Questions** | **CO/BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | |
| 1. | Find the output of - print(2\*\*3 + (5 + 6)\*\*(1 + 1)) | CO1/R | 1 |
| 2. | Python code block is indicated using \_\_\_\_\_\_\_\_\_\_\_\_. | CO1/U | 1 |
| 3. | \_\_\_\_\_\_\_\_\_ loop statement is not supported in python. | CO2/An | 1 |
| 4. | Loops are known as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_in programming. | CO2/R | 1 |
| 5. | Count () \_\_\_\_\_\_\_\_ manipulation functions in Python. | CO3/R | 1 |
| 6. | \_\_\_\_\_\_\_\_\_\_\_\_\_ function is used when we want to append the text or contents to a specific position in an existing file. | CO3/A | 1 |
| 7. | \*args are stored in Python as a \_\_\_\_\_\_\_\_\_. | CO4/An | 1 |
| 8. | List, tuple, and range are the\_\_\_\_\_\_\_\_of Data Types. | CO4/A | 1 |
| 9. | List the features of object-oriented programming. | CO5/U | 1 |
| 10. | The inheriting class is called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. | CO5/R | 1 |

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| **PART – B (6 X 3 = 18 MARKS)** | | | |
| 11. | Define Python Interpreter. | CO1/An | 3 |
| 12. | Comparing between local and global variable. | CO2/E | 3 |
| 13. | Give the method to create a List in python. | CO3/U | 3 |
| 14. | List the built-in functions that are used in Tuple. | CO4/R | 3 |
| 15. | Define recursive function. | CO5/R | 3 |
| 16. | Differentiate the micro python and python. | CO6/E | 3 |

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| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.no 17 to 23. Q.No 24 is Compulsory)** | | | | |
| 17. | a. | Discuss the int(), float(), str(), chr() and complex() type conversion functions with examples. | CO1/A | 5 |
| b. | Write a program to display the Fibonacci sequences up to nth term where n is provided by the use. | CO1/A | 7 |
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| 18. | a. | Illustrate the different types of control flow statements available in Python with flowcharts. | CO2/An | 6 |
| b. | Explain the need for continue and break statements with relevant examples. | CO2/A | 6 |
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| 19. |  | List out all the useful string methods which supports in python. Explain with an example for each method. | CO3/A | 12 |
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| 20. | a. | Explain the concept of slicing and indexing with proper examples. | CO4/E | 6 |
| b. | For a given list num=[45,22,14,65,97,72] write a python program to replace all the integers divisible by 3 with “ppp” and all integers divisible by 5 with “qqq” and replace all the integers divisible by both 3 and 5 with “pppqqq” and display the output. | CO4/A | 6 |
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| 21. |  | Discuss inheritance in Python programming language. Write a Python program to demonstrate the use of super() function. | CO5/U | 12 |
|  |  |  |  |  |
| 22. | a. | Explain the function arguments in python. | CO3/A | 6 |
| b. | Explain call by value and call by reference. | CO3/A | 6 |
|  |  |  |  |  |
| 23. |  | Explain Python dictionaries in detail discussing its operations and methods. | CO4/E | 12 |
| **COMPULSORY QUESTION** | | | | |
| 24. |  | With help of the pseudo code illustrate the application of RRT and RRT\* in robotics. | CO6/A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Outline the structure and components of a Python program. |
| CO2 | Explain loops and decision statements in Python. |
| CO3 | Illustrate class inheritance in Python for reusability |
| CO4 | Choose lists, tuples, and dictionaries in Python programs. |
| CO5 | Assess object‐oriented programs with Python classes. |
| CO6 | Develop simple code for robotics applications. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 1 | 12 | 3 | - | - | 17 |
| CO2 | 1 | - | 6 | 7 | 3 | - | 17 |
| CO3 | 1 | 3 | 25 | - | - | - | 29 |
| CO4 | 3 | - | 7 | 1 | 18 | - | 29 |
| CO5 | 4 | 13 | - | - | - | - | 17 |
| CO6 | - | - | 12 | - | 3 | - | 15 |
|  | | | | | | | **124** |



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| **Course Code** | **20RO1004** | **Duration** | **3hrs** |
| **Course Name** | **INTRODUCTION TO ROBOTICS AND AUTOMATION** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Describe the role of a Robotics Engineer. | | CO1 | R | 1 |
| 2. | Write the key elements of a Robotic Autonomous System. | | CO1 | R | 1 |
| 3. | Define a Sensor. | | CO2 | R | 1 |
| 4. | Express any two types of Range Sensors. | | CO2 | U | 1 |
| 5. | List the disadvantage of Intelligent Robot. | | CO3 | R | 1 |
| 6. | Indicate how a robot is programmed by Lead Through Method. | | CO3 | R | 1 |
| 7. | Identify the tasks performed by Robotic Machining System, | | CO4 | U | 1 |
| 8. | Give an example of Medical Robot. | | CO4 | U | 1 |
| 9. | Outline the aims of Industry 4.0 to create smart cities. | | CO5 | U | 1 |
| 10. | Describe Industrial Automation. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | State the three laws of Robotics formulated by Isaac Asimov. | | CO1 | R | 3 |
| 12. | Mention the characteristics of sensors that affect their measurement capabilities and sustainability for each application. | | CO2 | U | 3 |
| 13. | Summarize the advantages of Teach Pendant Method. | | CO3 | U | 3 |
| 14. | Give examples of soft Robots and its applications. | | CO4 | A | 3 |
| 15. | Write a short note on the Recent trends in the field of Automation. | | CO5 | A | 3 |
| 16. | Analyse the factors that contribute to the definition of a smart city. | | CO6 | An | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. | a. | Illustrate Robot Anatomy and the different types of joints with a neat sketch. | CO1 | U | 8 |
|  | b. | Categorize the essential qualities that characterize robots. | CO1` | U | 4 |
| 18. | a. | Explain in brief about the LVDT position sensor with a neat sketch. | CO2 | U | 6 |
|  | b. | Describe the basic Components and functions of an Hydraulic Actuator system. | CO2 | U | 6 |
| 19. | a. | Identify and explain the significance of the most commonly used programming languages in robotics. | CO3 | A | 6 |
|  | b. | Consider the forward transformation of the three-joint manipulator. Given that the length of joint 1, L1 = 10 in., the length of joint 2, L2 = 8 in., the length of joint 3, L3 = 8 in., the angle Ɵ1 = 30°, the angle Ɵ2 = 45° and the angle Ɵ3 = 30°. Compute the coordinate position (x and y coordinates) for the end-of-the-arm P. | CO3 | A | 6 |
| 20. | a. | Define Automation. Robotic automation can be used to perform a variety of tasks. Justify. | CO4 | E | 7 |
|  | b. | Explain in brief the consumer applications of robots that are becoming increasingly popular in the recent years. | CO4 | A | 5 |
| 21. | a. | Illustrate the benefits of Automation that makes it an attractive option for many industries. | CO5 | A | 4 |
|  | b. | Explain the key components of an automation system that work together to facilitate efficient and reliable operation of the robotic system. | CO5 | An | 8 |
| 22. | a. | Explain the Industrial Automation Process with an example. | CO6 | U | 4 |
|  | b. | Illustrate the different layers of Modern Building Automation System Architecture with the block diagram of a typical Building automation system. | CO6 | A | 8 |
| 23. | a. | Demonstrate how SCADA is used in industrial automation and robotics to monitor and control processes and to gather data from remote sensors and devices. | CO5 | A | 4 |
|  | b. | Explain the key elements of AI-based automation in robotics. | CO5 | U | 8 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | What is a Smart city? Explain with examples how smart city technologies and initiatives can be implemented to promote economic growth, social inclusion, and environmental sustainability. | CO6 | A | 7 |
|  | b. | Predict how the future of robotics and automation is expected to be transformative and impactful across many industries and sectors by specifying some potential trends and development. | CO6 | E | 5 |

CO – COURSE OUTCOME BL – BLOOMS’ LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Recall the evolution of robots and their classification. |
| CO2 | Analyse the applications of sensors and actuators in robotics. |
| CO3 | Describe the kinematics and dynamic behaviour of robots and its programming. |
| CO4 | Appraise the emerging technologies in the field of robotics. |
| CO5 | Compare different concepts of automation. |
| CO6 | Apply knowledge of automation in various fields. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 5 | 12 | - |  | - | - | 17 |
| CO2 | 1 | 16 |  | - | - | - | 17 |
| CO3 | 2 | 3 | 12 | - | - | - | 17 |
| CO4 | - | 2 | 8 | - | 7 | - | 17 |
| CO5 | - | 7 | 13 | 8 | - | - | 28 |
| CO6 | - | 7 | 16 | - | 5 | - | 28 |
|  | | | | | | | **124** |



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| **Course Code** | **20RO2001** | **Duration** | **3hrs** |
| **Course Name** | **DIGITAL ELECTRONICS AND MICROPROCESSORS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | Find the 2’s complement for the binary number 1011 1100. | | | CO1 | R | 1 |
| 2. | Name the universal logic gates. | | | CO1 | R | 1 |
| 3. | Show the Boolean expression for the given logic circuit | | | CO2 | U | 1 |
| 4. | How many data select lines are required for selecting eight inputs? | | | CO2 | R | 1 |
| 5. | Infer the output from a D flip-flop if the clock signal is low and D=0. | | | CO3 | U | 1 |
| 6. | Define 1 bit memory cell. | | | CO3 | R | 1 |
| 7. | Illustrate an example for shift register. | | | CO4 | U | 1 |
| 8. | Name the fastest type of Analog to Digital Converter. | | | CO4 | R | 1 |
| 9. | Infer the form of digital memory that can be designed with a fixed collection of AND gates and programmable collection of OR gates. | | | CO5 | U | 1 |
| 10. | Illustrate an example for 8 bit microprocessor. | | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | Construct logic diagram and truth table for the Boolean expression given  Q=AB+AC'. | | | CO1 | A | 3 |
| 12. | Develop a full adder circuit using two half adder. | | | CO2 | A | 3 |
| 13. | Classify different types of shift registers. | | | CO3 | U | 3 |
| 14. | Outline any three specifications of ADC. | | | CO4 | U | 3 |
| 15. | Distinguish between content addressable memory and charge coupled device memory. | | | CO5 | An | 3 |
| 16. | Outline the 8085 steps followed in fetching an instruction from memory. | | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | | |
| 17. | | a. | Determine the single error correcting codes for BCD number 1001 using even parity. | CO1 | An | 6 |
|  | | b. | Explain the operation of CMOS NAND gate. | CO1 | U | 6 |
| 18. | | a. | Simplify the following Boolean function F, using K-Map F(A,B,C,D)= ∑m(0,3,5,9,11)+∑d(4,10,15). | CO2 | A | 6 |
|  | | b. | Interpret 8x1 multiplexer with truth table and logic diagram. | CO2 | U | 6 |
| 19. | | a. | Develop truth table and excitation table for D Flip-flop. | CO3 | A | 6 |
|  | | b. | Summarize the operation of Serial In Serial Out Shift register. | CO3 | U | 6 |
| 20. | | a. | Examine the drawback of counter type ADC over successive approximation type ADC. | CO4 | An | 6 |
|  | | b. | Illustrate the operation of R-2R ladder DAC with necessary diagram | CO4 | U | 6 |
| 21. | | a. | Compare PROM, PLA and PAL. | CO5 | U | 6 |
|  | | b. | Design a combinational circuit using PROM which accepts 3-bit binary and generates its equivalent Excess 3 code. | CO5 | A | 6 |
| 22. | | a. | Summarize the operation of FPGA. | CO5 | U | 6 |
|  | | b. | Design 4 bit Parallel In Serial Out shift register. | CO2 | A | 6 |
| 23. | | a. | Explain the operation of Johnson counter. | CO1 | U | 8 |
|  | | b. | Develop logic circuit for 3 to 8 decoder. | CO2 | A | 4 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. | | a. | Explain the functional blocks of 8085 microprocessor. | CO6 | U | 6 |
|  | | b. | Discuss the bus structure in 8085 microprocessor. | CO6 | An | 6 |

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|  | **COURSE OUTCOMES** |
| CO1 | Recall the concepts of logic gates and tri state logic. |
| CO2 | Design Combinational Circuits using Boolean Logic. |
| CO3 | Implement Sequential Circuits using logic gates. |
| CO4 | Outline the process of Analog to Digital conversion and Digital to Analog conversion. |
| CO5 | Apply PLDs to implement the given logical problem. |
| CO6 | Relate the concepts of Digital Systems to Microprocessor Architecture. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 2 | 14 | 3 | 6 |  |  | 25 |
| CO2 | 1 | 7 | 19 |  |  |  | 27 |
| CO3 | 1 | 10 | 6 |  |  |  | 17 |
| CO4 | 1 | 10 |  | 6 |  |  | 17 |
| CO5 |  | 13 | 6 | 3 |  |  | 22 |
| CO6 |  | 10 |  | 6 |  |  | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20RO2002** | **Duration** | **3hrs** |
| **Course Name** | **MECHANICS OF SOLIDS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Describe the term Poisson’s ratio. | | CO1 | R | 1 |
| 2. | Discuss about Hooke’s law. | | CO2 | U | 1 |
| 3. | Indicate the relation between Young’s modulus; Modulus of rigidity and Poisson’s ratio. | | CO3 | U | 1 |
| 4. | Describe the term ‘Bulk modulus’. | | CO3 | U | 1 |
| 5. | Tell about cantilever beam. | | CO4 | R | 1 |
| 6. | Differentiate sagging and hogging bending moments. | | CO4 | U | 1 |
| 7. | Define the term polar modulus. | | CO5 | R | 1 |
| 8. | State the torsional equation. | | CO5 | R | 1 |
| 9. | Name the types of springs. | | CO5 | R | 1 |
| 10. | Illustrate the term ‘Principal stress’. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | A load of 5 kN is to be raised with the help of a steel wire. Compute the minimum diameter of the steel wire, if the stress is not to exceed 100 N/mm2. | | CO2 | A | 3 |
| 12. | For a material, Young’s modulus is given as 1.2 x 105 N/mm2 and Poisson’s ratio is 0.25. Calculate the Bulk modulus. | | CO3 | A | 3 |
| 13. | Sketch the shear force and bending moment diagram of a cantilever beam of length ‘l’, carrying a point load P at the free end. | | CO4 | A | 3 |
| 14. | Write the expression for section modulus of a hollow circular section. | | CO5 | A | 3 |
| 15. | Discuss on assumptions made in theory of simple bending. | | CO5 | U | 3 |
| 16. | Summarize on Mohr’s circle of stresses. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | A rod is 2 m long at a temperature of 10 ºC. Determine the expansion of the rod when the temperature is raised to 80 ºC. If this expansion is prevented, find the stress induced in the material of the rod. Take E = 1.0 x 105 MN/m2 and α = 0.000012 per ºC. | CO1 | A | 4 |
|  | b. | A steel rod ABCD 4.5 m long and 25 mm in diameter is subjected to the forces as shown in the figure. If the value of Young’s modulus for the steel is 2.1 x 105 N/mm2, calculate the deformation of the rod. | CO2 | An | 8 |
|  |  |  |  |  |  |
| 18. |  | A steel rod 5 m long and 30 mm in diameter is subjected to an axial tensile load of 50 kN. Compute the change in length; diameter and volume of the rod. Take E= 2 x 105 N/mm2 and Poisson’s ratio = 0.25. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | A simply supported beam of 4 m span is carrying loads as shown in figure. Illustrate and sketch the shear force and bending moment diagrams for the beam. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 20. |  | A simply supported beam carries a uniformly distributed load of 40 kN/m run over the entire span. The section of the beam is rectangular having a depth as 500 mm. If the maximum stress in the material of the beam is 120 N/mm2 and moment of inertia of the section is 7 x 108 mm4, evaluate the span of the beam. | CO5 | An | 12 |
|  |  |  |  |  |  |
| 21. | a. | Calculate the diameter of a solid shaft which will transmit 90 kW at 160 rpm, if the shear stress is limited to 60 N/mm2. Estimate also the length of the shaft, if the twist must not exceed 1 degree over the entire length. Take C as 8 x 104 N/mm2. | CO5 | An | 6 |
|  | b. | A close coiled helical spring of 100 mm mean diameter is made up of 10 mm diameter rod and has 20 turns. The spring carries a load of 200 N. Determine the shear stress. Taking the value of modulus of rigidity as 8.4 x 104 N/mm2, determine the deflection and stiffness in the spring. | CO5 | A | 6 |
|  |  |  |  |  |  |
| 22. |  | An overhanging beam ABC carries a uniformly distributed load of 4.5 kN/m over its entire span, as shown in figure. Illustrate and sketch the shear force and bending moment diagrams and compute the point of contraflexure, if any. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 23. |  | A block shown in figure weighing 35 kN is supported by three wires. The outer two wires are of steel and have an area of 100 mm2 each, whereas the middle wire of aluminium has an area of 200 mm2.  If the elastic modulii of steel and aluminium are 200 GPa and 80 GPa respectively, then calculate the stresses in the aluminium and steel wires. | CO2 | An | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | The tensile stresses at a point across two mutually perpendicular planes are 120 N/mm2 and 60 N/mm2. Calculate the normal, tangential and resultant stresses on a plane inclined at 30º to the axis of the minor stress. (Solve using either Analytical method or Graphical method) | CO6 | An | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the concepts of stress-strain relationships for homogenous, isotropic materials. |
| CO2 | Calculate stresses and strains in members subjected to axial structural loads and thermal loads. |
| CO3 | Determine the volumetric strain of the components and also derive the relationship between the elastic constants. |
| CO4 | Calculate the shear force and bending moment of beams. |
| CO5 | Compute the stresses and strains in members subject to flexural and torsional loadings. |
| CO6 | Illustrate principal stresses, maximum shearing stress, and the stresses acting on a structural member. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | - | 4 | - | - | - | 5 |
| CO2 | - | 1 | 3 | 20 | - | - | 24 |
| CO3 | - | 2 | 15 | - | - | - | 17 |
| CO4 | 1 | 1 | 3 | 24 | - | - | 29 |
| CO5 | 3 | - | 12 | 18 | - | - | 33 |
| CO6 | - | 1 | 3 | 12 | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20RO2003** | **Duration :** | **3hrs** |
| **Course Name** | **SENSORS AND PROTOCOLS FOR INSTRUMENTATION** | **Max. Marks :** | **100** |

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| **Q. No.** | **Questions** | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | |
| 1. | Define accuracy. | CO1 | R | 1 |
| 2. | Give the SI unit for speed. | CO1 | R | 1 |
| 3. | Give an example of NTC type temperature sensor. | CO2 | U | 1 |
| 4. | List the basic components for a Load Cell. | CO2 | R | 1 |
| 5. | Identify the circuit used along with a potentiometer. | CO3 | U | 1 |
| 6. | Identify the proximity sensor used in detect the presence of conductive objects. | CO3 | A | 1 |
| 7. | Mention the expression for discharge coefficient of venturi meter. | CO4 | R | 1 |
| 8. | Give the applications of gyroscope. | CO4 | U | 1 |
| 9. | What is half duplex transmission? | CO5 | U | 1 |
| 10. | Identify the no of wires used for I2C protocol. | CO5 | R | 1 |

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| **PART – B (6 X 3 = 18 MARKS)** | | | | |
| 11. | Tabulate the parameters to be checked when purchasing a sensor. | CO1 | R | 3 |
| 12. | Give the principle of Capacitance sensor. | CO2 | U | 3 |
| 13. | List the differences between incremental encoders and absolute encoders | CO3 | U | 3 |
| 14. | Identify the simple method used to measure level in a tank draw and illustrate the working. | CO4 | U | 3 |
| 15. | Mention the necessity of 4-20mA current loop. | CO5 | U | 3 |
| 16. | Comment on the merits and demerits of WiFi. | CO6 | R | 3 |

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| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. |  | Discuss in detail the static sensor characteristics. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 18. | a. | Explain the various circuits used along with strain gauge for conversion of the generated resistance into voltage. | CO2 | A | 6 |
| b. | Relate the sensor that works on the principle of Seebeck, explain its construction and working. | CO2 | An | 6 |
|  |  |  |  |  |  |
| 19. | a. | A linear variable differential transformer has a stroke length of ±150mm and produces a resolution of 40mV/mm when moved. Determine:  a) The LVDT’s maximum output voltage.  b) The output voltage when the core is moved 120mm from its null position.  c) The core position from center when the output voltage is 3.75 volts.  d) The change in output voltage when the core is moved from +80mm to -80mm displacement. | CO3 | A | 6 |
|  | b. | Find the sensor used in accelerator pedal of car to find the acceleration and elaborate the same with required diagram. | CO3 | A | 6 |
|  |  |  |  |  |  |
| 20. |  | Draw and explain the construction and working of Venturi meter. Derive the expression for discharge. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. | a. | With neat diagram explain the RS-485 protocol. | CO5 | R | 6 |
|  | b. | Find the protocol used for communication between and embedded controller and an IC based sensor. | CO5 | U | 6 |
|  |  |  |  |  |  |
| 22. |  | Discuss in detail the serial protocol designed to communicate with computer and modem. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 23. | a. | Draw and explain the various circuit configurations for RTD. | CO2 | A | 6 |
|  | b. | Draw the generalized instrumentation system block diagram and elaborate on each block. | CO1 | U | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Elaborate the architecture of Bluetooth protocol and its word structure in detail. | CO6 | U | 10 |
|  | b. | Give the differences between BLE & Bluetooth. | CO6 | R | 2 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Classify the types of errors in measurement system and identify the types of sensors. |
| CO2 | Compare the principle and working of temperature, pressure and flow sensors. |
| CO3 | Identify and apply appropriate sensor for measurement of displacement and velocity. |
| CO4 | Apply various sensors for designing and building robots. |
| CO5 | Describe the functions of different communication protocols. |
| CO6 | Apply the various wireless communication protocols in Sensor Interfacing. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 5 | 18 |  |  |  |  | 23 |
| CO2 | 1 | 4 | 12 | 6 |  |  | 23 |
| CO3 |  | 4 | 15 |  |  |  | 17 |
| CO4 | 1 | 16 |  |  |  |  | 17 |
| CO5 | 7 | 24 |  |  |  |  | 29 |
| CO6 | 5 | 10 |  |  |  |  | 15 |
|  | | | | | | | **124** |



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| **Course Code** | **20RO2007** | **Duration** | **3hrs** |
| **Course Name** | **SMART SENSORS FOR IOT APPLICATIONS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | For a roof garden automation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_is used to find the water requirement and water the plants. | | CO1 | A | 1 |
| 2. | List the sensor used in home automation. | | CO1 | A | 1 |
| 3. | Voltage divider can be used along \_\_\_\_\_\_\_\_\_\_\_\_ sensors. | | CO2 | An | 1 |
| 4. | \_\_\_\_\_\_\_\_\_\_\_ allows the frequency greater than cutoff frequency. | | CO2 | U | 1 |
| 5. | Give the number of op-amps required to implement the following equation:  Vo = V1 | | CO3 | U | 1 |
| 6. | Identify the sensor that can be connected to the transducer bridge amplifier | | CO3 | A | 1 |
| 7. | TIM stands for\_\_\_\_\_\_\_\_\_\_\_\_\_\_. | | CO4 | R | 1 |
| 8. | In smart sensors communication, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ currently has a limitation of availability and stability in remote locations. | | CO4 | R | 1 |
| 9. | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ board can be used to develop a wireless sensor. | | CO5 | A | 1 |
| 10. | Operational frequency of Zigbee is\_\_\_\_\_\_\_\_\_\_\_\_. | | CO5 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Define Seebeck Effect. | | CO1 | U | 3 |
| 12. | Design a high pass filter with a cut off frequency of 20KHz. | | CO2 | A | 3 |
| 13. | Draw the circuit diagram of voltage to current converter with grounded load. | | CO3 | R | 3 |
| 14. | Give the features of wireless sensors. | | CO4 | U | 3 |
| 15. | List the enhancement given by smart sensors. | | CO5 | E | 3 |
| 16. | Justify the use of open source hardware. | | CO6 | E | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. | a. | With neat diagram explain the working of CO2 Sensor | CO1 | U | 8 |
|  | b. | Give the criteria for selecting a sensor. | CO1 | R | 4 |
| 18. | a. | A 12Kohm resistive based sensor is used for angular measurement, has a reading of 40% of the full scale. The interface circuit for the angular sensor behave as a resistive load of 10kOhms. Find the current flowing thru the interfacing circuit.(Assume a 12 Volt Power supply) | CO2 | An | 6 |
|  | b. | With neat diagram explain the construction and working of bandpass filters. | CO2 | U | 6 |
| 19. | a. | Explain the basic application circuits of an Op-amp | CO2 | A | 9 |
|  | b. | Find the expression for the following circuit. | CO2 | E | 3 |
| 20. | a. | Elaborate on the evolution of the Smart Sensors. | CO5 | R | 8 |
|  | b. | Discuss the importance of smart sensors. | CO5 | E | 4 |
| 21. |  | Explain the architecture of Bluetooth and its application in wireless sensors. | CO4 | U | 12 |
| 22. |  | Design a transducer bridge instrumentation amplifier and sketch the circuit diagram using a thermistor for temperature indication. | CO3 | C | 12 |
| 23. |  | With neat diagram explain the construction and working of RTD with the required circuitry. | CO1 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Elaborate on the various aspects of home automation with respect to the sensor application and the use of wireless technology. | CO6 | An | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Describe the various sensors and their application. |
| CO2 | Identify an appropriate signal condition circuit for the sensor. |
| CO3 | Implement an efficient amplifier circuit for the sensor. |
| CO4 | Explain the use of wireless network. |
| CO5 | Apply the skills to develop smart sensors. |
| CO6 | Analyse the use of Smart Sensors and IOT. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 4 | 11 | 14 |  |  |  | 29 |
| CO2 |  | 7 | 12 | 7 | 3 |  | 29 |
| CO3 | 3 | 1 | 1 |  |  | 12 | 17 |
| CO4 | 2 | 15 |  |  |  |  | 17 |
| CO5 | 9 |  |  | 1 | 7 |  | 17 |
| CO6 |  |  |  | 12 | 3 |  | 15 |
|  | | | | | | | **124** |

**Graphical user interface, application

Description automatically generated with medium confidence**

**SUPPLEMENTARY EXAMINATION – JUNE 2023**

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| **Course Code** | **20RO2007** | **Duration :** | **3hrs** |
| **Course Name** | **SMART SENSORS FOR IOT APPLICATIONS** | **Max. Marks :** | **100** |

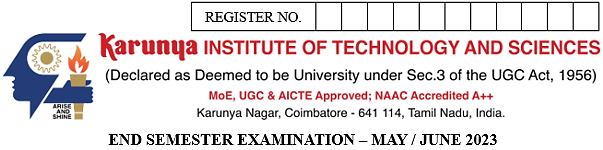
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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
|  | | **PART – A (10 X 1 = 10 MARKS)** | | | |
| 1. | Mention few sensor used in mobile. | | CO1 | A | 1 |
| 2. | A lux sensor can be used in \_\_\_\_\_\_\_\_\_\_\_\_ automation. | | CO1 | A | 1 |
| 3. | Identify the circuit used to convert resistance to voltage for potentiometer | | CO2 | R | 1 |
| 4. | Give the expression for lowpass filter. | | CO2 | R | 1 |
| 5. | Expression for inverting amplifier | | CO3 | U | 1 |
| 6. | Transducer bridge can be connected to \_\_\_\_\_\_\_\_\_\_\_. | | CO3 | A | 1 |
| 7. | Give the Sound frequency that audible for human ears. | | CO4 | R | 1 |
| 8. | The maximum distance a WIFI device can transmit is \_\_\_\_\_\_\_. | | CO4 | R | 1 |
| 9. | List the boards which can be used to develop a Wi-Fi device. | | CO5 | A | 1 |
| 10. | Identify the wireless protocol used in a car. | | CO5 | A | 1 |

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|  | | **PART – B (6 X 3 = 18 MARKS)** | | | |
| 11. | Give the principle of thermocouple. | | CO1 | R | 3 |
| 12. | Design a First Order low pass filter for with the cut off frequency of 500Hz. | | CO2 | A | 3 |
| 13. | Draw the circuits of inverting and non inverting amplifier. | | CO3 | U | 3 |
| 14. | List the wireless technologies used in Smart Sensors. | | CO4 | U | 3 |
| 15. | List the components of a smart sensors. | | CO5 | R | 3 |
| 16. | List a few open-source hardware and software. | | CO6 | A | 3 |

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|  | | **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.no 17 to 23)** | | | | |
| 17. | a. | | With neat diagram explain the working of CO2 Sensor. | CO1 | U | 8 |
|  | b. | | Give the criteria for selecting a sensor. | CO1 | R | 4 |
|  |  | |  |  |  |  |
| 18. | a. | | Derive the expression for loading effect of potentiometer. | CO2 | A | 6 |
|  | b. | | Draw and give explanation on the filter circuits used with sensors that generate signals not less than 500Hz . | CO2 | An | 6 |
|  |  | |  |  |  |  |
| 19. | a. | | Derive the expression for gain of an instrumentation amplifier with the circuit and its construction. | CO3 | An | 12 |
|  |  | |  |  |  |  |
| 20. | a. | | Explain the architecture of Bluetooth and its application in wireless sensors. | CO4 | R | 12 |
|  |  | |  |  |  |  |
| 21. | a. | | Examine various architecture of Smart Sensors with appropriate block diagram. | CO5 | A | 12 |
|  |  | |  |  |  |  |
| 22. | a. | | With neat diagram explain the construction and working of RTD with the required circuitry. | CO3 | R | 12 |
|  |  | |  |  |  |  |
| 23. | a. | | Explain construction and working of humidity sensor. | CO1 | R | 8 |
|  | b. | | List the parameters of the sensors to be considered while using for any particular application. | CO1 | A | 4 |
| **Compulsory:** | | | | | | |
| 24. | a. | | Give in detail the improvements that can happen to agriculture with IoT enabled devices. | CO6 | A | 12 |

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the various sensors and their application. |
| CO2 | Identify an appropriate signal condition circuit for the sensor. |
| CO3 | Implement an efficient amplifier circuit for the sensor. |
| CO4 | Explain the use of wireless network. |
| CO5 | Apply the skills to develop smart sensors. |
| CO6 | Analyse the use of Smart Sensors and IOT |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 15 | 8 | 6 |  |  |  | 29 |
| CO2 | 2 | 1 | 9 | 6 |  |  | 17 |
| CO3 | 13 | 3 | 1 | 12 |  |  | 29 |
| CO4 | 14 | 3 |  |  |  |  | 17 |
| CO5 | 3 |  | 14 |  |  |  | 17 |
| CO6 |  |  | 15 |  |  |  | 15 |
|  | | | | | | | **124** |



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| **Course Code** | **20RO3003** | **Duration** | **3hrs** |
| **Course Name** | **COMPUTER AIDED MODELLING AND DESIGN** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Explain the scope and applications of CAD in Mechanical Engineering. | CO1 | U | 8 |
|  | b. | Present and highlight the different types of CAD standards used in design. | CO1 | U | 8 |
|  |  |  |  |  |  |
| 2. |  | Discuss the DDA algorithm in detail with a suitable example. | CO2 | A | 16 |
|  |  |  |  |  |  |
| 3. |  | Explain about the CSG technique used in solid modeling in detail. | CO3 | A | 16 |
|  |  |  |  |  |  |
| 4. | a. | Highlight the working and applications of a CRT display in detail with a neat sketch. | CO4 | U | 12 |
|  | b. | Describe Product Cycle with a neat sketch. | CO4 | U | 4 |
|  |  |  |  |  |  |
| 5. |  | Express the different steps involved in Finite Element Analysis with neat sketches. | CO5 | U | 16 |
|  |  |  |  |  |  |
| 6. |  | Implement the different types of geometric transformation, with examples and neat sketches. | CO2 | A | 16 |
|  |  |  |  |  |  |
| 7. | a. | Highlight the features of wire frame modeling in CAD. State its applications. | CO3 | U | 8 |
|  | b. | Explain the different types of display systems used in CAD, with suitable applications. | CO4 | U | 8 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. |  | Explain the concept of Reverse Engineering and its applications in detail. | CO6 | A | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Demonstrate the basic structure and components of CAD. |
| CO2 | Outline the process of representing graphical entities in a CAD environment. |
| CO3 | Construct the geometric model using different techniques to represent a product. |
| CO4 | Illustrate various techniques and devices involved in CAD hardware. |
| CO5 | Analyze the models for design solutions using FEM. |
| CO6 | Discuss the various computer aided tools implemented in various industrial applications. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | - | 16 | - | - | - | - | 16 |
| CO2 | - |  | 32 | - | - | - | 32 |
| CO3 | - | 8 | 16 | - | - | - | 24 |
| CO4 | - | 24 | - | - | - | - | 24 |
| CO5 | - | 16 | - | - | - | - | 16 |
| CO6 | - | - | 20 | - | - | - | 20 |
|  | | | | | | | **132** |



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| --- | --- | --- | --- |
| **Course Code** | **20RO3004** | **Duration** | **3hrs** |
| **Course Name** | **DRIVES AND CONTROL SYSTEMS FOR AUTOMATION** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Describe the working of Induction motor and obtain its torque speed characteristics. Also obtain the condition for maximum torque. | CO1 | U | 12 |
|  | b. | A 3-phase induction motor is wound for 4 poles and is supplied from 50 Hz source. Calculate.  (1) synchronous speed.  (2) percentage slip of the motor when speed is 1440 rpm. | CO1 | An | 4 |
|  |  |  |  |  |  |
| 2. | a. | Explain the working of Brushless DC motor with suitable diagram. | CO2 | U | 12 |
|  | b. | A stepper motor has a step angle of 2.50. Calculate the number of steps required for the shaft to make 20 revolutions. | CO2 | An | 4 |
|  |  |  |  |  |  |
| 3. | a. | List out the methods used to convert rotational motion to linear motion. | CO3 | R | 6 |
|  | b. | Describe the types of Belt and Pulley mechanism used for drives. Also write its advantages and disadvantages. | CO3 | U | 10 |
|  |  |  |  |  |  |
| 4. | a. | Describe the step by step procedure to interface PLC with PC using TCP/IP protocol. | CO4 | A | 8 |
|  | b. | Explain the methods of PLC programming with suitable example. | CO4 | A | 8 |
|  |  |  |  |  |  |
| 5. | a. | Explain different Timer and Counter instructions used in PLC programming with suitable example. | CO5 | A | 16 |
|  |  |  |  |  |  |
| 6. | a. | Write down the necessity of HMI in Industrial Automation. Explain the types of HMI in detail. | CO5 | A | 16 |
|  |  |  |  |  |  |
| 7. | a. | Describe the working of Programmable Logic Controller in detail with the functional block diagram. | CO4 | U | 10 |
|  | b. | Compare Profibus and Profinet communications used between industrial controller and I/O devices | CO4 | An | 6 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Describe the step by step procedure to interface PLC with SCADA system. Also explain the SCADA programming with an example. | CO6 | A | 14 |
|  | b. | Compare DCS and SCADA. | CO6 | An | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the working principles of various types of motors, differences, characteristics and selection criteria. |
| CO2 | Apply the knowledge in selection of motors, heating effects and braking concepts in various industrial applications. |
| CO3 | Explain control methods of special drives. |
| CO4 | Elucidate various linear and rotary motion principles and methods and use the same to application areas. |
| CO5 | Design programming using PLC and use of various PLCs to Automation problems in industries. |
| CO6 | Discuss supervisory control and data acquisition method and use the same in complex automation areas. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 |  | 12 |  | 4 |  |  | 16 |
| CO2 |  | 12 |  | 4 |  |  | 16 |
| CO3 | 6 | 10 |  |  |  |  | 16 |
| CO4 |  | 10 | 16 | 6 |  |  | 32 |
| CO5 |  |  | 32 |  |  |  | 32 |
| CO6 |  |  | 14 | 6 |  |  | 20 |
|  | | | | | | | **132** |



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| **Course Code** | **20RO3014\_Ph.D.** | **Duration** | **3hrs** |
| **Course Name** | **INDUSTRIAL INTERNET OF THINGS AND ITS APPLICATIONS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Elaborate in detail about IoT enablers and connectivity layers. | CO1 | A | 15 |
|  | b. | Differentiate Industrial IoT and Consumer IoT. | CO1 | U | 5 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Elaborate the functional blocks of IoT service oriented architecture. | CO2 | A | 20 |
|  |  |  |  |  |  |
| 3. |  | With a neat block diagram, elaborate the functional blocks of IoT service oriented architecture. | CO2 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Explain in detail about connectivity technology in MQTT. | CO4 | U | 15 |
|  | b. | Classify the different Types of Protocols. | CO4 | R | 5 |
|  |  |  |  |  |  |
| 5. | a. | Describe about the network security techniques. | CO5 | A | 15 |
|  | b. | Discuss the conventional web technology and relationship with IIOT. | CO5 | R | 5 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Illustrate various layers in HART Protocol. | CO3 | A | 20 |
|  |  |  |  |  |  |
| 7. |  | Elaborate the functional blocks of CoAP architecture. | CO4 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Write short note on Zigbee Protocol and its significant characteristics. | CO4 | U | 15 |
|  | b. | Highlight the role of IoT in Automotive Industry | CO5 | U | 5 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Discuss the applications of IoT in the manufacturing sector and describe the process of implementation with a relevant case study. | CO6 | A | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Recall the overview of IoT. |
| CO2 | Discuss architecture of IIoT. |
| CO3 | Discuss the sensor and its interfaces. |
| CO4 | Explain protocol and cloud concepts. |
| CO5 | Explain web security and its need. |
| CO6 | Create simple IIoT applications. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 |  | 5 | 15 |  |  |  | 20 |
| CO2 |  |  | 40 |  |  |  | 40 |
| CO3 |  |  | 20 |  |  |  | 20 |
| CO4 | 5 | 30 | 20 |  |  |  | 55 |
| CO5 | 5 | 5 | 15 |  |  |  | 25 |
| CO6 |  |  | 20 |  |  |  | 20 |
|  | | | | | | | **180** |



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| **Course Code** | **20RO3014** | **Duration** | **3hrs** |
| **Course Name** | **INDUSTRIAL INTERNET OF THINGS AND ITS**  **APPLICATIONS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Analyze the use of IIoT in plant maintenance practices and assess its impact on reducing downtime, maintenance costs, and improving equipment performance. | CO1 | An | 8 |
|  | b. | Evaluate the role of IIoT in promoting innovation and entrepreneurship in industries. | CO1 | E | 8 |
|  |  |  |  |  |  |
| 2. | a. | Define the various architectures of IIoT and evaluate their advantages and disadvantages in industrial applications. | CO2 | C | 8 |
|  | b. | Explain the role of sensors in IIoT systems and assess their impact on the automation and optimization of industrial processes. | CO2 | U | 8 |
|  |  |  |  |  |  |
| 3. |  | Evaluate the advantages and limitations of HART, MODBUS, Ethernet, BACNet protocols in the context of IIoT systems. | CO3 | E | 16 |
|  |  |  |  |  |  |
| 4. |  | Compare and contrast different types of protocols used in IIoT systems such as Wi-Fi, Zigbee, Z-wave, Modbus, and I2C. | CO4 | U | 16 |
|  |  |  |  |  |  |
| 5. | a. | Summarize the importance of web security in the era of increased cyber-attacks. | CO5 | U | 8 |
|  | b. | Outline the effectiveness of various privacy protection mechanisms in web security. | CO5 | U | 8 |
|  |  |  |  |  |  |
| 6. |  | Identify the challenges faced in implementing data analytics in IIoT systems. | CO4 | A | 16 |
|  |  |  |  |  |  |
| 7. |  | Assess the special requirements for sensors in IIoT systems such as durability, reliability, and accuracy. Analyze the challenges faced in meeting these requirements and evaluate the potential solutions. | CO3 | E | 16 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. |  | Using R programming, write a script that reads in a dataset of sensor readings and calculates the average value for each sensor over a given time period. | CO6 | A | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Recall the overview of IoT. |
| CO2 | Discuss architecture of IIoT. |
| CO3 | Discuss the sensor and its interfaces. |
| CO4 | Explain protocol and cloud concepts. |
| CO5 | Explain web security and its need. |
| CO6 | Create simple IIoT applications. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 |  |  |  | 8 | 8 |  | 16 |
| CO2 |  | 8 |  |  |  | 8 | 16 |
| CO3 |  |  |  |  | 32 |  | 32 |
| CO4 |  | 16 | 16 |  |  |  | 32 |
| CO5 |  | 16 |  |  |  |  | 16 |
| CO6 |  |  | 20 |  |  |  | 20 |
|  | | | | | | | **132** |



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| **Course Code** | **20RO3015** | **Duration** | **3hrs** |
| **Course Name** | **OPTIMIZATION TECHNIQUES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Compare biological neuron and artificial neuron. | CO1 | U | 10 |
|  | b. | Summarize the applications of soft computing. | CO1 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Differentiate single layer and multilayer perceptron. | CO1 | An | 10 |
|  | b. | Discuss about the various types of soft computing techniques. | CO5 | U | 10 |
|  |  |  |  |  |  |
| 3. | a. | Explain the architecture of Hopfield network. | CO1 | A | 10 |
|  | b. | Apply the concept of neural network toolbox for embedded applications. | CO5 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Elaborate on Radial basis function networks. | CO3 | U | 10 |
|  | b. | Discuss about stability constraints. | CO3 | U | 10 |
|  |  |  |  |  |  |
| 5. | a. | Compare the various fuzzy membership functions. | CO2 | A | 10 |
|  | b. | Explain the fundamentals of fuzzy set theory. | CO2 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Analyze the concept of linear programming. | CO3 | An | 20 |
|  |  |  |  |  |  |
| 7. |  | Classify the various optimization problems. | CO4 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Explain the fitness functions of genetic algorithm. | CO5 | A | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Explain the steepest ascent hill climbing algorithm with relevant example. | CO4 | A | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Apply neural network tool box for embedded applications. |
| CO2 | Analyze the concept of fuzzy logic and neuro fuzzy systems. |
| CO3 | Examine various optimization techniques. |
| CO4 | Choose appropriate optimization techniques for engineering applications. |
| CO5 | Apply genetic algorithm concepts and tool box for embedded applications |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 |  | 20 | 10 | 10 |  |  | 40 |
| CO2 |  | 10 | 10 |  |  |  | 20 |
| CO3 |  | 20 |  | 20 |  |  | 40 |
| CO4 |  | 20 | 20 |  |  |  | 40 |
| CO5 |  | 20 |  | 20 |  |  | 40 |
|  | | | | | | | **180** |



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| **Course Code** | **20RO3018** | **Duration** | **3hrs** |
| **Course Name** | **ARTIFICIAL INTELLIGENCE IN ROBOTICS & AUTOMATION** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Consider the water jug problem: You are given two jugs, a 4-gallon one and 3-gallon one. Neither has any measuring marker on it. There is a pump that can be used to fill the jugs with water. How can you get exactly 2 gallons of water from the 4-gallon jug? Explicit Assumptions: A jug can be filled from the pump, water can be poured out of a jug on to the ground, water can be poured from one jug to another and that there are no other measuring devices available. Apply suitable production rules to solve this problem. | CO1 | An | 8 |
|  | b. | Predict depth first search and breadth first search for the given graph with starting node as 1. | CO1 | C | 8 |
|  |  |  |  |  |  |
| 2. | a. | Consider the graph given below, Assume that in the initial state is A to the goal state is G. Find a path from the initial state to the goal state using BEST FIRST search. Also report the solution cost. The straight line distance heuristic estimates for the nodes are as follows : h (1) =40, h( 2) =32, h(3)=25, h( 4) =35, h(5)=19,h(6)=17, h(7)= 10  Description: C:\Users\Admin\Desktop\al.png | CO2 | An | 10 |
|  | b. | Sketch the various regions in the state space diagram of Hill Climbing. | CO2 | U | 6 |
|  |  |  |  |  |  |
| 3. | a. | Draw a semantic network representing the following knowledge :  Every vehicle is a physical object. Every car is a vehicle. Every car has four wheels. Electrical system is a part of car. Battery is a part of electrical system. Pollution system is a part of every vehicle. Vehicle is used in transportation. Swift is a car. | CO3 | A | 8 |
|  | b. | Represent the information used in the below mentioned problem in predicate logic.  There is a monkey at the door in a room. In the middle of the room a bunch of banana is hanging from the ceiling. The monkey is hungry and wants to get the banana, but he cannot stretch high enough from the floor. At the window of the room there is a box. | CO3 | U | 8 |
|  |  |  |  |  |  |
| 4. | a. | Explain the goal stack planning and non -linear planning with examples. | CO3 | U | 8 |
|  | b. | State the Bayes theorem. Explain the statistical reasoning with an example. | CO3 | U | 8 |
|  |  |  |  |  |  |
| 5. |  | Elaborate “learning by example”. | CO4 | C | 16 |
|  |  |  |  |  |  |
| 6. | a. | Draw the diagram for an ANN network. Discuss the various types of learning involved in it. | CO4 | C | 8 |
|  | b. | With the help of an example, explain the decision tree process. | CO4 | U | 8 |
|  |  |  |  |  |  |
| 7. | a. | Analyze the potential threats from AI technology to society. What threats are most serious, and how might they be combated? | CO5 | An | 8 |
|  | b. | Compare the various attributes of robot with those of human being. Explain a robot structure with a sketch. | CO5 | E | 8 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Enumerate the non-manufacturing areas where robots are expected to be used. Discuss robot application for welding and machine loading. | CO6 | C | 10 |
|  | b. | State characteristics of work which promote application of robots. Discuss robot application for assembly and inspection. | CO6 | C | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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| CO1 | 1. Describe the basics of AI. |
| CO2 | 2. Understand the various intelligent search methods. |
| CO3 | 3. Explain the concepts of knowledge and reasoning. |
| CO4 | 4. Understand the in-depth concepts of learning methods. |
| CO5 | 5. Explore the ethics of AI. |
| CO6 | 6. Understand the application of AI for robotics. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 |  |  |  | 8 |  | 8 | 16 |
| CO2 |  | 6 |  | 10 |  |  | 16 |
| CO3 |  | 24 | 8 |  |  |  | 32 |
| CO4 |  | 8 |  |  |  | 24 | 32 |
| CO5 |  |  |  | 8 | 8 |  | 16 |
| CO6 |  |  |  |  |  | 20 | 20 |
|  | | | | | | | **132** |



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| **Course Code** | **20RO3019** | **Duration** | **3hrs** |
| **Course Name** | **ADVANCED MACHINE LEARNING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Brief the following: (i) Joint probability (ii) Conditional probability and (iii) Bayesian rule.  A patient takes a lab test and the result comes back positive. It is known that the test returns a correct positive result in only 98% of the cases and a correct negative result in only 97% of the cases. Furthermore, only 0.008 of the entire population has this disease. 1. What is the probability that this patient has cancer? 2. What is the probability that he does not have cancer? 3. What is the diagnosis? | CO1 | U | 10 |
|  | b. | Consider the two dimensional patterns (2.5, 2.4), (0.5, 0.7), (2.2, 2.9), (1.9, 2.2), (3.1, 3.0). Compute the principal component using PCA Algorithm. | CO1 | A | 10 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Explain the concept of dimensionality reduction. | CO1 | An | 20 |
|  |  |  |  |  |  |
| 3. |  | Analyze the relationship between attributes using Covariance and Correlation. | CO2 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Describe the concept on density based clustering and write the steps involved in DBSCAN algorithm. | CO3 | U | 20 |
|  |  |  |  |  |  |
| 5 |  | Calculate the Pearson correlation coefficient and Spearman correlation coefficient for the following data.   |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | X | 5 | 10 | 5 | 11 | 12 | 4 | 3 | 2 | 7 | 1 | | Y | 1 | 6 | 2 | 9 | 5 | 1 | 4 | 8 | 5 | 7 | | CO4 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Explain the k-nearest neighbor algorithm. | CO4 | U | 20 |
|  |  |  |  |  |  |
| 7. |  | Explain the support vector machine from the perspective of the nonlinear Kernel by means of an algorithm. Derive the margin of the support vectors with an example and depict it with necessary diagrams. | CO5 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Discuss about the random forest algorithm using bagging and boosting models. | CO5 | U | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Discuss the benefits of applying the Apriori principle in the context of the Apriori algorithm for the association rules mining. | CO6 | A | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Describe overview of ML techniques. |
| CO2 | Classify and contrast pros and cons of various machine learning techniques. |
| CO3 | Illustrate various methods for clustering. |
| CO4 | Infer various machine learning approaches and paradigms. |
| CO5 | Explain the importance of support vector machine. |
| CO6 | Discuss the concept of association rule mining. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 |  | 10 | 10 | 20 |  |  | 40 |
| CO2 |  |  |  | 20 |  |  | 20 |
| CO3 |  | 20 |  |  |  |  | 20 |
| CO4 |  | 20 | 20 |  |  |  | 40 |
| CO5 |  | 40 |  |  |  |  | 40 |
| CO6 |  |  | 20 |  |  |  | 20 |
|  | | | | | | | **180** |



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| **Course Code** | **21RO2001** | **Duration** | **3hrs** |
| **Course Name** | **INTRODUCTION TO MECHANICAL SYSTEMS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define Resultant force. | | 1 | R | 1 |
| 2. | Discuss the static equilibrium conditions. | | 1 | U | 1 |
| 3. | Differentiate centroid and center of gravity. | | 2 | U | 1 |
| 4. | In a body that is symmetrical about the axes, the centroid is the point of intersection of ---------------, | | 2 | U | 1 |
| 5. | Distance travelled by a body in the nth second of its motion is --------------, | | 3 | R | 1 |
| 6. | Give examples of rectilinear motion of objects. | | 3 | U | 1 |
| 7. | Define the momentum of a particle. | | 4 | R | 1 |
| 8. | When the elements of the pair are kept in contact by the action of external forces, the pair is said to be a form closed pair (True/False) | | 5 | U | 1 |
| 9. | Classify different kinds of joints. | | 5 | U | 1 |
| 10. | Define the factor of safety. | | 6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | The two forces P and Q act on bolt A . Determine their resultant. | | 1 | A | 3 |
| 12. | State the theorem of **Pappus-Guldin.** | | 2 | U | 3 |
| 13. | Explain the path of a projectile. | | 3 | U | 3 |
| 14. | An automobile is decelerating from a speed of 65km/h at the rate of 1.5 m/s2 . How long will it take to come to rest and how far will it have gone? | | 4 | A | 3 |
| 15. | Explain with a neat diagram, the Grashoffs law. | | 5 | An | 3 |
| 16. | Indicate the steps involved in design of a machine element. | | 6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Four forces act on bolt A as shown. Determine the resultant of the forces on the bolt.  C:\Users\Admin\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Picture4.png | 1 | A | 10 |
|  | b. | Explain the principle of transmissibility. | 1 | U | 2 |
|  |  |  |  |  |  |
| 18. |  | A tower guy wire is anchored using a bolt at A. The tension in the wire is 2500 N. Determine (a) the components Fx, Fy , Fz of the force acting on the bolt, (b) the angles ɵx, ɵy, ɵz, defining the direction of the forces | 1 | An | 12 |
|  |  |  |  |  |  |
| 19. |  | Evaluate the centroid of the figure given below. | 2 | E | 12 |
|  |  |  |  |  |  |
| 20. | a. | 2 weights are connected by a string and move along the rough horizontal plane under the action of force 40 N, applied to the first weight as in fig. The coefficient of friction between the sliding surfaces of weights and the plane is 0.3. Determine the acceleration of weights in tension in the string using D’Alembert’s principle. | 3 | An | 10 |
|  | b. | State the principle of work and energy. | 4 | A | 2 |
|  |  |  |  |  |  |
| 21. | a. | A car of mass 150 kg is traveling on a horizontal track at 36 km/hr. Determine the time needed to stop the car. The coefficient of friction between the tires and the road is 0.45. | 4 | A | 10 |
|  | b. | Derive the parallel axis theorem with neat sketch. | 2 | An | 2 |
|  |  |  |  |  |  |
| 22. | a. | Calculate the degrees of freedom of the mechanisms shown in figure below: | 5 | An | 6 |
|  | b. | Explain any two inversions of four bar mechanism with neat diagrams and examples. | 5 | A | 6 |
|  |  |  |  |  |  |
| 23. | a. | Find the reactions forces at B and D for the beam and loading shown: | 1 | An | 6 |
|  | b. | A beam is subjected to the forces shown in the fig. Reduce the force system to a single force and a couple system at A.  10001 | 1 | An | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Illustrate about the maximum principal stress theory of failure. | 6 | A | 6 |
| b. | Examine the factors to be considered for selection of material for a machine component. | 6 | A | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Recall the basic concepts of equilibrium of forces. |
| CO2 | Interpret the properties of engineered surfaces and volumes. |
| CO3 | Recognize the motion characteristics of particles using laws of motion. |
| CO4 | Describe the motion characteristics of rigid bodies. |
| CO5 | Identify the kinematic principles of simple mechanisms. |
| CO6 | Explain the elementary design process of the simple machine components. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 3 | 13 |  |  |  | 29 |
| CO2 |  | 7 |  | 2 | 12 |  | 21 |
| CO3 | 1 | 4 |  | 22 |  |  | 27 |
| CO4 | 1 |  | 15 |  |  |  | 16 |
| CO5 |  | 11 | 6 | 9 |  |  | 17 |
| CO6 | 1 | 3 | 12 |  |  |  | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **21RO2002** | **Duration** | **3hrs** |
| **Course Name** | **AUTOMATIC CONTROL SYSTEMS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Mention the rule for eliminating feedback loop in block diagram implementation. | | CO1 | R | 1 |
| 2. | Define non-touching loop. | | CO1 | R | 1 |
| 3. | State damping ratio. | | CO2 | R | 1 |
| 4. | Determine the type and order of the following system transfer function  . | | CO2 | U | 1 |
| 5. | Define state vector. | | CO3 | R | 1 |
| 6. | List the advantages of state variable approach. | | CO3 | U | 1 |
| 7. | Define bandwidth. | | CO4 | R | 1 |
| 8. | The first column of the Routh array is 5, 1, 2, 4, -3. Determine the number of roots in right half of s-plane. | | CO5 | R | 1 |
| 9. | Define gain crossover frequency. | | CO5 | U | 1 |
| 10. | List the Characteristics of P-controller. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Mention the force balance equation of ideal mass element. | | CO1 | U | 3 |
| 12. | A second order system has a damping ratio of 0.6 and natural frequency of oscillation is 10 rad/sec. Determine the damped frequency of oscillation. | | CO2 | U | 3 |
| 13. | Give the condition for routh stability. | | CO3 | R | 3 |
| 14. | Sketch Polar plot for the transfer function | | CO4 | U | 3 |
| 15. | Give the general form of state variable representation. | | CO5 | U | 3 |
| 16. | State the advantages of frequency response analysis. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Determine the transfer function for the system shown below. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. |  | Apply Mason’s gain formula for determining the overall transfer function of the system shown below. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | Derive the response of second order system when the input is unit step. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 20. |  | The characteristic polynomial of a system is s 6+ 2s5+ 8s4+ 12s3+ 20s2+ 16s + 16 = 0.   1. Determine the location of roots on the s-plane. 2. Comment on the stability of the system. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | Sketch bode plot for the following transfer function and obtain the gain cross over frequencies. . | CO4 | A | 12 |
|  |  |  |  |  |  |
| 22. |  | Consider the matrix A. Compute the state estimation matrix, . . | CO5 | A | 12 |
|  |  |  |  |  |  |
|  |  | Consider a unity feedback system with open transfer function, G(s)=5/s(s+0.05)(s+1). Design a PD controller so that the phase margin of the system is 30o at a freqency of 1.2 rad/sec. | CO6 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | The open loop transfer function of a unity feedback system is given by G(s) = 1/s2(1+s)(1+2s).   1. Sketch the polar plot. 2. Determine the gain margin and phase margin. | CO4 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Develop mathematical models of control components and physical systems |
| CO2 | Analyze the time domain responses of LTI systems and determine transient/steady state time response related performance goals. |
| CO3 | Derive equivalent differential equation, transfer function and state space model for a given system. |
| CO4 | Examine the frequency domain specifications of the LTI systems |
| CO5 | Evaluate stability of the linear systems with respect to time domain |
| CO6 | Investigate the stability of systems based on frequency domain by using different techniques. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 3 | 24 |  |  |  | 29 |
| CO2 | 1 | 4 | 12 |  |  |  | 17 |
| CO3 | 4 | 1 | 12 |  |  |  | 17 |
| CO4 | 1 | 3 | 24 |  |  |  | 28 |
| CO5 | 1 | 4 | 12 |  |  |  | 17 |
| CO6 | 1 | 3 | 12 |  |  |  | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **21RO2003** | **Duration** | **3hrs** |
| **Course Name** | **SENSOR SIGNAL CONDITIONING CIRCUITS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | List the characteristics of an ideal op-amp. | | CO1 | R | 1 |
| 2. | A differential amplifier has a differential voltage gain of 2000 and common mode gain of 0.2. Determine CMRR. | | CO1 | A | 1 |
| 3. | Define pass band and stop band of a filter. | | CO2 | R | 1 |
| 4. | State the Barkhausen’s criteria for sustained oscillations. | | CO2 | R | 1 |
| 5. | Draw the diagram for a Positive clipper circuits. | | CO3 | R | 1 |
| 6. | How a zero crossing detector does works? | | CO3 | R | 1 |
| 7. | Mention the applications of PLL | | CO4 | R | 1 |
| 8. | Calculate the i) tHigh ii) tLow and iii) duty cycle for an astable 555 timer IC using the given values RA=6.8kΩ, RB=3.3kΩ, C = 0.1 µF, | | CO4 | A | 1 |
| 9. | What is the largest value of output voltage from an 8 bit DAC that produces 1.0V for a digital input of 00110010? | | CO5 | R | 1 |
| 10. | List the challenges faced by a sensor interfacing circuit in a robotics system. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Define Slew rate and what causes slew rate. | | CO1 | R | 3 |
| 12. | Design a differentiator to differentiate an input signal that varies in frequency from 10Hz to 1kHz. | | CO2 | A | 3 |
| 13. | Differentiate the Schmitt trigger and comparator circuit. | | CO3 | U | 3 |
| 14. | Draw the circuit diagram for a pulse modulation circuit for a 555 timer IC in mono-stable mode. | | CO4 | U | 3 |
| 15. | Find the number of resistances required for an 8 bit weighted DAC converter. Consider the smallest resistance is R and obtain those resistance values. | | CO5 | R | 3 |
| 16. | Define conversion and resolution in Digital to analog converter. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Draw the schematic diagram of inverting op-amp with voltage series feedback; Explain it and derive the expression for a) Voltage Gain b) Input Resistance and c) Output Resistance. | CO1 | U | 4 |
|  | b. | Discuss the DC characteristics of an operational amplifier. | CO1 | U | 8 |
|  |  |  |  |  |  |
| 18. |  | What is an instrumentation amplifier? Derive the expression of its output voltage using three OP-amps. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Design and draw the circuit diagram of a second order low pass Butterworth filter having a high cut-off frequency of l kHz. Use capacitor value < l µF. | CO2 | U | 4 |
|  | b. | With a neat diagram explain the astable multivibrator using IC 741 and derive an expression for the frequency of oscillation with relevant waveforms. | CO3 | U | 8 |
|  |  |  |  |  |  |
| 20. | a. | Discuss comparator circuit using op-amp. Write down the characteristics and limitations of op-amp as comparator. | CO3 | U | 6 |
|  | b. | Draw and explain the operation of op-amp based sample and hold circuit. Also draw the input and output waveforms. | CO3 | U | 6 |
|  |  |  |  |  |  |
| 21. | a. | With a neat functional diagram, explain the working of 555 timers as a mono-stable multivibrator and derive an expression for the frequency of oscillation with relevant waveforms. | CO4 | U | 6 |
|  | b. | Explain the applications of PLL for AM detection, FSK demodulation | CO4 | U | 6 |
|  |  |  |  |  |  |
| 22. |  | With the help of a neat circuit diagram draw the Wien bridge oscillator and derive an expression for the frequency of oscillation of the circuit. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 23. | a. | With a neat block diagram explain the working of successive approximation type analog to digital converter (ADC). | CO5 | U | 6 |
|  | b. | With a neat block diagram explain the flash type ADC and state its merits and demerits. | CO5 | U | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Discuss in detail about the grounding and shielding effects in strain gauge and thermocouple sensors. | CO6 | U | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Define the characteristics of operational amplifiers. |
| CO2 | Describe the linear applications of op-amp. |
| CO3 | Design circuits for non-linear applications of op-amp. |
| CO4 | Apply the knowledge of special ICs like IC 555 to design circuits. |
| CO5 | Discuss about the types of ADCs and DACs. |
| CO6 | Analyze the parameters to be considered for interfacing. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 4 | 12 | 1 |  |  |  | 17 |
| CO2 | 2 | 28 | 3 |  |  |  | 33 |
| CO3 | 2 | 23 |  |  |  |  | 25 |
| CO4 | 1 | 15 | 1 |  |  |  | 17 |
| CO5 | 4 | 12 |  |  |  |  | 16 |
| CO6 | 4 | 12 |  |  |  |  | 16 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **21RO2012** | **Duration** | **3hrs** |
| **Course Name** | **ROBOTICS AND ITS APPLICATIONS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Name the manipulator that requires 6 DOFs. | | CO1 | R | 1 |
| 2. | Identify the workspace of a Cartesian configuration Robot. | | CO1 | U | 1 |
| 3. | Define the sensor used to detect the rate of change of an applied force. | | CO2 | R | 1 |
| 4. | Express any two types of velocity sensors. | | CO2 | U | 1 |
| 5. | List the disadvantages of a Serial Manipulator. | | CO3 | R | 1 |
| 6. | Indicate the End-effectors used for grasping the ferrous materials. | | CO3 | U | 1 |
| 7. | Express the matrices used in dynamics of mobile robots to represent the robot's motion and dynamics. | | CO4 | U | 1 |
| 8. | Classify the Mobile Robots based on interaction with humans. | | CO4 | U | 1 |
| 9. | Describe Collaborative Robots. | | CO5 | U | 1 |
| 10. | Mention the medical applications of robots. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | State the three laws of Robotics formulated by Isaac Asimov. | | CO1 | R | 3 |
| 12. | Mention how sensors are being utilized in Robots. | | CO2 | U | 3 |
| 13. | Classify Serial Chain Manipulators based on its design and capabilities. | | CO3 | U | 3 |
| 14. | Write the formulas commonly used in the kinematics of mobile robots. | | CO4 | A | 3 |
| 15. | Demonstrate how the level of intelligence is exhibited by a robotic system. | | CO5 | A | 3 |
| 16. | Explain the Palletizing application of robots in material handling and logistics. | | CO6 | An | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Recall the origin of Robotics through the most important moments to the present day. | CO1 | R | 6 |
|  | b. | Illustrate Robot Anatomy and the different types of joints with a neat sketch. | CO1 | An | 6 |
|  |  |  |  |  |  |
| 18. | a. | Explain in brief about any one force sensor with a neat sketch. | CO2 | A | 6 |
|  | b. | Compare hydraulic and electric actuators. | CO2 | An | 6 |
|  |  |  |  |  |  |
| 19. | a. | Consider the forward transformation of the three-joint manipulator. Given that the length of joint 1, L1 = 6 in., the length of joint 2, L2 = 12 in., the length of joint 3, L3 = 8 in., the angle Ɵ1 = 30°, the angle Ɵ2 = 45° and the angle Ɵ3 = 60°. Compute the coordinate position (x and y coordinates) for the end-of-the-arm P. | CO3 | A | 6 |
|  | b. | Describe an End effector. Classify the common types of end-effectors based on the application and the task that the robot is designed to perform. | CO3 | An | 6 |
|  |  |  |  |  |  |
| 20. | a. | The design of wheels in mobile robots is an important factor that can affect the robot's performance, efficiency and ability to navigate in different environments. Justify. | CO4 | E | 6 |
|  | b. | Analyse how wheeled mobile robots can be classified into several different categories for manufacturing and logistics applications. List their advantages and disadvantages in flat and complex environments. | CO4 | An | 6 |
|  |  |  |  |  |  |
| 21. | a. | Describe surgical robots. Explain the range of robotic technologies used by the Surgical robots. | CO5 | An | 6 |
|  | b. | Define space robots. Explain the robotic technologies used to operate Space exploration robots. | CO5 | An | 6 |
|  |  |  |  |  |  |
| 22. | a. | Explain in brief the spray painting application of robots that are becoming increasingly popular in the automotive industry with a neat block diagram. | CO6 | A | 9 |
|  | b. | Identify the types of Robots that can be used for industrial applications. | CO6 | U | 3 |
|  |  |  |  |  |  |
| 23. | a. | Illustrate the different types of Robot configurations with a neat diagram. | CO1 | A | 6 |
|  | b. | Analyze the various factors that affect the stability of a mobile robot. | CO4 | An | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Sketch the steps followed in a robot-assisted surgery with a neat block diagram. | CO6 | A | 6 |
|  | b. | Design a rehabilitation robot that focuses on the development of machines/**robots** that help people recover from physical trauma. | CO6 | C | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Describe the concept of robots and robotics. |
| CO2 | Identify and select sensors and actuators robotic applications. |
| CO3 | Analyse the working principle of the serial chain manipulators. |
| CO4 | Analyse the working principle and characteristics of mobile robots. |
| CO5 | Identify the robotic technology used in the different domains. |
| CO6 | Discuss different applications of the robots in several domains. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 10 | 1 | 6 | 12 |  | - | 29 |
| CO2 | 1 | 4 | 6 | 6 | - | - | 17 |
| CO3 | 1 | 4 | 6 | 6 | - | - | 17 |
| CO4 | - | 2 | 3 | 6 | 6 | - | 17 |
| CO5 | - | 1 | 3 | 12 | - | - | 16 |
| CO6 | - | 4 | 15 | 3 | - | 6 | 28 |
|  | | | | | | | **124** |

**Graphical user interface, application

Description automatically generated with medium confidence**

**SUPPLEMENTARY EXAMINATION – JUNE 2023**

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| --- | --- | --- | --- |
| **Course Code** | **21RO2012** | **Duration** | **3hrs** |
| **Course Name** | **ROBOTICS AND ITS APPLICATIONS** | **Max. Marks** | **100** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define World Reference Frame. | | CO1 | R | 1 |
| 2. | Identify the workspace of a Jointed Arm configuration Robot, | | CO1 | U | 1 |
| 3. | Name the sensor used for**measuring the speed of moving objects.** | | CO2 | R | 1 |
| 4. | Express any two types of force sensors. | | CO2 | U | 1 |
| 5. | Give examples of Serial chain Manipulators. | | CO3 | U | 1 |
| 6. | Identify the popular pick-and-place assembly robot which has four degrees of freedom. | | CO3 | R | 1 |
| 7. | Indicate the matrices used in kinematics of mobile robots to represent the robot's motion and dynamics. | | CO4 | U | 1 |
| 8. | Classify the Mobile Robots based on their size. | | CO4 | U | 1 |
| 9. | Describe Humanoid Robots. | | CO5 | U | 1 |
| 10. | Mention the industrial applications of robots. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Indicate what robots can do to ease the life of humans. | | CO1 | U | 3 |
| 12. | Mention the characteristics of sensors that affect their measurement capabilities and sustainability for each application. | | CO2 | U | 3 |
| 13. | Predict how the design/choice of the end effector is an important factor in the overall performance of the robot. | | CO3 | A | 3 |
| 14. | Write the forumlas commonly used in the dynamics of Mobile Robots. | | CO4 | A | 3 |
| 15. | Demonstrate how Modern robotic systems are equipped with a variety of technologies that enable them to exhibit varying levels of intelligence. | | CO5 | A | 3 |
| 16. | Explain the Depalletizing application of robots in material handling and logistics. | | CO6 | An | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Illustrate Robot Anatomy and the different types of joints with a neat sketch. | CO1 | An | 6 |
|  | b. | Classify the different types of Robots as defined by RIA (Robotic Industries Association) and JARA (Japanese Robot Association). | CO1 | An | 6 |
| 18. | a. | Explain in brief about the LVDT position sensor with a neat sketch. | CO2 | A | 6 |
|  | b. | Compare hydraulic and pneumatic actuators. | CO2 | An | 6 |
|  |  |  |  |  |  |
| 19. | a. | Consider the forward transformation of the three-joint manipulator. Given that the length of joint 1, L1 = 5 in., the length of joint 2, L2 = 7 in., the length of joint 9, L3 = 8 in., the angle Ɵ1 = 45°, the angle Ɵ2 = 60° and the angle Ɵ3 = 30°. Compute the coordinate position (x and y coordinates) for the end-of-the-arm P. | CO3 | A | 6 |
|  | b. | Describe a Parallel manipulator. Discuss the advantages and disadvantages of parallel manipulators. | CO3 | U | 6 |
|  |  |  |  |  |  |
| 20. | a. | Maneuverability is an important characteristic of mobile robots, as it determines the robot's ability to navigate through its environment and perform its intended tasks. Justify. | CO4 | E | 6 |
|  | b. | Analyse the various factors that affect the controllability of a mobile robot. | CO4 | An | 6 |
|  |  |  |  |  |  |
| 21. | a. | Define Aerial robots? Explain the range of robotic technologies used by the Aerial robots. | CO5 | An | 6 |
|  | b. | Describe Underwater robots? Explain the robotic technologies used to operate underwater robots. | CO5 | An | 6 |
|  |  |  |  |  |  |
| 22. | a. | Indicate the types of Robots that can be used for industrial applications. | CO6 | U | 3 |
|  | b. | Explain in brief the application of robotic assembly system for pick and place operations with a neat block diagram. | CO6 | A | 9 |
|  |  |  |  |  |  |
| 23. | a. | Illustrate the different types of Robot configurations with a neat diagram. | CO1 | A | 6 |
|  | b. | Recall the origin of Robotics through the most important moments to the present day. | CO1 | R | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Design a household application system that incorporates an effective and reliable indoor environment system. | CO6 | C | 6 |
|  | b. | Interpret the different Assistive applications of robots in the field of medicine. | CO6 | A | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Describe the concept of robots and robotics. |
| CO2 | Identify and select sensors and actuators robotic applications. |
| CO3 | Analyse the working principle of the serial chain manipulators. |
| CO4 | Analyse the working principle and characteristics of mobile robots. |
| CO5 | Identify the robotic technology used in the different domains. |
| CO6 | Discuss different applications of the robots in several domains. |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 7 | 4 | 6 | 12 | - | - | 29 |
| CO2 | 1 | 4 | 6 | 6 | - | - | 17 |
| CO3 | 1 | 7 | 9 | - | - | - | 17 |
| CO4 | - | 2 | 3 | 6 | 6 | - | 17 |
| CO5 | - | 1 | 3 | 12 | - | - | 16 |
| CO6 | - | 7 | 12 | 3 | - | 6 | 28 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **21RO3003** | **Duration** | **3hrs** |
| **Course Name** | **SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Describe the Fuzzy model with an example. | CO1 | U | 10 |
|  | b. | Explain in detail about Black box model. | CO1 | R | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Describe the OE Model of LTI Systems. | CO1 | An | 10 |
|  | b. | Illustrate in detail about State Space model in Linear Time Invariant System. | CO1 | A | 10 |
|  |  |  |  |  |  |
| 3. |  | Explain the process in Recursive least square analysis with a suitable example. | CO2 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Summarize the Spectral Analysis transient response in detail. | CO2 | R | 20 |
|  |  |  |  |  |  |
| 5. | a. | List the Non-linear identification and explain it in detail | CO3 | U | 10 |
|  | b. | State the process to identify closed loop in Wiener Models. | CO3 | R | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Describe the various State estimation techniques to classify open and closed loop. | CO4 | U | 10 |
|  | b. | Illustrate the Self-tuning regulators adaptive control in detail. | CO4 | R | 10 |
|  |  |  |  |  |  |
| 7. | a. | Explain about Stochastic adaptive control with a relevant example. | CO5 | U | 10 |
|  | b. | Explain the process of Gain scheduling in adaptive control. | CO5 | R | 10 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Summarize the inverted pendulum procedure to control in detail. | CO6 | E | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Illustrate the Ship steering system control with the parameters of models for different ships. | CO6 | C | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Classify the various models for identification. |
| CO2 | Identify the given process model. |
| CO3 | Validate the given model. |
| CO4 | Design adaptive control. |
| CO5 | Apply the design of adaptive controllers for various industrial and real time applications. |
| CO6 | Discuss Case Studies on System identification for robotic systems. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 10 | 10 | 10 | 10 | - | - | 40 |
| CO2 | 20 | 20 | - | - | - | - | 40 |
| CO3 | 10 | 10 | - | - | - | - | 20 |
| CO4 | 10 | 10 | - | - | - | - | 20 |
| CO5 | 10 | 10 | - | - | - | - | 20 |
| CO6 | - | - | - | - | 20 | 20 | 40 |
|  | | | | | | | **180** |



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| **Course Code** | **22RO1001** | **Duration** | **3hrs** |
| **Course Name** | **MATERIAL SCIENCE** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Find the attribute of a material which resists the flow of electricity known?  a) Conductivity b) Thermoelectricity c) Dielectric strength d) Resistivity | | CO1 | U | 1 |
| 2. | Identify the point at which two liquidus lines meet is called \_\_\_\_\_\_\_\_  a) Eutectic point b) Isothermal point c) Solidus point d) Peritectic point | | CO1 | R | 1 |
| 3. | Cite the effect of time-temperature on the ……………………changes of steel can be shown by the TTT diagram.  a)Microstructure b)Macrostructure c)Nanostructure d)Partial structure | | CO2 | U | 1 |
| 4. | Fick's ……… law of diffusion states that the movement of solute takes place from higher concentration to lower concentration. | | CO2 | R | 1 |
| 5. | Define magnetostriction effect. | | CO3 | U | 1 |
| 6. | The Electron gun function is to generate, shape and deflect the ………. beam to drill or machine the workpiece | | CO3 | R | 1 |
| 7. | The ……..hardness test method consists of indenting the test material with a 10 mm diameter hardened steel subjected to a load of 3000 kg | | CO4 | U | 1 |
| 8. | In materials, stress is defined as the ratio of applied force divided by …….. | | CO4 | R | 1 |
| 9. | Recall that type I superconductors behave as perfect…... magnetic materials | | CO5 | U | 1 |
| 10. | ………. is the fundamental unit of a liquid crystal that induces structural order in the crystals. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Describe ionic bonding in solids with an example. | | CO1 | U | 3 |
| 12. | Indicate any four phases that appear in the iron carbide diagram. | | CO2 | U | 3 |
| 13. | Explain thermionic emission process with any two example materials. | | CO3 | A | 3 |
| 14. | Compare and contrast the terms stress and strain in solids. | | CO4 | A | 3 |
| 15. | Differentiate hard and soft magnetic materials properties with an example. | | CO5 | An | 3 |
| 16. | Describe liquid crystals and its properties in brief. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Describe different types of crystal systems present in solid. | CO1 | U | 4 |
|  | b. | Illustrate the phase diagram of CO2 in detail with its graph and explain critical and triple point in detail. | CO1 | A | 8 |
|  |  |  |  |  |  |
| 18. | a. | Compare and contrast hypo and hyper eutectoid steels in brief. | CO2 | U | 4 |
|  | b. | Explain T-T-T diagram for eutectoid steel with its graph and explain its curves and phases in detail | CO2 | A | 8 |
|  |  |  |  |  |  |
| 19. | a. | Describe the conducting materials properties with few examples. | CO3 | U | 4 |
|  | b. | Explain the major components of electron beam machining system in detail and draw its schematic diagram. | CO3 | A | 8 |
|  |  |  |  |  |  |
| 20. | a. | Distinguish the properties of elastic and plastic deformation in brief | CO4 | An | 4 |
|  | b. | Illustrate the details involved in Rockwell hardness test in analyzing the macro hardness of a given material with necessary diagram. | CO4 | An | 8 |
|  |  |  |  |  |  |
| 21. | a. | Differentiate creep and fracture in the analysis of hardness of materials. | CO4 | An | 4 |
|  | b. | Illustrate the hysteresis curve in detail with its characteristics graph | CO5 | An | 8 |
|  |  |  |  |  |  |
| 22. | a. | Describe ferromagnetic domains in brief with necessary diagram. | CO5 | U | 4 |
|  | b. | Explain the types of superconductors and its properties in detail. | CO5 | A | 8 |
|  |  |  |  |  |  |
| 23. | a. | Describe any three important applications of liquid crystals in brief. | CO6 | U | 4 |
|  | b. | Illustrate the characteristics of insulating materials and its applications in detail. | CO5 | A | 8 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain thrermotropic liquid crystal and its three types in detail. | CO6 | A | 4 |
|  | b. | Illustrate multiferroics and biomimetic materials properties and applications in detail. | CO6 | An | 8 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the various phase diagrams and their applications. |
| CO2 | Explain the applications of Ferrous alloys. |
| CO3 | Discuss about the electrical properties of materials. |
| CO4 | Summarize the mechanical properties of materials and their measurement. |
| CO5 | Differentiate magnetic, dielectric and superconducting properties of materials. |
| CO6 | Outline the application of modern engineering materials. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 8 | 8 |  |  |  | 17 |
| CO2 | 1 | 8 | 8 |  |  |  | 17 |
| CO3 | 1 | 1 | 11 |  |  |  | 13 |
| CO4 | 1 | 1 | 3 | 16 |  |  | 21 |
| CO5 |  | 5 | 16 | 11 |  |  | 32 |
| CO6 | 1 | 7 | 8 | 8 |  |  | 24 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **22RO1002** | **Duration** | **3hrs** |
| **Course Name** | **FUNDAMENTALS OF PYTHON PROGRAMMING FOR ROBOTICS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | List two built-in modules in python. | | CO1 | R | 1 |
| 2. | Identify the method that removes any whitespace from the beginning of the end. | | CO1 | A | 1 |
| 3. | Name any two operators in python. | | CO2 | R | 1 |
| 4. | Identify the output for the following python code  x = 2  for i in range(x):  x += 1  print (x) | | CO2 | A | 1 |
| 5. | Name the function used to write all the characters in python. | | CO3 | R | 1 |
| 6. | Which command is used for getting Current Working Directory (CWD). | | CO3 | R | 1 |
| 7. | Illustrate an example for function call with two arguments. | | CO4 | U | 1 |
| 8. | What is aliasing in python. | | CO4 | R | 1 |
| 9. | How do you instantiate a class in python. | | CO5 | R | 1 |
| 10. | Which function is used to delete properties on objects. | | CO5 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | List the features of python. | | CO1 | An | 3 |
| 12. | Develop a python code to find the sum of the all numbers between 1 and 10. | | CO2 | C | 3 |
| 13. | Classify different modes in python files. | | CO3 | U | 3 |
| 14. | Differentiate: tuples and lists in Python. | | CO4 | An | 3 |
| 15. | Create a class named **Student**, which will inherit the properties and methods from the **Person** class. | | CO5 | C | 3 |
| 16. | Outline the steps in programming ESP32 with Micropython. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Develop a python code to find factorial of a given number. | CO1 | C | 6 |
|  | b. | Summarize different data types in python. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | Build a python code to convert Celsius to Fahrenheit. | CO2 | A | 6 |
|  | b. | Create python script to calculate the surface area and volume of a cube with the length of an edge as input. | CO2 | C | 6 |
|  |  |  |  |  |  |
| 19. |  | Discuss how to search for a string in text files with algorithm and python code | CO3 | C | 12 |
|  |  |  |  |  |  |
| 20. | a. | Distinguish between: Del, Remove and Pop operators in Python Lists. | CO4 | An | 6 |
|  | b. | Summarize the features of a dictionary. | CO4 | U | 6 |
|  |  |  |  |  |  |
| 21. |  | **Discuss Polymorphism with Inheritance with example.** | CO5 | C | 12 |
|  |  |  |  |  |  |
| 22. |  | Develop an algorithm and python code to generate 10 random numbers and insert into a list. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | Create a Python program to replace the last value of tuples in a list.  Sample list: [(10, 20, 40), (40, 50, 60), (70, 80, 90)]  Expected Output: [(10, 20, 100), (40, 50, 100), (70, 80, 100)] | CO4 | C | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Explain the steps involved in programming unmanned aerial vehicle with Micropython. | CO6 | U | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Outline the structure and components of a Python program. |
| CO2 | Explain loops and decision statements in Python. |
| CO3 | Illustrate class inheritance in Python for reusability |
| CO4 | Choose lists, tuples, and dictionaries in Python programs. |
| CO5 | Assess object‐oriented programs with Python classes. |
| CO6 | Develop simple code for robotics applications. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 6 | 1 | 3 |  | 6 | 17 |
| CO2 | 1 |  | 7 |  |  | 9 | 17 |
| CO3 | 2 | 3 | 12 |  |  | 12 | 29 |
| CO4 | 1 | 7 |  | 9 |  | 12 | 29 |
| CO5 | 2 |  |  |  |  | 15 | 17 |
| CO6 |  | 15 |  |  |  |  | 15 |
|  | | | | | | | **124** |



|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **22RO2011** | **Duration** | **3hrs** |
| **Course Name** | **ROBOTIC PROCESS AUTOMATION** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Is Robotic Process Automation the same as Artificial Intelligence? Justify. | | CO1 | U | 1 |
| 2. | List the debugging procedures in Uipath. | | CO1 | R | 1 |
| 3. | Label the different properties in UiPath. | | CO2 | U | 1 |
| 4. | Enumerate the risks of RPA in terms of security. | | CO2 | R | 1 |
| 5. | Mention the advantage of click activity in UiPath. | | CO3 | U | 1 |
| 6. | Discover the advantages of scraping the screen. | | CO3 | R | 1 |
| 7. | Specify the significant features of data scraping. | | CO4 | U | 1 |
| 8. | Recognize reasons that leads to the failure of RPA projects. | | CO4 | R | 1 |
| 9. | Mention the port number of Smtp Gmail. | | CO5 | U | 1 |
| 10. | Recall the advantages of implementing each row in data table activity. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |  |  | R |
| 11. | Indicate the advantages of RPA. | | CO1 | U | 3 |
| 12. | Relate the industries where RPA is employed. | | CO2 | R | 3 |
| 13. | Differentiate robotic process automation and chatbot. | | CO3 | U | 3 |
| 14. | Classify sequences and flowchart**.** | | CO4 | U | 3 |
| 15. | Identify the application of read range activity. | | CO5 | U | 3 |
| 16. | Mention the main components of Orchestrator. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Explain in detail about the history of Robotic Process Automation. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 18. |  | Express the process flow of notepad automation in RPA. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. |  | Relate the automation of notepad using UiPath-Recording. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 20. |  | Explain the process flow to determine even number using Uipath. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 21. | a. | Construct the addition of two numbers by passing variables and arguments. | CO3 | A | 6 |
|  | b. | Explain in detail about orchestrator in UiPath. | CO6 | U | 6 |
|  |  |  |  |  |  |
| 22. |  | Build a Data- Scraping automation using amazon.com and UiPath. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | Associate the process flow of google forms automation using UiPath. | CO6 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Summarize the working of Email automation in UiPath . | CO5 | A | 6 |
|  | b. | Discuss the process flow of read PDF using OCR activity. | CO5 | A | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Relate RPA, where it can be applied and how it's implemented. |
| CO2 | Outline the different types of variables, Control Flow and data manipulation techniques. |
| CO3 | Identify and understand Image, Text and Data Tables Automation. |
| CO4 | Interpret how to handle the User Events and various types of Exceptions and strategies. |
| CO5 | Illustrate the RPA interfacing aspects with E-mail Automation. |
| CO6 | Understand the Deployment of the Robot and to maintain the connection. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 16 |  |  |  |  | 17 |
| CO2 | 4 | 25 |  |  |  |  | 29 |
| CO3 | 1 | 16 | 6 |  |  |  | 23 |
| CO4 | 1 | 4 | 12 |  |  |  | 17 |
| CO5 |  | 4 | 12 |  |  |  | 16 |
| CO6 |  | 10 | 12 |  |  |  | 22 |
|  | | | | | | | **124** |