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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 closed system. | | CO1 | R | 1 |
| 2. | Relate the significance of heat and temperature. | | CO1 | U | 1 |
| 3. | Estimate the displacement work of a system. | | CO2 | U | 1 |
| 4. | Determine Boyle’s law. | | CO2 | A | 1 |
| 5. | Sketch p-v diagram of a diesel 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 buoyancy. | | CO4 | R | 1 |
| 9. | Determine the number of centroids for an object. | | CO5 | A | 1 |
| 10. | Explain the term kinetics. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Give examples of open system. | | CO1 | U | 3 |
| 12. | Differentiate between specific heat and latent heat. | | CO2 | An | 3 |
| 13. | Explain different parts of engine cylinder. | | CO3 | A | 3 |
| 14. | Determine the Bernoulli’s equation. | | CO4 | A | 3 |
| 15. | Sketch different types of loads acting on a beam. | | CO5 | A | 3 |
| 16. | Explain work energy principle 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. | Describe the concept of temperature and heat. | CO1 | U | 4 |
|  |  |  |  |  |  |
| 18. | a. | Determine the constant pressure process of a gas with a neat sketch | CO2 | An | 8 |
|  | b. | Explain the first law of thermodynamics with an example. | CO2 | U | 4 |
|  |  |  |  |  |  |
| 19. | a. | Illustrate the processes in a compression ignition engine with a neat sketch. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 20. | a. | Describe the Archimedes principle. | 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 3.5m and of depth 2.5m, when it floats horizontally in the water. The density of the wooden block is 650 kg/m3 and its length 6m. | CO4 | A | 8 |
|  |  |  |  |  |  |
| 21. | a. | Evaluate the x and y components of each of the forces shown | CO5 | E | 12 |
|  |  |  |  |  |  |
| 22. | a. | Distinguish between four-stroke petrol engine and a four-stroke diesel engine | CO3 | U | 8 |
|  | b. | Construct the free body diagram of the following figure  Free body diagrams of cylindrical rollers - mechanics, Mechanical ... | 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 curved 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 |  | 5 | 1 | 11 |  |  | 17 |
| CO3 | 1 | 14 | 4 | 12 |  |  | 31 |
| CO4 | 1 | 5 | 11 | 6 |  |  | 23 |
| CO5 |  |  | 8 |  | 12 |  | 20 |
| CO6 |  | 1 | 3 |  | 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)**  **(Answer all the questions)** | | | | | |
| 1. | State Asimov’s laws of robotics | | CO1 | R | 1 |
| 2. | A rotational robot axis has a total range of 1200. The robot’s control memory has an 8 bit storage capacity. Determine the control resolution of the axis. | | CO1 | A | 1 |
| 3. | Identify the coordinate transformation that is done in Fig.2 below, where re represents the cartesian coordinates and θ represents the joint angles.    Fig.2 | | CO2 | U | 1 |
| 4. | Why is the rotation matrix said to be orthogonal? | | CO2 | U | 1 |
| 5. | Differentiate total work envelope and dexterous work envelope. | | CO3 | An | 1 |
| 6. | Specify the characteristics of a holonomic robot. | | CO3 | U | 1 |
| 7. | Give the expression for manipulator dexterity. | | CO4 | R | 1 |
| 8. | Write the Jacobian Matrix Equation and mention its significance. | | CO4 | U | 1 |
| 9. | Mention the two approaches of robot dynamic analysis. | | CO5 | R | 1 |
| 10. | Differentiate path and trajectory of a robot. | | CO6 | An | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Compare Serial and Parallel Manipulators with relevant examples. | | CO1 | An | 3 |
| 12. | Write the general form of Homogeneous Transformation Matrix and indicate the function of each component of the matrix. | | CO2 | U | 3 |
| 13. | Calculate the pseudoinverse of A= | | CO3 | A | 3 |
| 14. | Outline the features of resolved motion rate control. | | CO4 | U | 3 |
| 15. | Describe Coriolis Forces with respect to Robot Dynamics. | | CO5 | U | 3 |
| 16. | Compare Slew Motion and Interpolated motion of robot manipulators. | | 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 industrial robots based on their physical configuration. | CO1 | U | 6 |
|  | b. | Mention the performance parameters that characterize a robot and specify the significance of each parameter. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | With relevant diagrams and explanations, derive the forward kinematic equation of a 2 link RR Manipulator and thereby compute the cartesian coordinates for the end of the arm, given that the length of joints L1 = 15 in, L2 = 12 in, angles θ1 = 600 and θ2 = 450. | CO2 | A | 6 |
|  | b. | For the point *3i+7j+5k*, perform the following operations in order.   * Rotate 900 about Z axis * Translate 10 units along X axis | CO2 | A | 6 |
|  |  |  |  |  |  |
| 19. | a. | Determine the DH parameters and thereby derive the Arm Equation of a 2 axis articulated robotic arm shown in Fig.3    Fig.3 | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. | a. | Derive the Jacobian equation for a 2 link RR manipulator. | CO4 | A | 6 |
|  | b. | Comment on the Joint Space Singularity State of a robot joint. | CO4 | An | 6 |
|  |  |  |  |  |  |
| 21. | a. | Determine the Lagrange function and hence derive the equation of motion of the two-link manipulator shown in Fig.4    Fig. 4 | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | Derive the inverse kinematic equation of a 2 link planar manipulator with revolute joints. | CO2 | A | 6 |
|  | b. | A point P in space is defined as P (2, 3, 5)T relative to frame B which is attached to the origin of the reference frame A and is parallel to it. Apply the following transformations to frame B and find P with respect to A frame.   1. Rotate 900 about n-axis, 2. Then Rotate 900 about local a-axis | CO2 | A | 6 |
|  |  |  |  |  |  |
| 23. | a. | Specify the various control techniques based on which robots are classified and describe each type with an example. | CO1 | U | 6 |
|  | b. | Draw the robot anatomy and indicate the components. Describe the function of each component. | CO1 | U | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | It is desired to have the first joint of a 6-axis robot go from initial angle  of 300 to a final angle of 750 in 5 seconds. Using a third-order polynomial, calculate the joint angle at 1, 2, 3, and 4 seconds. Draw the position, velocity and acceleration curves of motion. | CO6 | A | 12 |

**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 Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 24 | 1 | 3 |  |  | 29 |
| CO2 |  | 5 | 24 |  |  |  | 29 |
| CO3 |  | 1 | 15 | 1 |  |  | 17 |
| CO4 | 1 | 4 | 6 | 6 |  |  | 17 |
| CO5 | 1 | 3 | 12 |  |  |  | 16 |
| CO6 |  |  | 12 | 4 |  |  | 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. | Identify the wavelength for visible light spectrum. | | CO1 | R | 1 |
| 2. | Define Weber ratio. | | CO1 | R | 1 |
| 3. | Write the logarithmic gray level transformation formula to enhance an image. | | CO2 | A | 1 |
| 4. | Enumerate the significance of histogram equalization. | | CO2 | R | 1 |
| 5. | Give examples of topological features of a region. | | CO3 | U | 1 |
| 6. | Name the techniques involved in region-based segmentation. | | CO3 | R | 1 |
| 7. | Define the term ‘feature’ in the object recognition technique. | | CO4 | R | 1 |
| 8. | List the properties of transformation of objects with sharp edges for recognition of object. | | CO4 | R | 1 |
| 9. | Enumerate the camera’s extrinsic parameters. | | CO5 | R | 1 |
| 10. | Identify the ROS package used to convert ROS image messages to OpenCV image formats. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Distinguish between photopic and scotopic vision. | | CO1 | U | 3 |
| 12. | Describe sampling and quantization in the context of digital images. | | CO2 | R | 3 |
| 13. | Categorize the key parameters by which the regional descriptors are analyzed. | | CO3 | An | 3 |
| 14. | Identify the sources of variability that affects the object recognition. | | CO4 | A | 3 |
| 15. | Describe the process of camera calibration. | | CO5 | R | 3 |
| 16. | Enumerate the key features of Robot Operating System. | | 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. | Discuss the elements of a general-purpose digital image processing system. | CO1 | U | 5 |
|  | b. | Describe the functions of a human eye with a suitable diagram and label its anatomical parts. | CO1 | R | 7 |
|  |  |  |  |  |  |
| 18. | a. | Explain the process of filtering an image in the frequency domain and classify the smoothing and sharpening filters in frequency domain. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Summarize the concepts of boundary descriptors in object recognition model. | CO3 | U | 8 |
|  | b. | Interpret the sequence of erosion and dilation operations applied for the removal of noise in an image. | CO3 | U | 4 |
|  |  |  |  |  |  |
| 20. | a. | Discuss the object recognition techniques in digital image processing with suitable block diagram. | CO4 | U | 4 |
|  | b. | Explain the fundamental machine vision approaches to recognize the object in an image. | CO4 | U | 8 |
|  |  |  |  |  |  |
| 21. | a. | Define k-means clustering and explain the tasks performed in k-means clustering algorithm. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 22. | a. | Apply 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 | 8 | 10 | 10 | 2 | 12 | 16 | 4 | 2 | | CO2 | A | 9 |
|  | b. | Illustrate the image subtraction process with suitable application. | CO2 | U | 3 |
|  |  |  |  |  |  |
| 23. | a. | Discuss the edge linking and boundary detection using Hough transform. | CO3 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain the Gazebo, ArbotiX and STAGE simulators used to run the robots to venture into the real world. | CO6 | U | 8 |
|  | b. | Describe the three pillars of computer vision in the ROS community. | CO6 | R | 4 |

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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 | 9 | 8 | - | - | - | - | 17 |
| CO2 | 4 | 15 | 10 | - | - | - | 29 |
| CO3 | 1 | 25 | - | 3 | - | - | 29 |
| CO4 | 2 | 12 | 3 | - | - | - | 17 |
| CO5 | 4 | 12 | - | - | - | - | 16 |
| CO6 | 8 | 8 | - | - | - | - | 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)** | | | |
| 1. | In the Vertical integration of the Industrial automation, SCADA comes in the \_\_\_\_\_\_\_\_\_\_ layer. | CO1/R | 1 |
| 2. | The sensors convert the \_\_\_\_\_\_\_\_\_\_\_\_\_ into electrical signals. | CO1/U | 1 |
| 3. | The logical value of a normally opened contact is \_\_\_\_\_\_\_\_\_\_\_\_\_\_. | CO2 /A | 1 |
| 4. | The no of times an output can be used \_\_\_\_\_\_\_\_\_\_\_\_\_ in a rung. | CO 2/R | 1 |
| 5. | Cascading counters will \_\_\_\_\_\_\_\_\_\_\_\_\_ the pre-set value. | CO3/R | 1 |
| 6. | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ function is used to ON the lamp when one normally open pushbutton is pressed and off the lamp when another normally open push button is pressed. | CO3/E | 1 |
| 7. | Jump subroutine in ladder diagram is equal to \_\_\_\_\_\_\_\_\_\_\_\_\_\_ in C++. | CO4/An | 1 |
| 8. | Master Control Relay is used to \_\_\_\_\_\_\_\_\_\_\_\_\_\_. | CO4/R | 1 |
| 9. | Automation in industries helps in increasing \_\_\_\_\_\_\_\_\_\_\_\_\_\_. | CO5/U | 1 |
| 10. | Operator panel is integrated with \_\_\_\_\_\_\_\_\_\_\_\_\_\_. | CO5/R | 1 |

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| **PART – B (6 X 3 = 18 MARKS)** | | | |
| 11. | List the control elements used in automation. | CO1/A | 3 |
| 12. | Give the capabilities of a PLC. | CO2/An | 3 |
| 13. | Implement the ex-or logic in ladder diagram. | CO3/A | 3 |
| 14. | Discuss the bit functions used in PLC. | CO4/R | 3 |
| 15. | Mention the necessity of automation in industries. | CO5/E | 3 |
| 16. | Compare the industrial protocols used in PLC. | 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. | Elaborate on the development of the various automation in industries. | CO1/U | 12 |
|  |  |  |  |  |
| 18. | a. | With neat diagram illustrate on the block diagram of PLC. | CO2/R | 12 |
|  |  |  |  |  |
| 19. | a. | A wood saw, W, a fan, F and a lubricating pump P, all go on when start button is pushed. A stop button. A stop button stops the saw only. The fan is to run an additional 5 seconds to blow the chips away. The lube pump is to run for 8sec after the shutdown of W. Additionally, if the saw has run for more than 1 min. the fan should stay on indefinitely. The fan may be turned off by pushing a separate reset button. If the saw has run less than one minute, the pump should go off when the saw is turned off. The 8sec time delay off does not take place for a running time of less than 1 min. | CO3/A | 12 |
|  |  |  |  |  |
| 20. | a. | List out PLC sequencer functions and explain any one of its functions with process control application. | CO4/A | 12 |
|  |  |  |  |  |
| 21. | a. | Give an overall view of HMI and elaborate on the recent trends and advancements in the HMI technology. | CO5/E | 12 |
|  |  |  |  |  |
| 22. | a. | Design a PLC program that will execute the following control circuit: Turns on a timer when a switch is closed.  Timer is automatically reset by an input switch.  Counter counts the number of times the timer goes to 10 sec.  A second input switch at a count of 5 automatically resets the counter.  Latches on a light at the count of 5. | CO3/A | 6 |
| b. | There are three machines, each with its own start–stop buttons. Any two may run at one time. Also any one may run by itself. Construct the circuit with appropriate interlocking. | CO3/A | 6 |
|  |  |  |  |  |
| 23. | a. | Explain in detail about PLC arithmetic functions and number comparison functions. | CO4/A | 12 |
|  |  | **Compulsory:** | | |
| 24. | a. | Explain about PLC installation, its troubleshooting procedures and maintenance procedures. | CO6/A | 12 |
|  | **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 | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 13 | 3 | - | - | - | 17 |
| CO2 | 13 |  | 1 | 3 | - | - | 17 |
| CO3 | 1 | - | 25 | - | 1 | - | 27 |
| CO4 | 4 | - | 24 | 1 |  |  | 29 |
| CO5 | 1 | 1 | - | - | 15 | - | 17 |
| CO6 | - | - | 12 | - | 3 | - | 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)** | | | | | |
| 1. | Interpret the term optimization. | | CO1 | U | 1 |
| 2. | Give details on the term simulation. | | CO1 | U | 1 |
| 3. | Mention any two mechanical components which are used for linear movements in the motion control applications. | | CO2 | U | 1 |
| 4. | State any two applications of motion control. | | CO2 | U | 1 |
| 5. | Indicate the device which allows linear motion that utilizes rolling elements. | | CO3 | U | 1 |
| 6. | Identify the formula for friction with respect to the loads and friction resistance. | | CO3 | U | 1 |
| 7. | Expand NIOSH. | | CO4 | U | 1 |
| 8. | Sketch the basic diagram of dolly. | | CO4 | U | 1 |
| 9. | Identify the conveyor capable of handling a wide variety of bulk materials. | | CO5 | U | 1 |
| 10. | Specify the equipment which is used to remove foreign steel in the material being conveyed on the belt. | | CO5 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Define mechatronics. | | CO1 | R | 3 |
| 12. | Mention any three mechanical components used in motion control applications. | | CO2 | R | 3 |
| 13. | Write short notes on fatigue flaking. | | CO3 | R | 3 |
| 14. | State the space utilization principle of material handling. | | CO4 | R | 3 |
| 15. | Interpret the term plow. | | CO5 | R | 3 |
| 16. | Discuss the economics of automation system design. | | 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 sensing parameters used in automated manufacturing system. | CO1 | U | 4 |
|  | b. | Illustrate the key elements in the mechatronic system. | CO1 | U | 8 |
|  |  |  |  |  |  |
| 18. | a. | Demonstrate the procedure and steps to calculate the motor load for the selecting the suitable motor. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Explain the principle of selecting linear guideways and explain its procedure in detail. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. | a. | With necessary diagrams, describe the working of various types of conveyors. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. | a. | Describe the construction and working of belt trippers and belt cleaners in detail with necessary diagrams. | CO5 | U | 6 |
|  | b. | Illustrate the construction and working of Pinion-swivel arrangement for foot of belt conveyor. | CO5 | U | 6 |
|  |  |  |  |  |  |
| 22. | a. | Describe the working of ASRS in detail with required diagrams. | CO4 | U | 6 |
|  | b. | Write short notes on the types of counterbalanced lift truck. | CO5 | U | 6 |
|  |  |  |  |  |  |
| 23. | a. | Describe the construction and working of suspended idlers, belt cleaners and safety protection at pulleys. | CO5 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Illustrate the concept of integration of machine tending robot with a CNC machine. | CO6 | U | 12 |

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|  | **COURSE OUTCOMES** |
| CO1 | Assemble mechanical devices and equipment by applying carpentry and fitting practices |
| CO2 | Apply welding and drilling skills to fabricate useful products. |
| CO3 | Design simple electric circuits and apply different types of wiring |
| CO4 | Identify the operation and handling of measuring instruments |
| CO5 | Perform troubleshooting of electric motors |
| CO6 | Fabricate PCB boards for specific applications. |

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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 | 14 |  |  |  |  | 17 |
| CO3 | 3 | 14 |  |  |  |  | 17 |
| CO4 | 3 | 20 |  |  |  |  | 23 |
| CO5 | 3 | 32 |  |  |  |  | 35 |
| CO6 | 3 | 12 |  |  |  |  | 15 |
|  | | | | | | | **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** | | | **Course Outcome** | **Bloom’s Level** | | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | | |
| 1. | PACs are designed not only to perform traditional automation tasks. Select (True or False). | | | CO1 | U | | 1 |
| 2. | State the operating temperature range of PACs in industrial environments. | | | CO1 | R | | 1 |
| 3. | HMI can be a part of SCADA but SCADA can't be a part of HMI. Select (True or False) | | | CO2 | U | | 1 |
| 4. | Identify the year when the first generation SCADA systems were developed. | | | CO2 | R | | 1 |
| 5. | Define OPC UA protocol. | | | CO3 | R | | 1 |
| 6. | Name the software designed to work with DDE servers. | | | CO3 | R | | 1 |
| 7. | Infer the role of operator station in DCS. | | | CO4 | A | | 1 |
| 8. | Name the control mode in which the final control element is moved from one of two fixed positions to the other. | | | CO4 | R | | 1 |
| 9. | The two position control mode is best adapted to \_\_\_\_\_\_\_\_\_\_\_ scale system with relatively slow process rate. | | | CO5 | U | | 1 |
| 10. | Describe different determinants of plant layout. | | | CO6 | U | | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | | |
| 11. | Explain the advantages of industrial automation. | | | CO1 | | U | 3 |
| 12. | Compare proprietary and open protocol. | | | CO2 | | An | 3 |
| 13. | Interpret the Programming languages used for DCS. | | | CO3 | | An | 3 |
| 14. | Define DCS. | | | CO4 | | R | 3 |
| 15. | Infer the functions of local control unit in DCS. | | | CO5 | | An | 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. | Explain various level components in TIA, with the help of block diagram. | CO1 | | A | 12 |
|  | |  |  |  | |  |  |
| 18. | | a. | Explain hardware and software architecture of SCADA. | CO2 | | U | 12 |
|  | |  |  |  | |  |  |
| 19. | | a. | Explain the procedure to configure User Administration feature in SCADA. | CO3 | | A | 12 |
|  | |  |  |  | |  |  |
| 20. | | a. | Explain different functionalities of SCADA in detail. | CO4 | | A | 12 |
|  | |  |  |  | |  |  |
| 21. | | a. | With relevant diagram, explain the Communication interface of DCS with field devices. | CO5 | | A | 12 |
|  | |  |  |  | |  |  |
| 22. | | a. | Explain the task architecture of DCS in detail. | CO5 | | U | 12 |
|  | |  |  |  | |  |  |
| 23. | | a. | Describe the components involved in process layout. Also write down the advantages and disadvantages of process layout. | CO6 | | U | 12 |
| **COMPULSORY QUESTION** | | | | | | | |
| 24. | | a. | List out the factors influencing plant layout. Explain. | CO6 | | U | 6 |
|  | | b. | Explain the principles of plant layout. | CO6 | | U | 6 |

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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 applications |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 4 | 12 |  |  |  | 17 |
| CO2 | 1 | 13 |  | 3 |  |  | 17 |
| CO3 | 2 |  | 12 | 3 |  |  | 17 |
| CO4 | 4 |  | 13 |  |  |  | 17 |
| CO5 |  | 13 | 12 | 3 |  |  | 28 |
| CO6 |  | 28 |  |  |  |  | 28 |
|  | | | | | | | **124** |



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| **Course Code** | **18RO2015** | **Duration** | **3hrs** |
| **Course Name** | **FIELD AND SERVICE 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. | Give the DOF of Mobile Robot. | | CO1 | R | 1 |
| 2. | Define Mobility. | | CO1 | R | 1 |
| 3. | Write the specifications of service robot. | | CO2 | U | 1 |
| 4. | Define AMR. | | CO2 | U | 1 |
| 5. | Express the application of Service Robot. | | CO2 | A | 1 |
| 6. | Define Particle filter. | | CO3 | R | 1 |
| 7. | Mention the three types of error in mobile robot localization. | | CO4 | U | 1 |
| 8. | Define SLAM. | | CO4 | R | 1 |
| 9. | Give one advantage of Resistive sensing elements. | | CO5 | An | 1 |
| 10. | List the industrial applications of Tactile sensor. | | CO6 | A | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | List the future trends in field robots. | | CO1 | R | 3 |
| 12. | Define Workspace. | | CO2 | R | 3 |
| 13. | Mention the effector noise in Robot localization. | | CO3 | U | 3 |
| 14. | Define Markov Assumption. | | CO4 | U | 3 |
| 15. | Distinguish Cell Decomposition and Potential Path Planning. | | CO5 | R | 3 |
| 16. | List the applications of Humanoids. | | 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 application of field and service robot in medical field. | CO1 | R | 12 |
|  |  |  |  |  |  |
| 18. | a. | Describe the Kinematic Models and Constraints representing the robot position. | CO2 | R | 12 |
|  |  |  |  |  |  |
| 19. | a. | Explain the wheel configurations for rolling vehicles with the neat diagrams. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. | a. | Summarize Kalman filter algorithm with an example. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 21. | a. | Explain the position beacon system and landmark based navigation in Mobile robot localization. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 22. | a. | Describe the Sector Maps with neat sketch. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 23. | a. | Distinguish Road Map Approaches in Mobile Robot Path Planning. | CO5 | R | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Describe the touch, sound and vision sensors in Humanoids. | CO6 | A | 12 |

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

|  |  |
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|  | **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 | 17 | - | - | - | - | - | 17 |
| CO2 | 15 | 2 | 1 | - | - | - | 18 |
| CO3 | 13 | 3 | 12 | - | - | - | 28 |
| CO4 | 1 | 16 | - | 12 | - | - | 29 |
| CO5 | 15 | - | - | 1 | - | - | 16 |
| CO6 | 3 | - | 13 | - | - | - | 16 |
|  | | | | | | | **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)**  **(Answer all the questions)** | | | | | |
| 1. | Unit cell of polyethylene has ­­­­­­­­­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_ **­­­­­­­­­­­­­­­­­­­­** geometry. | | CO1 | R | 1 |
| 2. | Identify the material \_\_\_\_\_\_\_\_\_\_\_\_\_ which is more resistant to high temperatures and harsh environments   1. Metals      b) Polymers    c) Ceramics  d) both metals and ceramics | | CO1 | R | 1 |
| 3. | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ refers to the movement of atoms in solids. | | CO2 | R | 1 |
| 4. | Ferrite experiences a polymorphic transformation to \_\_\_\_\_\_\_\_\_\_\_\_\_\_. | | CO2 | R | 1 |
| 5. | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_is a property of ferromagnetic materials which causes  them to expand or contract in response to a magnetic field. | | CO3 | U | 1 |
| 6. | Fermi–Dirac statistics describe a distribution of particles over energy states in systems consisting of many identical particles that obey the \_\_\_\_\_\_\_\_\_\_\_\_\_\_. | | CO3 | U | 1 |
| 7. | \_\_\_\_\_\_\_\_\_\_\_\_\_ in non-crystalline solids (as well as liquids) occurs by a viscous flow mechanism. | | CO4 | R | 1 |
| 8. | A material that experiences very little or no plastic deformation upon fracture is termed \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. | | CO4 | R | 1 |
| 9. | The measure of the degree to which material can be magnetized known as \_\_\_\_\_\_\_\_\_\_\_\_\_. | | CO5 | U | 1 |
| 10. | Give an example for application of Bio-mimetic materials. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | List the three basic classes of solid materials. | | CO1 | R | 3 |
| 12. | State Fick’s first law and second law. | | CO2 | R | 3 |
| 13. | Sketch the four different types of band structures possible at 0 K. | | CO3 | A | 3 |
| 14. | Define creep resistance. Sketch the creep curve which represents the typical constant load creep behavior of metals. | | CO4 | A | 3 |
| 15. | Sketch the magnetic lines of force around a current loop and a bar magnet. | | CO5 | A | 3 |
| 16. | List the three types of liquid crystals polymers. | | 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 short notes on Bohr’s Atomic model. | CO1 | U | 3 |
|  | b. | Explain in brief the three types of simple metallic crystal structures found for most of the common metals. | CO1 | R | 9 |
|  |  |  |  |  |  |
| 18. | a. | Describe how Pearlite, Martensite and Bainite transformation begins in eutectoid steel with the TTT diagram. | CO2 | R | 12 |
|  |  |  |  |  |  |
| 19. | a. | What is EDM? Explain the working of Electrical Discharge Machining and the three different types of EDM with a neat diagram. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. | a. | Compare the Rockwell hardness test method with Brinell hardness test method. | CO4 | An | 8 |
|  | b. | Explain the tensile test that can be used to ascertain several mechanical properties that are important in design. | CO4 | A | 4 |
|  |  |  |  |  |  |
| 21. | a. | Explain the properties of the hard and soft magnetic materials with a B-H characteristic curve. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | Analyze the hysteresis curve of ferromagnetic materials using domain theory. | CO5 | An | 6 |
|  | b. | Explain the concept of Super conductivity. | CO5 | A | 6 |
|  |  |  |  |  |  |
| 23. | a. | Write short notes on Multiferroic materials. | CO6 | A | 4 |
|  | b | Explain the one-dimensional photonic crystal consisting of a periodic stack of dielectric layers used for Fibre Bragg Grating application with a neat schematic diagram. | CO6 | A | 8 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Define composite materials and indicate some common composite materials that offer high stiffness and strength across a wide temperature range. | CO6 | A | 12 |

**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. | | | | | | | |
| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | | | |
| **CO / P** | | **R** | **U** | **A** | **An** | **E** | **C** | **Total** | |
| CO1 | | 14 | 3 | - | - | - | - | 17 | |
| CO2 | | 17 | - | - | - | - | - | 17 | |
| CO3 | | - | 2 | 15 | - | - | - | 17 | |
| CO4 | | 2 | - | 7 | 8 | - | - | 17 | |
| CO5 | | - | 1 | 21 | 6 | - | - | 28 | |
| CO6 | | - | 4 | 24 | - | - | - | 28 | |
|  | | | | | | | | **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. | Mention the important tool in the drilling machine. | | CO1 | U | 1 |
| 2. | Interpret the term CRO. . | | CO3 | R | 1 |
| 3. | Mention the specific operation of voltmeter. | | CO3 | R | 1 |
| 4. | Expand PCB. | | CO5 | R | 1 |
| 5. | List the material used for processing the etching solution. | | CO5 | R | 1 |
| 6. | Mention any 3-D model design software. | | CO6 | R | 1 |
| 7. | Represent the device that can measure resistance, voltage and current. | | CO2 | R | 1 |
| 8. | The carbon brushes are the reason for ………. | | CO4 | U | 1 |
| 9. | Give the other name for NOT gate. | | CO2 | R | 1 |
| 10. | Identify any one application of robotics in healthcare industry. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | List out the steps involved in carpentry. | | CO1 | U | 3 |
| 12. | Describe the use of Wattmeter in measuring instruments. | | CO3 | U | 3 |
| 13. | Define reaming. | | CO2 | U | 3 |
| 14. | Compare the different types of DC motors. | | CO4 | U | 3 |
| 15. | Write short notes on eagle software. | | CO5 | U | 3 |
| 16. | Write the merits and demerits of 3-D Model. | | 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. | With necessary diagrams, explain the construction and applications of middle lap joint. | CO1 | C | 12 |
|  |  |  |  |  |  |
| 18. | a. | Illustrate the operations of fitting process in detail with necessary diagrams. | CO1 | An | 12 |
|  |  |  |  |  |  |
| 19. | a. | Describe the function of oscilloscope and write any three characteristics in detail. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 20. | a. | State the principle of KVL and KCL. Also apply it for the given circuit diagram.  Kirchhoff's Current and Voltage Laws - Northwestern Mechatronics Wiki | CO2 | A | 12 |
|  |  |  |  |  |  |
| 21. | a. | Demonstrate the procedure for PCB etching process with necessary diagrams. | CO5 | An | 12 |
|  |  |  |  |  |  |
| 22. | a. | Describe the principle, construction and working of digital storage oscilloscope. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 23. | a. | Explain the steps involved in assembling and disassembling of universal motor. | CO4 | E | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain the steps involved in fabrication of 3-D model using 3-D printer. | CO6 | E | 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 | 15 | - | 12 | - | - | 29 |
| CO2 | - | 4 | - | 24 | - | - | 28 |
| CO3 | 5 | 1 | - | - | 12 | - | 18 |
| CO4 | - | 16 | - | - | - | - | 16 |
| CO5 | 2 | 15 | - | - | - | - | 17 |
| CO6 | 1 | 3 | - | - | 12 | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **THEORY AND PROGRAMMING OF CNC MACHINES** | **Duration** | **3hrs** |
| **Course Name** | **19RO2001** | **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. | Cite the syntax of G03 used in part program. | | CO1 | | U | | 1 | |
| 2. | The function of head stock in a lathe machine is \_\_\_\_\_\_\_\_\_\_\_. | | CO1 | | U | | 1 | |
| 3. | Illustrate the definition of PLC as per NEMA. | | CO2 | | U | | 1 | |
| 4. | Describe the architecture of PLC. | | CO2 | | U | | 1 | |
| 5. | Distinguish the frictional force. | | CO3 | | U | | 1 | |
| 6. | The function of a circuit breaker is \_\_\_\_\_\_\_\_\_. | | CO4 | | U | | 1 | |
| 7. | Describe the circuit for MCB. | | CO4 | | U | | 1 | |
| 8. | CAPP is the abbreviation of \_\_\_\_\_\_\_\_. | | CO5 | | U | | 1 | |
| 9. | G91 code is known as\_\_\_\_\_\_\_\_\_\_\_\_\_. | | CO5 | | U | | 1 | |
| 10. | Estimate the machining cost. | | CO6 | | U | | 1 | |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | | | | |
| 11. | Establish CNC machines over traditional machines. | | CO1 | | A | | 3 | |
| 12. | Infer the function of controller in CNC machines. | | CO2 | | An | | 3 | |
| 13. | Establish the differences between DC and Servo motors. | | CO3 | | A | | 3 | |
| 14. | Illustrate the differences between circuit breakers and isolators. | | CO4 | | An | | 3 | |
| 15. | Illustrate the absolute and incremental programming with one example. | | CO5 | | A | | 3 | |
| 16. | Compare three major headings in the calculation of total manufacturing cost. | | 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. | Compare the merits, demerits and applications of a CNC machines with NC machines. | | CO1 | | U | | 6 |
|  | b. | Discuss the working behavior of Water Jet Machining with a neat diagram. | | CO1 | | A | | 6 |
|  |  |  | |  | |  | |  |
| 18. | a. | Explain the important features and the principle of operation of a CNC Laser machine. | | CO2 | | An | | 6 |
|  | b. | Illustrate the working of an automatic tool changer with suitable diagram. | | CO2 | | A | | 6 |
|  |  |  | |  | |  | |  |
| 19. | a. | Establish the working servo motor with neat diagram with one industrial application. | | CO3 | | A | | 6 |
|  | b. | Illustrate the Stepper motor working with neat diagrams. | | CO3 | | A | | 6 |
|  |  |  | |  | |  | |  |
| 20. | a. | Illustrate the following with neat sketches: MCB, MCCB, RCCB and ELCB. | | CO4 | | U | | 8 |
|  | b. | Interpret the control relays used in a CNC machine, explain it’s working with a neat sketch? | | CO4 | | A | | 4 |
|  |  |  | |  | |  | |  |
| 21. | a. | Illustrate G172 and G173 rectangular pocket canned cycle. | | CO5 | | An | | 4 |
|  | b. | Predict the required data and write the part program for the geometry given below: | | CO5 | | E | | 8 |
|  |  |  | |  | |  | |  |
| 22. | a. | Describe the functions of preventive maintenance of CNC machines. | | CO6 | | A | | 6 |
|  | b. | Illustrate the practical aspects to consider during the introduction of CNC. | | CO6 | | An | | 6 |
|  |  |  | |  | |  | |  |
| 23. | a. | Restate the machining parameters and the costs involved in carrying out the machining operation. | | CO6 | | U | | 6 |
|  | b. | Determine the prominent factors involved in the economics of CNC machine tools. | | CO6 | | A | | 6 |
| **COMPULSORY QUESTION** | | | | | | | | |
| 24. | a. | Explain the direct method for the selection of proximity sensors. | | 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 | - | 8 | 9 | - | - | - | 17 |
| CO2 | - | 2 | 6 | 9 | - | - | 17 |
| CO3 | - | 1 | 15 | - | - | - | 16 |
| CO4 | - | 10 | 4 | 15 | - | - | 29 |
| CO5 | - | 2 | 3 | 4 | 8 | - | 17 |
| CO6 | - | 7 | 12 | 9 | - | - | 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 RADAR. | | CO2 | U | 1 |
| 2. | Specify the types of chassis frames in a car. | | CO1 | R | 1 |
| 3. | State the types of drive system in AV. | | CO2 | R | 1 |
| 4. | Define Powertrains. | | CO1 | U | 1 |
| 5. | List the application of LIDAR. | | CO2 | U | 1 |
| 6. | Define Passive Sonar System. | | CO3 | R | 1 |
| 7. | Specify the limitations of Night Vision System. | | CO2 | U | 1 |
| 8. | Define Image thresholding. | | CO3 | R | 1 |
| 9. | Specify the Legal Issues in AV. | | CO6 | A | 1 |
| 10. | Define OBD. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | State the Entertainment services available in Car. | | CO1 | R | 3 |
| 12. | Mention the uses of RADAR in ADAS. | | CO2 | R | 3 |
| 13. | Write the advantages and disadvantages of Near Infrared active system. | | CO3 | R | 3 |
| 14. | List the Components of Machine Vision System. | | CO3 | R | 3 |
| 15. | Specify the Insurance consideration in AV. | | CO6 | U | 3 |
| 16. | Define V2X network attacks in AV. | | 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 hardware components of Autonomous Vehicles. | CO1 | U | 6 |
|  | b. | Describe the working principle of Electronic Control Unit. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | Explain the Advanced Driver Assistance System (ADAS) with an example. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Explain the Image Feature Extraction techniques in AV. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. | a. | Describe the Ultrasonic Sonar System with the block diagram of an Active Sonar. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 21. | a. | Describe the five levels of Automation in AV. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 22. | a. | Describe the architecture of Multi-sensor Data Fusion system. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 23. | a. | Explain in detail the Dedicated Short Range Communications in AV. | CO4 | U | 12 |
|  |  | **COMPULSORY QUESTION** |  |  |  |
| 24. | a. | Discuss the challenges in AV in the aspects of Technical, Security and Legal issues. | CO6 | An | 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 / BL** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 4 | 13 |  |  |  |  | 17 |
| CO2 | 4 | 27 |  |  |  |  | 31 |
| CO3 | 8 | 12 | 12 |  |  |  | 32 |
| CO4 |  | 12 |  |  |  |  | 12 |
| CO5 |  | 12 |  |  |  |  | 12 |
| CO6 | 1 | 6 | 1 | 12 |  |  | 20 |
|  | | | | | | | **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. | State the definition of an industrial robot as given by the Robot Institute of America. | | CO1 | R | 1 |
| 2. | Define work volume of a robot. | | CO1 | R | 1 |
| 3. | For what purposes robot vision system is mostly used in the industrial robots. | | CO2 | A | 1 |
| 4. | Define SLAM. | | CO2 | U | 1 |
| 5. | Write diameter range of spot welding. | | CO3 | R | 1 |
| 6. | Mention the major manufactures of Robot for welding process. | | CO3 | A | 1 |
| 7. | Write the other name of Vacuum gripper. | | CO4 | U | 1 |
| 8. | The meaning of IP67 rating is **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | | CO5 | U | 1 |
| 9. | Define unit load. | | CO6 | R | 1 |
| 10. | Define Material Handling. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Compare the functions of automation and robotics with an example. | | CO1 | An | 3 |
| 12. | Write the steps involved in image processing. | | CO2 | A | 3 |
| 13. | In a single phase spot welding machine, input supply voltage is 480V, input current 200A and turns ratio 100. Obtain the output current of the machine. | | CO3 | An | 3 |
| 14. | Write down the advantages and disadvantages of magnetic gripper. | | CO4 | U | 3 |
| 15. | Write down the components of robot performance test. | | CO5 | U | 3 |
| 16. | Write down the functions and types of conveyors. | | 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. | Outline the significance of payload capacity in the selection of an industrial robot with necessary diagrams. | CO1 | U | 6 |
|  | b. | Illustrate the effect of robot inertia on its payload with an example. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | Classify the different types of robot work cell and mention the features of each type. | CO1 | U | 6 |
|  | b. | Describe the process of robot cell design and the various types of work cells. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 19. | a. | Draw the block diagram of general purpose machine vision system. Explain its components in detail. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 20. | a. | With relevant diagrams, explain the functionalities of Robotic spot welding mechanism. | CO3 | A | 6 |
|  | b. | Explain any one application of Robot for assembly of work parts in detail. | CO3 | A | 6 |
|  |  |  |  |  |  |
| 21. | a. | Derive the expression for gripping force of gripper used in robotic arm. | CO4 | An | 6 |
|  | b. | A 5 Kg rectangular block is gripped in the two finger gripper and lifted vertically at a velocity 1 m/s. If the acceleration is 27.5 m/s2 and the co-efficient of friction between the pads is 0.48. Calculate the minimum force that would prevent slippage. | CO4 | An | 6 |
|  |  |  |  |  |  |
| 22. | a. | Explain the methods to test the performance of robot. | CO5 | An | 6 |
|  | b. | Discuss the impact of robot on industry and society in detail. | CO5 | An | 6 |
|  |  |  |  |  |  |
| 23. | a. | Describe the different automated guided vehicle systems used in industry with suitable example. | CO6 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain the types of Automatic Storage/Retrieval system with suitable example. | CO6 | A | 12 |

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|  | **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 | 24 |  | 3 |  |  | 29 |
| CO2 |  | 13 | 4 |  |  |  | 17 |
| CO3 | 1 |  | 13 | 3 |  |  | 17 |
| CO4 |  | 4 |  | 12 |  |  | 16 |
| CO5 |  | 4 |  | 12 |  |  | 16 |
| CO6 | 2 | 3 | 24 |  |  |  | 29 |
|  | | | | | | | **124** |



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| **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. | Define cognitive robotics. | | CO1 | R | 1 |
| 2. | List any two states of cognition. | | CO1 | R | 1 |
| 3. | Identify one software used for robot simulation. | | CO2 | A | 1 |
| 4. | List any one limitation of voronai diagram in road map. | | CO2 | R | 1 |
| 5. | Define Roadmap. | | CO3 | R | 1 |
| 6. | Identify the types of data structure in road map. | | CO3 | R | 1 |
| 7. | Name any two Simultaneous Localization and Mapping (SLAM) application. | | CO4 | R | 1 |
| 8. | Relate the importance of landmark in SLAM. | | CO4 | U | 1 |
| 9. | Identfiy the use of Sound Navigation and Ranging (SONAR) display in robotics. | | CO5 | R | 1 |
| 10. | List any one application of autonomous navigation robot. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Differentiate: Supervised and Unsupervised learning. | | CO1 | An | 3 |
| 12. | Discuss feature based model in cognition. | | CO2 | U | 3 |
| 13. | Differentiate repulsion forces by boundaries and obstacles. | | CO3 | An | 3 |
| 14. | State the disadvantages of Graph-based optimization techniques. | | CO4 | U | 3 |
| 15. | Interpret the importance of wandering within the workspace for cognitive robotics. | | CO5 | U | 3 |
| 16. | Interpret the factors that affect imaging geometry in robot vision systems. | | 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. | Classify different cycles of cognition. | CO1 | An | 6 |
|  | b. | Compare and contrast supervised and unsupervised learning in machine learning. | CO1 | A | 6 |
|  |  |  |  |  |  |
| 18. | a. | Elaborate the process of constructing a 2D world map. | CO2 | U | 6 |
|  |  | Consider a circular mobile robot that can orient itself in any of the following eight directions: north (N), north-east (NE), east (E), south-east (SE), south (S), south-west (SW), west (W) and northwest (NW). Write a depth first algorithm for mapping the above robot. | CO2 | A | 6 |
|  |  |  |  |  |  |
| 19. | a. | Elaborate the process of constructing a voronoi diagram and it usage in robot path planning. | CO3 | U | 6 |
|  | b. | Consider a mobile robot with range sensor is rotating in anticlockwise direction as shown in figure. Obstacles are shown in grey color. Construct the active list, edges (E) and vertices (v) responsible for the robot visibility. | CO3 | C | 6 |
|  |  |  |  |  |  |
| 20. | a. | Explain the use of the Extended Kalman filter in Simultaneous Localization and Mapping (SLAM) highlighting its limitations. | CO4 | U | 6 |
|  | b | Distinguish various taxonomy used in SLAM problem | CO4 | A | 6 |
|  |  |  |  |  |  |
| 21. | a. | Compare and contrast tele-operation and autonomous navigation | CO5 | An | 6 |
|  | b. | Develop an algorithm for BotSpeak program that can be used to control robot’s movements and actions. | CO5 | C | 6 |
|  |  |  |  |  |  |
| 22. | a. | With flow diagram, explain the server-client communication in autonomous robot. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 23. | a. | Develop a path optimization algorithm using quad tree approach for the following 2D world map of a robot containing obstacles denoted by the shaded regions. | CO3 | C | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Elaborate the process of 3D reconstruction in robot vision systems, including the techniques used to integrate data from multiple sensors. | CO6 | U | 12 |

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

|  |  |
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|  | **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 explaining about the programs used |
| CO4 | Develop knowledge about simultaneous localization and mapping based techniques and paradigms. |
| CO5 | Elaborate the various robot programming packages for display, tele-operation and other applications. |
| CO6 | Describe the aspects of Imaging Techniques used in Robotic Applications |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 |  | 6 | 9 |  |  | 17 |
| CO2 | 1 | 9 | 7 |  |  |  | 17 |
| CO3 | 2 | 6 |  | 3 |  | 18 | 29 |
| CO4 | 1 | 10 |  |  |  | 6 | 17 |
| CO5 | 1 | 3 | 12 | 6 |  | 6 | 28 |
| CO6 | 1 | 12 | 3 |  |  |  | 16 |
|  | | | | | | | **124** |



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| **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)**  **(Answer all the questions)** | | | | | |
| 1. | Specify the goal of surgical assistance. | | CO1 | R | 1 |
| 2. | Indicate the first application of surgical CAD/CAM System. | | CO1 | R | 1 |
| 3. | Mention the two different types of fiber optic tracking systems. | | CO2 | U | 1 |
| 4. | Interpret the term gait. | | CO2 | U | 1 |
| 5. | Mention the other name of gamma knife type of radio surgery. | | CO3 | R | 1 |
| 6. | Expand SBRS in medical surgery. | | CO3 | R | 1 |
| 7. | Give the full form of ECoG. | | CO4 | U | 1 |
| 8. | Interpret the term physiotherapy. | | CO4 | U | 1 |
| 9. | Name any two applications of robots in medical assistance. | | CO5 | U | 1 |
| 10. | Mention the wearable structures that support and assist movement. | | CO5 | A | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | State the two basic augmentation strategies in surgical assistance. | | CO1 | U | 3 |
| 12. | Write short notes on the hybrid system position sensor. | | CO2 | U | 3 |
| 13. | List out five motion control modes in surgical robots. | | CO3 | R | 3 |
| 14. | Mention any 3 applications of rehabilitation robot for elders. | | CO4 | A | 3 |
| 15. | Describe the potential benefits to surgeon and patient for the machining function in orthopedic surgery. | | CO5 | U | 3 |
| 16. | Distinguish between mechanical robots and medical robots | | 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. | Mention the various types of medical robots and explain any two types of medical robots in detail. | CO1 | A | 8 |
|  | b. | Describe the concept of motion replication in detail. | CO1 | U | 4 |
|  |  |  |  |  |  |
| 18. | a. | Classify the types of position sensors and demonstrate the construction & working of any 4 types of positions sensors. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Describe the step-by-step procedure involved in moving beam systems type of radio surgery with necessary diagrams. | CO3 | U | 8 |
|  | b. | State the general procedure of neurosurgery. | CO3 | R | 4 |
|  |  |  |  |  |  |
| 20. | a. | Describe the features of medical robots to render support for stroke patients. | CO4 | R | 6 |
|  | b. | With necessary diagrams, explain the features and working of deep brain stimulation in detail. | CO4 | U | 6 |
|  |  |  |  |  |  |
| 21. | a. | Explain the features and working of the following assistive robots: ReStore Exo-Suit and Atalante. | CO5 | A | 8 |
|  | b. | Describe the support of various technologies in the surgical robots. | CO5 | U | 4 |
|  |  |  |  |  |  |
| 22. | a. | Describe the different innovations involved in robotics for healthcare. | CO1 | U | 6 |
|  | b. | Demonstrate the procedure for knee replacement orthopedic surgery in detail. | CO3 | A | 6 |
|  |  |  |  |  |  |
| 23. | a. | Describe the working of urologic surgery and robotic imaging with necessary diagrams. | CO3 | A | 8 |
|  | b. | Discuss the treatment process of robotic fracture surgery system. | CO5 | U | 4 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Describe the analysis of the medico-surgical gestures. | CO6 | AN | 6 |
|  | b. | Illustrate the characterization of gestures to the design of robots. | CO6 | A | 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 Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 13 | 8 | - | - | - | 23 |
| CO2 | - | 17 | - | - | - | - | 17 |
| CO3 | 9 | 8 | 14 | - | - | - | 31 |
| CO4 | 6 | 8 | 3 | - | - | - | 17 |
| CO5 | - | 12 | 9 | - | - | - | 21 |
| CO6 | - | - | 6 | 9 | - | - | 15 |
|  | | | | | | | **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)**  **(Answer all the questions)** | | | | | |
| 1. | What do you mean by a well–posed learning problem? | | CO1 | U | 1 |
| 2. | Define the R squared statistical measure of regression model. | | CO1 | R | 1 |
| 3. | What is Gini Index? | | CO2 | R | 1 |
| 4. | How is pruning possible in a decision tree? | | CO2 | R | 1 |
| 5. | Enumerate the kernel functions used in SVM. | | CO3 | U | 1 |
| 6. | List the different types of clustering. | | CO4 | R | 1 |
| 7. | Can PCA be used to reduce the dimensionality of a highly nonlinear dataset? | | CO4 | R | 1 |
| 8. | What is the role of a synapse in a biological neuron? | | CO5 | R | 1 |
| 9. | Recognise the importance of the RELU activation function in Convolution Neural Network (CNN)? | | CO5 | R | 1 |
| 10. | Sketch the multilayer feed forward network. | | CO6 | A | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Compare Classification with regression with an example. | | CO1 | U | 3 |
| 12. | Calculate the entropy of a dataset with two classes, where the number of instances for class A is 25 and for class B is 35. | | CO2 | A | 3 |
| 13. | With appropriate equations, describe the logistic regression technique. | | CO3 | U | 3 |
| 14. | List the various clustering techniques. | | CO4 | R | 3 |
| 15. | Calculate the output y of a three input neuron with bias. The input feature vector is (x1, x2, x3) = (0.8,0.6,0.4) and weight values are [w1,w2,w3, b] =[0.2, 0.1, -0.3, 0.35]. Use binary Sigmoid function as activation function. | | CO5 | A | 3 |
| 16. | Explain the primary objective of Principal Component Analysis (PCA) in data reduction. | | 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 distinctive block diagram for a machine learning project that includes each of the required components and phases. | CO1 | A | 8 |
|  | b. | Distinguish supervised learning from reinforcement learning and unsupervised learning. | 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 | A | 12 |
|  |  |  |  |  |  |
| 19. | a. | Consider the training data in the following table where Play is a class attribute. In the table, the Humidity attribute has values “L” (for low) or “H” (for high), Sunny has values “Y” (for yes) or “N” (for no), Wind has values “S” (for strong) or “W” (for weak), and Play has values “Yes” or “No”. What is class label for the following day. (Humidity=L, Sunny=N, Wind=W), according to naïve Bayesian classification?   |  |  |  |  | | --- | --- | --- | --- | | Humidity | Sunny | Wind | Play | | L | N | S | No | | H | N | W | Yes | | H | Y | S | Yes | | H | N | W | Yes | | L | Y | S | No | | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. | a. | Consider the two dimensional patterns given for the principal component methods (2, 1), (3, 5), (4, 3), (5, 6), (6, 7) and compute the principal components using PCA Algorithm. | CO4 | An | 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 that support vector machine is better than linear classifiers. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 23. | a. | Use the k-means clustering algorithm and Euclidean distance to cluster the following 8 datas into 3 clusters: A1=(2,10), A2=(2,5), A3=(8,4), A4=(5,8), A5=(7,5), A6=(6,4), A7=(1,2), A8=(4,9): Suppose that the initial seeds (centers of each cluster) are A1, A4 and A7. Run the k-means clustering algorithm for 2 epochs only. At the end of this epoch shows: a) The new clusters (i.e. the examples belonging to each cluster). b) The centers of the new clusters c) Draw the result for each epoch. | CO4 | An | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Demonstrate 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

|  |  |
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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 Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 8 | 8 |  |  |  | 17 |
| CO2 | 2 |  | 15 |  |  |  | 17 |
| CO3 |  | 16 | 12 |  |  |  | 28 |
| CO4 | 5 |  |  | 24 |  |  | 29 |
| CO5 | 2 |  | 3 | 12 |  |  | 17 |
| CO6 | 1 | 3 |  | 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** | | **Course Outcome** | **Bloom’s Level** | | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | Define an agent. | | CO1 | R | | 1 |
| 2. | Name two artificial intelligent systems used in your daily-routine. | | CO1 | R | | 1 |
| 3. | Reproduce the infrastructure of search algorithms for each node in the tree. | | CO2 | R | | 1 |
| 4. | List the uninformed search strategies. | | CO2 | R | | 1 |
| 5. | Quote the admissible heuristic estimate for State-Space Search. | | CO3 | R | | 1 |
| 6. | Interpret the states in GraphPlan algorithm. | | CO3 | U | | 1 |
| 7. | Define the term supervised learning. | | CO4 | R | | 1 |
| 8. | List the advantages of Bayesian view of learning. | | CO4 | R | | 1 |
| 9. | State the goal of reinforcement learning. | | CO5 | R | | 1 |
| 10. | State the importance of Cognition. | | CO6 | R | | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | Summarize the need for artificial intelligence in robotics. | | CO1 | | U | 3 |
| 12. | Represent the basic binary tree of the breadth-first search algorithm. | | CO2 | | R | 3 |
| 13. | Solve the following cryptarithmetic problem.  SEND  + MORE  MONEY | | CO3 | | A | 3 |
| 14. | Interpret the causes of uncertainty by an agent to occur in the real world. | | CO4 | | U | 3 |
| 15. | List the types of learning methods adopted in AI and brief them. | | CO5 | | R | 3 |
| 16. | State the three laws of robotics. | | 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. | Discuss the learning-based agent. | CO1 | | U | 8 |
|  | b. | Describe the components of basic artificial neuron with a suitable diagram. | CO1 | | U | 4 |
|  |  |  |  | |  |  |
| 18. | a. | Compare the Best-First search and A\* search algorithm for problem solving with a suitable example. | CO2 | | U | 12 |
|  |  |  |  | |  |  |
| 19. | a. | Explain the state-space search progression and regression planning algorithm. | CO3 | | U | 12 |
|  |  |  |  | |  |  |
| 20. | a. | Illustrate the Bayesian view of learning with an example. | CO4 | | U | 12 |
|  |  |  |  | |  |  |
| 21. | a. | List the applications of Natural Language Processing. | CO5 | | R | 4 |
|  | b. | Explain the components used to generate the language from machine. | CO5 | | A | 8 |
|  |  |  |  | |  |  |
| 22. | a. | Explain the state-of-the-art of Artificial Intelligence in robotics. | CO1 | | U | 10 |
|  | b. | Reproduce the standard definition for the term “Artificial Intelligence”. | CO1 | | R | 2 |
|  |  |  |  | |  |  |
| 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 the path planning of a robot. | CO6 | | U | 12 |

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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 Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 4 | 25 | - | - | - | - | 29 |
| CO2 | 5 | 24 | - | - | - | - | 29 |
| CO3 | 1 | 13 | 3 | - | - | - | 17 |
| CO4 | 2 | 15 | - | - | - | - | 17 |
| CO5 | 8 | - | 8 | - | - | - | 16 |
| CO6 | 4 | 12 | - | - | - | - | 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** | | **Course Outcome** | **Bloom’s Level** | | **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. | Indicate the velocity range of steam in industries. | | CO3 | R | | 1 |
| 7. | Write the name of the compressor suitable for low evaporator pressures. | | CO4 | U | | 1 |
| 8. | Classify pumps. | | CO4 | R | | 1 |
| 9. | Write the energy recovery rate from Biomass. | | CO5 | U | | 1 |
| 10. | Write the range of industrial-boiler plant efficiency. | | 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. | Write short notes on the volute casing. | | CO4 | | An | 3 |
| 15. | Describe the different ways of waste management. | | CO5 | | U | 3 |
| 16. | Write short notes on computers in energy savings. | | 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 also mention the merits and demerits. | CO1 | | U | 12 |
|  |  |  |  | |  |  |
| 18. | a. | Illustrate the energy storage systems in detail. | CO2 | | R | 12 |
|  |  |  |  | |  |  |
| 19. | a. | Discuss the plant combined cycle cogeneration steam system. | CO3 | | An | 12 |
|  |  |  |  | |  |  |
| 20. | a. | Explain the various types of Industrial pumps with neat sketches. | CO4 | | A | 12 |
|  |  |  |  | |  |  |
| 21. | a. | Define waste management. Discuss the detailed process of waste management. | CO5 | | An | 12 |
|  |  |  |  | |  |  |
| 22. | a. | Discuss the various types of energy storage systems. | CO2 | | A | 12 |
|  |  |  |  | |  |  |
| 23. | a. | Explain Solar energy production; also discuss its merits and demerits. | CO4 | | U | 12 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. | a. | Explain energy and waste management by computerized systems with suitable sketches. | CO6 | | An | 12 |

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

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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. | Name the element that is used to detect the input parameter in a process control loop. | | CO1 | R | 1 |
| 2. | Define ‘set point’. | | CO1 | R | 1 |
| 3. | Enumerate the field buses used to integrate device with a controller. | | CO2 | R | 1 |
| 4. | Indicate the variables to be measured in a food process control system. | | CO2 | U | 1 |
| 5. | Identify the purpose of deep penetrating needle gripper. | | CO3 | R | 1 |
| 6. | Enumerate the main classes of multi-finger grippers to withstand normal force to hold the object. | | CO3 | R | 1 |
| 7. | Sketch the wireless star network topology on a single-hop communication. | | CO4 | A | 1 |
| 8. | Define smart dust. | | CO4 | R | 1 |
| 9. | Write the system model employed for the design and calibration of PID controllers. | | CO5 | A | 1 |
| 10. | Identify the usage of air ejector in optical sorting machine. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Summarize the neural network-based unit operations in the snack-food manufacturing plant. | | CO1 | U | 3 |
| 12. | Write an application of sensors used for automated food process control system. | | CO2 | A | 3 |
| 13. | Describe the gripper challenges in food process automation with soft materials. | | CO3 | U | 3 |
| 14. | Classify the RFID tags used in wireless hardware platforms. | | CO4 | U | 3 |
| 15. | Write the significance of extremum-seeking framework of a fed-batch reactor. | | CO5 | A | 3 |
| 16. | Distinguish between the operation of autonomous trunk boning machine and leg boning machine. | | 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 the process control system and the structure in the food industry with a PID controller. | CO1 | U | 8 |
|  | b. | Enumerate the components of a process control loop. | CO1 | R | 4 |
|  |  |  |  |  |  |
| 18. | a. | Explain the sensors used for measuring the temperature and flow variables that influence the food industry. | CO2 | U | 7 |
|  | b. | Discuss the applications of machine vision in the food industry with suitable illustrations. | CO2 | U | 5 |
|  |  |  |  |  |  |
| 19. | a. | Explain the concepts of pinching, enclosing, and penetrating grippers used for various gripping tasks in food industry. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. | a. | Explain the evaluation of the crusting degree of a sausage using the fuzzy logic concept and an adapted image analysis. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 21. | a. | Describe the processes to control the bioconversion in a fed-batch reactor. | CO5 | R | 6 |
|  | b. | Discuss the PID control scheme for food processes in a fed-batch reactor with a suitable sketch. | CO5 | U | 6 |
|  |  |  |  |  |  |
| 22. | a. | Explain the salient features required to implement SCADA network for baking process in food industry. | CO2 | An | 8 |
|  | b. | Enumerate the benefits and challenges of SCADA for the food processing industry. | CO2 | R | 4 |
|  |  |  |  |  |  |
| 23. | a. | Explain the role of wireless sensor network in agriculture and food production. | CO4 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain the robotics and automation technologies for bulk sorting in the food industry. | CO6 | An | 12 |

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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 | 6 | 11 | - | - | - | - | 17 |
| CO2 | 5 | 13 | 3 | 8 | - | - | 29 |
| CO3 | 2 | 15 | - | - | - | - | 17 |
| CO4 | 1 | 15 | 1 | 12 | - | - | 29 |
| CO5 | 6 | 6 | 4 | - | - | - | 16 |
| CO6 | 1 | 3 | - | 12 | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **19RO2015** | **Duration** | **3hrs** |
| **Course Name** | **NEURAL NETWORKS AND FUZZY 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 monotonic function. | | CO1 | U | 1 |
| 2. | Cite a specific example where feed forward networks have been put to use in practical applications. | | CO1 | A | 1 |
| 3. | List the control methods which utilize neural networks in conjunction with classical controllers. | | CO2 | A | 1 |
| 4. | What is the significance behind the concept of neural control? | | CO2 | U | 1 |
| 5. | Name the first mathematical model of a neural network. | | CO3 | U | 1 |
| 6. | Cite any one application of deep learning algorithm. | | CO3 | A | 1 |
| 7. | State De-Morgan’s law. | | CO4 | R | 1 |
| 8. | List the common operations on fuzzy sets. | | CO4 | U | 1 |
| 9. | Define fuzzification. | | CO5 | U | 1 |
| 10. | Mention the applications of neural network control system. | | CO6 | A | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Identify the components that make up the basic structure of an artificial neuron by comparing with the Biological Neural Network. | | CO1 | A | 3 |
| 12. | Describe the purpose of a neural network as a function approximator with a neat diagram. | | CO2 | A | 3 |
| 13. | Summarize the problems that arise with convolution. Specify how the problem can be solved. | | CO3 | A | 3 |
| 14. | Indicate the properties that are to be satisfied in equivalence relation. | | CO4 | An | 3 |
| 15. | Determine crisp λ-cut relation when λ = 0.1, 0**+**, 0.9 for the relation,    Rλ = {1 **|** μR(x,y) ≥ λ; 0 **|** μR(x,y) < λ} | | CO5 | An | 3 |
| 16. | Differentiate between neural networks and fuzzy logic Systems. | | 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. | List any six differences by comparing ANN and BNN. | CO1 | An | 6 |
|  | b. | Explain in brief any two types of non-linear activation functions on the basis of their range or curves. | CO1 | A | 6 |
|  |  |  |  |  |  |
| 18. | a. | Consider the following set of input training vectors of OR gate. x1=[0 0 1 1], x2=[0 1 0 1], w0=-0.3(bias), Initial weight vectors, w1=w2=0.5, learning rate, n=0.5 and xd=1. Calculate the final weights using delta learning rule. | CO2 | E | 8 |
|  | b. | Explain the steps involved in training an auto-associative neural network using the Hebb or Delta Learning Rule. | CO2 | A | 4 |
|  |  |  |  |  |  |
| 19. | a. | Analyze the evolution of deep learning as a powerful branch of A**rtificial Intelligence**(AI) that enabled computers to learn from complex data. | CO3 | An | 6 |
|  | b. | Explain the two distinct, interconnected viewpoints that motivated the development of deep architecture to solve problems in computer vision. | CO3 | A | 6 |
|  |  |  |  |  |  |
| 20. | a. | Consider two fuzzy sets,  Find the following:   1. b) c) d) e)   f) g)  k) l) | CO4 | E | 12 |
|  |  |  |  |  |  |
| 21. | a. | Consider 2 fuzzy sets A and B, both defined on the universe of discourse X, given as follows :   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  | X1 | X2 | X3 | X4 | X5 | | A | 0.4 | 0.5 | 0.6 | 0.8 | 0.9 | | B | 0.2 | 0.3 | 0.4 | 0.7 | 0.1 |   Express (Ā)0.5 using Zadin’s notation. | CO5 | E | 3 |
|  | b. | Find the defuzzified value of the trapezoidal functions given in the figure below using centre of sums defuzzification method. | CO5 | An | 9 |
|  |  |  |  |  |  |
| 22. | a. | Using Hebb Rule, find weights required to perform the following classifications of given input pattern ‘+’ symbols which represent the value 1 and empty squares which indicate -1. Consider ‘I’ belongs to the members of class (target value 1) and ‘O’ does not belong to the members of class (target value = -1).    **‘I’** ‘O’ | CO2 | An | 12 |
|  |  |  |  |  |  |
| 23. | a. | Find the defuzzified value X\* for the below fuzzy set by center of gravity (COG) defuzzification method. | CO5 | An | 12 |
|  |  |  |  |  |  |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Design and develop a neuro-controller that learns to counteract a disturbance occurring in a non-linear system such an inverted pendulum using an adaptive neural network. | CO6 | An | 6 |
|  | b. | Design and develop a self-driving car with the help of a convolutional neural network. | CO6 | An | 6 |

**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 | - | 1 | 10 | 6 | - | - | 17 |
| CO2 | - | 1 | 8 | 12 | 8 | - | 29 |
| CO3 | - | 1 | 10 | 6 | - | - | 17 |
| CO4 | 1 | 1 | - | 3 | 12 | - | 17 |
| CO5 | - | 1 | - | 12 | 3 | - | 28 |
| CO6 | - | - | 4 | 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** | | **CO** | **BL** | **Marks** | |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | Mention the internal RAM capacity of 8051. | | CO1 | R | 1 | |
| 2. | Identify the register used along with A register for multiplication and division operation in 8051. | | CO1 | R | 1 | |
| 3. | Identify the 8051 instruction used to get the ones complement of a numbers. | | CO2 | R | 1 | |
| 4. | Name the register that hold the address of the next instruction to be fetched by the microcontroller. | | CO2 | R | 1 | |
| 5. | Determine the status of carry and parity flag after executing the following instruction.  MOV A,#9C ADD A,#64H | | CO3 | A | 1 | |
| 6. | Define Zigbee protocol. | | CO3 | R | 1 | |
| 7. | Mention any two pipelining hazards in ARM 9 processor. | | CO4 | U | 1 | |
| 8. | Identify the instruction used to transfer the content of R1 register to R0 register in ARM 9 processor. | | CO4 | U | 1 | |
| 9. | Mention the type of mode used for exception handling in ARM Cortex M4. | | CO5 | R | 1 | |
| 10. | Name any two examples for digital sensor. | | CO6 | R | 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 function of Nested Vectored Interrupt Controller. | | CO4 | U | 3 | |
| 15. | Examine the significance of Thread mode in ARM cortex M4 processor. | | 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. | Develop a circuit which interfaces memory with 8051 microcontroller in order to fetch a data 40h from memory. | CO1 | An | | 6 |
|  | b. | Explain the characteristics of embedded system. | CO1 | U | | 6 |
|  |  |  |  |  | |  |
| 18. | a. | Develop an assembly language program to find the smallest number in an array of 10 numbers. | CO2 | An | | 6 |
|  | b. | Illustrate with example, different data transfer instructions in 8051. | CO2 | A | | 6 |
|  |  |  |  |  | |  |
| 19. | a. | Differentiate SPI and I2C protocols. | CO3 | A | | 6 |
|  | b. | Design an interfacing circuit for 8051 with Bluetooth technology. | CO3 | An | | 6 |
|  |  |  |  |  | |  |
| 20. | a. | Categorize operating modes of ARM 9 processor. | CO4 | An | | 6 |
|  | b. | Summarize the functional blocks of ARM 9 Processor. | CO4 | U | | 6 |
|  |  |  |  |  | |  |
| 21. | a. | Outline the salient features of ARM Cortex M4. | CO5 | U | | 6 |
|  | b. | Categorize different memory regions in ARM Cortex M4. | CO5 | An | | 6 |
|  |  |  |  |  | |  |
| 22. | a. | Elaborate programmers model of ARM 9 Processor. | CO4 | 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 | CO2 | An | | 6 |
|  |  |  |  |  | |  |
| 23. | a. | Explain the functional block diagram of 8051 microcontroller. | CO1 | U | | 8 |
|  | b. | Distinguish between 8 bit and 32 bit microcontroller. | CO1 | A | | 4 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. | a. | Create an interfacing circuit which connects LCD with microcontroller and write the steps to display the character and commands. | CO6 | C | | 6 |
|  | b. | Develop an 8051 interfacing circuit which rotates DC motor in clockwise direction. | CO6 | An | | 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 | 2 | 3 | 6 | 12 |  |  | 23 |
| CO3 | 1 |  | 7 | 9 |  |  | 17 |
| CO4 |  | 11 |  | 12 |  |  | 23 |
| CO5 | 1 | 6 | 3 | 6 |  |  | 16 |
| CO6 | 1 | 3 |  | 6 |  | 6 | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20RO1003** | **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 any two standard data types in python. | | CO1 | R | 1 |
| 2. | Write the syntax for print statement. | | CO1 | R | 1 |
| 3. | Identify the operator used in the given code and write the output  >> 7//3. | | CO2 | An | 1 |
| 4. | Find the output of the following code  for x in range(2, 6):   print(x) | | CO2 | R | 1 |
| 5. | Identify the function used to read single line from file. | | CO3 | U | 1 |
| 6. | Name the command to list files in directory. | | CO3 | R | 1 |
| 7. | Identify the function which returns largest value from a list of 10 numbers. | | CO4 | U | 1 |
| 8. | Write the syntax for python function. | | CO4 | U | 1 |
| 9. | What is polymorphism in python? | | CO5 | U | 1 |
| 10. | What is method overriding in python? | | CO5 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | List the rules for python variables. | | CO1 | U | 3 |
| 12. | Differentiate between: for loop and while loop. | | CO2 | An | 3 |
| 13. | Explain how to create a dictionary in python. | | CO3 | U | 3 |
| 14. | Create a python function to check whether x is even or odd. | | CO4 | C | 3 |
| 15. | Outline the importance of inheritance in python. | | CO5 | U | 3 |
| 16. | What are the steps involved in programming hardware using Micro python? | | 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 swap two variables. | CO1 | A | 6 |
|  | b. | Outline python code to test whether a given year is leap year or not. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | Create python code to calculate the diameter, circumference, surface area and volume of a sphere. | CO2 | C | 6 |
|  | b. | Summarize types of operators in python with appropriate example. | CO2 | U | 6 |
|  |  |  |  |  |  |
| 19. | a. | Examine how to encrypt and decrypt strings in python. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 20. | a. | Illustrate basic list operations that can be performed in python. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. | a. | Explain how to define a function inside a python class with example. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | Write a python program to reverse the given number. | CO2 | C | 6 |
|  | b. | Develop a python program which accepts the radius of a circle from the user and compute the area. | CO2 | A | 6 |
|  |  |  |  |  |  |
| 23. | a. | Design the following pattern using Fibonacci series with python code:  1  1 1  1 1 2  1 1 2 3  1 1 2 3 5  1 1 2 3 5 8 | CO4 | C | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Develop an algorithm for pick and place robot with micropython. | 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** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 9 | 6 |  |  |  | 17 |
| CO2 | 1 | 6 | 6 | 4 |  | 12 | 29 |
| CO3 | 1 | 4 |  | 12 |  |  | 17 |
| CO4 |  | 14 |  |  |  | 15 | 29 |
| CO5 |  | 5 | 12 |  |  |  | 17 |
| CO6 |  | 3 | 12 |  |  |  | 15 |
|  | | | | | | | 124 |



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| **Code :** | **20RO1004** | **Duration :** | **3hrs** |
| **Sub. 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. | Define the term industrial robot. | CO1 / R | 1 |
| 2. | Describe the degrees of freedom of the wrist. | CO1 / U | 1 |
| 3. | Give an example of a proximity sensor used in robotic applications. | CO2 / R | 1 |
| 4. | Name the data reduction techniques used in machine vision. | CO2 / U | 1 |
| 5. | Define the general form of a homogeneous transformation matrix. | CO3 / R | 1 |
| 6. | Identify the type of robot motion analysis that involves the forces acting on the robot. | CO3 / U | 1 |
| 7. | Compare internal and external grippers. | CO4 / U | 1 |
| 8. | List the significant features of a collaborative robot. | CO4 / A | 1 |
| 9. | List the types of industrial automation. | CO5 / R | 1 |
| 10. | Bring out the salient technologies in Industry 4.0. | CO5 / U | 1 |

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| **PART – B (6 X 3 = 18 MARKS)** | | | |
| 11. | State Asimov’s laws of robotics. | CO1 / R | 3 |
| 12. | Differentiate internal and external state sensors. | CO2 / U | 3 |
| 13. | Identify the significance of forward and inverse kinematic analysis of a robot. | CO3 /An | 3 |
| 14. | Highlight the basic concepts of RPA. | CO4 / U | 3 |
| 15. | List a few applications of robots in healthcare. | CO5 / U | 3 |
| 16. | What are the benefits of industrial automation? | CO6 /An | 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. | With neat diagrams and relevant explanations, give the classification of robots based on the work volume. | CO1 / U | 6 |
| b. | List the performance specifications of a robot and elaborate the significance of each one. | CO1/ U | 6 |
|  |  |  |  |  |
| 18. | a. | Express the use of proximity sensors in robotic systems and explain in detail about the working principle of any one type of proximity sensor with neat sketches and examples. | CO2 /A | 12 |
|  |  |  |  |  |
| 19. | a. | Describe the working of vacuum type grippers and mention its advantages and disadvantages. | CO4 /U | 6 |
| b. | Specify the considerations to be made while selecting a gripper. | CO4/An | 6 |
|  |  |  |  |  |
| 20. | a. | Bring out the significance of forward and inverse kinematic analysis of robots and derive the expression for forward and inverse kinematics of a 2 DoF two link manipulator. | CO3 /U | 12 |
|  |  |  |  |  |
| 21. | a. | Illustrate the applications of robots in manufacturing automation. | CO4 / A | 8 |
| b. | Briefly describe the concept of collaborative robots. | CO4 / A | 4 |
|  |  |  |  |  |
| 22. | a. | Sketch the building blocks of an automatic control system and explain the function of each block. Elaborate the need for automation. | CO5 / U | 12 |
|  |  |  |  |  |
| 23. | a. | With relevant diagrams and explanation, summarize the functional elements of home automation systems and their merits. | CO6 /A | 12 |
|  |  | **Compulsory:** | | |
| 24. | a. | Specify the different types of robot programming techniques with suitable examples and diagrams. | CO3 / A | 12 |

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|  | **COURSE OUTCOMES** |
| CO1 | Recall the evolution of robots and their classification |
| CO2 | Analyze the applications of sensors and actuators in robotics. |
| CO3 | Describe the kinematics and dynamic behavior 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 Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 4 | 12 |  |  |  |  | 16 |
| CO2 | 1 | 4 | 12 |  |  |  | 17 |
| CO3 | 1 | 13 | 12 | 3 |  |  | 29 |
| CO4 |  | 10 | 13 | 6 |  |  | 20 |
| CO5 | 1 | 16 |  |  |  |  | 17 |
| CO6 |  |  | 12 | 3 |  |  | 15 |
|  | | | | | | | **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)**  **(Answer all the questions)** | | | | | |
| 1. | List the different Boolean theorems. | | CO1 | R | 1 |
| 2. | Convert binary to decimal (1011.01)2 | | CO1 | U | 1 |
| 3. | Convert hexadecimal to decimal(5826.12)16 | | CO2 | U | 1 |
| 4. | Determine the 2’s complement for the binary number 1011 1100 | | 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)**  **(Answer all the questions)** | | | | | |
| 11. | Perform the subtraction using 1’s complement (0.01111 - 0.01001). | | CO1 | R | 3 |
| 12. | Convert the gray code to binary code 1100101. | | CO2 | U | 3 |
| 13. | Compare combinational circuit and sequential circuit. | | CO3 | U | 3 |
| 14. | Outline three specifications of ADC. | | CO4 | U | 3 |
| 15. | Distinguish between content addressable memory and charge coupled device memory. | | CO5 | U | 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. | Convert decimal (8957.75)10 into equivalent (a) binary (b) octal  (c) hexadecimal. | A | CO1 | 12 |
|  |  |  |  |  |  |
| 18. | a. | Explain DeMorgan’s theorem and apply to:  (a) (b) | CO1 | A | 12 |
|  |  |  |  |  |  |
| 19. | a. | Minimize the Boolean function f=A'B'C'+A'BC'+AB'C'+ ABC' =Σ(0,2,4,6) using K-Map. | CO2 | A | 6 |
|  | b. | Obtain the canonical SOP form of the given function. F (A,B,C,D) =  (AB'C)+(A'D) | CO2 | A | 6 |
|  |  |  |  |  |  |
| 20. | a. | Develop truth table and excitation table for D Flip-flop. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 21. | a. | Illustrate the operation of R-2R ladder DAC with necessary diagram. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 22. | a. | Design a combinational circuit using PROM which accepts 3-bit binary and generates its equivalent Excess 3 code. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 23. | a. | Compare PROM, PLA and PAL. | CO5 | U | 6 |
|  | b. | Summarize the operation of FPGA. | CO5 | U | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain the functional blocks of 8085 microprocessor. | CO6 | U | 12 |

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

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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 Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 4 | 1 | 24 | - | - | - | 29 |
| CO2 | 1 | 4 | 12 | - | - | - | 17 |
| CO3 | 1 | 4 | 12 | - | - | - | 17 |
| CO4 | 1 | 16 | - | - | - | - | 17 |
| CO5 | - | 16 | 12 | - | - | - | 28 |
| CO6 | - | 16 | - | - | - | - | 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. | List the types of errors. | CO1 | U | 1 |
| 2. | Give the SI unit for acceleration. | CO1 | R | 1 |
| 3. | Find the sensor used in weighing scale. | CO2 | A | 1 |
| 4. | Mention the semiconductor-based temperature sensor. | CO2 | R | 1 |
| 5. | Find any two types of sensor used for measurement of angular rotation. | CO3 | A | 1 |
| 6. | Give the application of a potentiometer. | CO3 | A | 1 |
| 7. | Identify the principle of Electromagnetic flow meters. | CO4 | An | 1 |
| 8. | Find the basic sensor used in a tactile sensor. | CO4 | E | 1 |
| 9. | Give the operational frequency of Bluetooth. | CO5 | R | 1 |
| 10. | Give the short distance protocol used in embedded systems. | CO5 | U | 1 |

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| **PART – B (6 X 3 = 18 MARKS)** | | | | |
| 11. | Define Resolution. | CO1 | U | 3 |
| 12. | Identify & draw the circuits used for resistance-based temperature sensors | CO2 | A | 3 |
| 13. | Give the principle of Resolver. | CO3 | U | 3 |
| 14. | Give the principle of ultrasonic level measurement. | CO4 | R | 3 |
| 15. | Define Protocol. | CO5 | U | 3 |
| 16. | Tabulate the frequency allocation of electromagnetic spectrum. | 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. | a. | List the types of errors occur in sensor measurements and explain the same. | CO1 | R | 6 |
| b. | Assume an industrial process for which you need to identify a sensor, List the considerations that you will take before buying a sensor. | CO1 | E | 6 |
|  |  |  |  |  |  |
| 18. | a. | Categories the different types of temperature sensors and elaborate on the NTC & PTC type temperature Sensors. \* | CO2 | A | 12. |
|  |  |  |  |  |
|  |  |  |  |  |  |
| 19. |  | Discuss the types of sensors used for speed measurement and position of a shaft. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 20. | a. | Identify the sensor used for measurement of level in a dairy industry. | CO4 | A | 6 |
|  | b. | Explain the working of Photoelectric sensor. | CO4 | A | 6 |
|  |  |  |  |  |  |
| 21. |  | Identify the layers in OSI reference model and illustrate their functions. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 22. |  | Illustrate the sensor that reads the speed of a motor as analog value. | CO3 | An | 6 |
|  |  | Summarize the working principle of torque sensor. | CO4 | R | 6 |
|  |  |  |  |  |  |
| 23. | a. | Find the sensor that uses the faraday law. Explain the construction and working of the same. | CO2 | A | 8 |
| b. | 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). | CO3 | A | 4 |
|  |  | **Compulsory:** | | | |
| 24. |  | Discuss the wireless protocols used in sensor networks.\* | CO6 | A | 12 |

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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 | 7 | 4 |  |  | 6 |  | 17 |
| CO2 | 1 |  | 24 |  |  |  | 25 |
| CO3 |  | 3 | 6 | 18 |  |  | 27 |
| CO4 | 9 |  | 12 | 1 | 1 |  | 23 |
| CO5 | 1 | 16 |  |  |  |  | 17 |
| CO6 | 3 |  | 12 |  |  |  | 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)**  **(Answer all the questions)** | | | | | |
| 1. | Identify the sensors used in mobile phones. | | CO1 | A | 1 |
| 2. | A thermocouple is a temperature sensor which gives change in \_\_\_\_\_\_\_\_\_\_ with respect to the input temperature. | | CO1 | U | 1 |
| 3. | Voltage divider circuits are used to convert \_\_\_\_\_\_\_\_\_\_\_ to voltage signals. | | CO2 | U | 1 |
| 4. | Find the value of resistance for the high pass filter with a cutoff frequency of 200Hz. Assume C= 0.1nF. | | CO2 | A | 1 |
| 5. | Give the pin number of inverting terminal in IC 741. | | CO3 | A | 1 |
| 6. | Buffer amplifier is also known as \_\_\_\_\_\_\_\_\_ amplifier. | | CO3 | U | 1 |
| 7. | Give the operational frequency of ZigBee. | | CO4 | A | 1 |
| 8. | The maximum distance a Bluetooth device can transmit is \_\_\_\_\_\_\_. | | CO4 | R | 1 |
| 9. | List a few applications of smart sensors. | | CO5 | A | 1 |
| 10. | The data processing unit is where the data can be \_\_\_\_\_\_\_\_\_\_\_\_\_\_ by analysts. | | CO5 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Define linearity. | | CO1 | R | 3 |
| 12. | Draw and give the expression of potential divider. | | CO2 | U | 3 |
| 13. | List the ideal characteristics of Op-amp. | | CO3 | R | 3 |
| 14. | Tabulate the differences between Bluetooth and ZigBee. | | CO4 | A | 3 |
| 15. | List the advantages of smart sensor. | | CO5 | U | 3 |
| 16. | Mention the benefits of open sources hardware. | | 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. | Categories the different types of temperature sensors and elaborate on the NTC & PTC type temperature Sensors. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. | a. | Explain the passive high pass and low pass filters in detail. | CO2 | U | 6 |
|  | b. | A resistance-based accelerometer sensor is moved by 30% from its initial value, whose full-scale reading is 64 Kohm. The interface circuit for the angular sensor behaves as a resistive load of 20 Kohm. Find the current flowing through the interfacing circuit. (Assume a 12 Volt Power supply) | CO2 | A | 6 |
|  |  |  |  |  |  |
| 19. | a. | Derive the expression for I/V and V/I convertor. | CO3 | U | 6 |
|  |  | Derive the expression for summing amplifier. | CO3 | U | 6 |
|  |  |  |  |  |  |
| 20. | a. | Explain the architecture of Bluetooth and its application in wireless sensors. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. | a. | Discuss the components used in smart sensors. | CO5 | U | 6 |
|  | b. | Elaborate the design aspects of smart sensor. | CO5 | A | 6 |
|  |  |  |  |  |  |
| 22. | a. | Design an instrumentation amplifier with a gain of 58. | CO3 | A | 4 |
|  | b. | Obtain the expression of gain for inverting and non-inverting amplifiers. | CO3 | A | 8 |
|  |  |  |  |  |  |
| 23. | a. | Identify the sensors used in agriculture automation and explain any two sensors with their principle and working. | CO1 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Discuss the role of IoT sensor technologies in smart cities. | 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 | Analyze the use of Smart Sensors and IOT |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 3 | 1 | 25 |  |  |  | 29 |
| CO2 |  | 10 | 7 |  |  |  | 17 |
| CO3 | 3 | 13 | 13 |  |  |  | 29 |
| CO4 | 1 | 12 | 4 |  |  |  | 17 |
| CO5 | 1 | 9 | 7 |  |  |  | 17 |
| CO6 |  | 3 |  | 12 |  |  | 15 |
|  | | | | | | | **124** |



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| **Course Code** | **20RO3005** | **Duration** | **3hrs** |
| **Course Name** | **EMBEDDED SYSTEMS FOR AUTOMATION** | **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. | Illustrate the concept of watch dog timer. | CO1 | R | 10 |
|  | b. | Explain the concepts of DMA. | CO1 | R | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Illustrate the working principle of RS 232 & 485 standards. | CO2 | U | 10 |
|  | b. | Explain the sophisticated interfacing features in device ports. | CO2 | U | 10 |
|  |  |  |  |  |  |
| 3. | a. | Explain the device driver and Interrupt servicing mechanism in an embedded device. | CO2 | R | 10 |
|  | b. | Explain the various features in USB Communication protocol. | CO2 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Describe the frame format and working of I2C protocol with features. | CO3 | R | 10 |
|  | b. | Illustrate the synchronous and asynchronous communications from serial devices. | CO3 | U | 10 |
|  |  |  |  |  |  |
| 5. | a. | Summarize preemptive and non-preemptive multitasking. | CO3 | R | 10 |
|  | b. | Describe the real time operating systems VxWorks, Linux and RT Linux | CO3 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Summarize the advantages and disadvantages of open-source hardware with an example. | CO4 | A | 20 |
|  |  |  |  |  |  |
| 7. | a. | Describe the various elements in JAVA program. | CO4 | R | 10 |
|  | b. | Illustrate the various features of MIDP. | CO5 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Describe the working of adaptive cruise control in a car with RADAR system. | CO5 | An | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Summarize the various modelling of EDLC. | CO6 | R | 20 |

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

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Recall the basic concepts of embedded systems |
| CO2 | Summarize the concepts of embedded networking and interrupt service mechanisms. |
| CO3 | Identifications of various RTOS features for real time applications. |
| CO4 | Analyze the scope of UML for creating visual models of software intensive systems. |
| CO5 | Describe the basic concepts of Embedded OS. |
| CO6 | Design the real time embedded systems using the concepts of RTOS. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 20 | - | - | - | - | - | 20 |
| CO2 | 10 | 30 | - | - | - | - | 40 |
| CO3 | 20 | 20 | - | - | - | - | 40 |
| CO4 | 10 | - | 20 | - | - | - | 30 |
| CO5 | - | 10 | - | 20 | - | - | 30 |
| CO6 | 20 | - | - | - | - | - | 20 |
|  | | | | | | | **180** |



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| **Course Code** | **20RO3005** | **Duration** | **3hrs** |
| **Course Name** | **EMBEDDED 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. | Explain the building blocks of an embedded system. | CO1 | R | 8 |
|  | b. | Discuss the criteria for selecting the processor. | CO1 | An | 8 |
|  |  |  |  |  |  |
| 2. | a. | Identify and elaborate the protocols that are used for short distance data communication in embedded systems. | CO2 | U | 16 |
|  |  |  |  |  |  |
| 3. | a. | Explain the terminologies Semaphores, Mailbox, Pipes, and shared memory in RTOS. | CO3 | R | 8 |
|  | b. | Elaborate the basic functionality and operation of RTOS. | CO3 | U | 8 |
|  |  |  |  |  |  |
| 4. | a. | List the different types of open-source hardware available for embedded programming with its capabilities. | CO4 | R | 6 |
|  | b. | Elaborate features and capabilities of the single board computers. | CO4 | U | 10 |
|  |  |  |  |  |  |
| 5. | a. | Enumerate the CLDC framework and its application in embedded system. | CO5 | A | 8 |
|  | b. | Define Operator. Explain type of operators in Java with example programs. | CO5 | A | 8 |
|  |  |  |  |  |  |
| 6. | a. | Identify the different types of memory management methods used in embedded systems and explain same in detail. | CO1 | A | 16 |
|  |  |  |  |  |  |
| 7. | a. | Discuss the characteristics and operation of RS232 Protocol. | CO2 | U | 10 |
|  | b. | Illustrate the concept of interrupt latency and deadline. | CO2 | R | 6 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Illustrate the steps involved in the software development of smart cards. | CO6 | C | 20 |

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

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Recall the basic concepts of embedded systems |
| CO2 | Summarize the concepts of embedded networking and interrupt service mechanisms. |
| CO3 | Identification of various RTOS features for real time applications |
| CO4 | Analyze the scope of UML for creating visual models of software-intensive systems. |
| CO5 | Describe the basic concepts of embedded OS |
| CO6 | Design real time embedded systems using the concepts of RTOS |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 8 |  | 16 | 8 |  |  | 32 |
| CO2 | 6 | 26 |  |  |  |  | 32 |
| CO3 | 8 | 8 |  |  |  |  | 16 |
| CO4 | 6 | 10 |  |  |  |  | 16 |
| CO5 |  |  | 16 |  |  |  | 16 |
| CO6 |  |  |  |  |  | 20 | 20 |
|  | | | | | | | **132** |



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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 (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Explain IoT enablers and connectivity layers. | CO1 | A | 10 |
|  | b. | Explain the block diagram of Industrial IoT. | CO1 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Elaborate the functional blocks of IoT service oriented architecture. | CO2 | A | 20 |
|  |  |  |  |  |  |
| 3. | a. | Explain the various types of sensors with their applications in IoT. | CO3 | A | 10 |
|  | b. | Compare the types of actuators used in IoT applications. | CO3 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Explain connectivity technology in MQTT. | CO4 | U | 10 |
|  | b. | Mention the need of different types of protocols. | CO4 | R | 10 |
|  |  |  |  |  |  |
| 5. | a. | Describe the network security techniques. | CO5 | A | 10 |
|  | b. | Explain the conventional web technology and relationship with IIOT. | CO5 | R | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Explain various layers in HART Protocol. | CO3 | A | 10 |
|  | b. | Distinguish between failed node and selfish node in MQTT protocol. | CO3 | U | 10 |
|  |  |  |  |  |  |
| 7. | a. | Elaborate the functional blocks of CoAP architecture. | CO4 | A | 10 |
|  | b. | Explain in detail about cots cloud platforms. | CO4 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Highlight the desirable characteristics of sensors used in IoT applications. | CO2 | U | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | List the applications of IoT in the manufacturing sector and describe the process of implementation with a relevant case study. | CO6 | A | 10 |
|  | b. | Explain the role of analytics in IoT. | CO6 | U | 10 |

**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 | - | 10 | 10 | - | - | - | 20 |
| CO2 | - | 20 | 20 | - | - | - | 40 |
| CO3 | - | 20 | 20 | - | - | - | 40 |
| CO4 | 10 | 20 | 10 | - | - | - | 40 |
| CO5 | 10 | - | 10 | - | - | - | 20 |
| CO6 | - | 10 | 10 | - | - | - | 20 |
|  | | | | | | | **180** |



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| --- | --- | --- | --- |
| **Course Code** | **20RO3017** | **Duration** | **3hrs** |
| **Course Name** | **IMAGE PROCESSING AND MACHINE VISION** | **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 digital representation of an image in a 2D discrete space. | CO1 | U | 6 |
|  | b. | Explain with neat sketch, the various components of digital image processing. | CO1 | U | 10 |
|  |  |  |  |  |  |
| 2. | a. | Describe the functions of a human eye with a suitable diagram and label its anatomical parts. | CO2 | U | 12 |
|  | b. | Distinguish between subjective brightness adaptation and brightness discrimination. | CO2 | U | 4 |
|  |  |  |  |  |  |
| 3. | a. | Apply 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 | 15 | 10 | 4 | 11 | 8 | 9 | | CO3 | A | 10 |
|  | b. | Tabulate the arithmetic and logic array operations carried out between the pixel pairs of digital images. | CO3 | R | 6 |
|  |  |  |  |  |  |
| 4. | a. | Explain the digital image compression and coding model with a suitable block diagram. | CO4 | An | 10 |
|  | b. | Discuss the concepts of lossless predictive coding to map the encoded prediction error. | CO4 | U | 6 |
|  |  |  |  |  |  |
| 5. | a. | Explain the application of machine vision in inspection and identification of parts in industries. | CO5 | An | 16 |
|  |  |  |  |  |  |
| 6. | a. | Define a pixel and illustrate the relationship between the neighborhood pixels with suitable examples. | CO2 | U | 12 |
|  | b. | Identify the fundamental characteristics that demonstrate the resemblance between a camera and the human eye. | CO2 | U | 4 |
|  |  |  |  |  |  |
| 7. | a. | Explain the concepts of machine vision in mobile robot application. | CO5 | An | 16 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Discuss the illumination techniques used in industrial machine vision systems. | CO6 | U | 10 |
|  | b. | Illustrate the camera calibration process for computer vision system with a suitable example. | CO6 | U | 10 |

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|  | **COURSE OUTCOMES** |
| CO1 | Recall the concepts of image processing basics. |
| CO2 | Explain the fundamentals of digital image processing. |
| CO3 | Discuss image enhancement techniques. |
| CO4 | Explain the importance of image compression. |
| CO5 | Explain the concepts of machine vision. |
| CO6 | Describe the importance of industrial machine vision. |

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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 | 6 | - | 10 | - | - | - | 16 |
| CO4 | - | 6 | - | 10 | - | - | 16 |
| CO5 | - | - | - | 32 | - | - | 32 |
| CO6 | - | 20 | - | - | - | - | 20 |
|  | | | | | | | **132** |



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| **Course Code** | **20RO3019 (Ph.D)** | **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. | Represent the different phases of Machine learning with a block diagram and mention few applications of Machine Learning. | CO1 | A | 10 |
|  | b. | Highlight the application of Principal Component Analysis for dimensionality reduction. | CO1 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Differentiate supervised, unsupervised and reinforcement techniques of machine learning with suitable examples. | CO1 | An | 10 |
|  | b. | Illustrate the linear regression and logistic regression techniques with the help of an example. | CO2 | A | 10 |
|  |  |  |  |  |  |
| 3. | a. | Comment on the application of linear regression and logistic regression for prediction. | CO2 | An | 10 |
|  | b. | The marks obtained by a student are dependent on her/his study time. Given the study time in minutes and marks out of 2000, find the relationship between study time and marks using the concept of linear regression. Also predict the marks for a student if she/he studied for 790 minutes.   |  |  |  | | --- | --- | --- | | S.No. | Study time(min) | Marks Obtained | | 1 | 600 | 720 | | 2 | 1070 | 1600 | | 3 | 630 | 1000 | | 4 | 890 | 850 | | 5 | 740 | 1350 | | 6 | 560 | 490 | | CO2 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Outline the concept of density based clustering and indicate the steps involved in DBSCAN algorithm. | CO3 | U | 10 |
|  | b. | Determine the final result of hierarchical clustering with complete link by drawing a dendrogram. | CO3 | A | 10 |
|  |  |  |  |  |  |
| 5. | a. | Illustrate K means clustering algorithm with an example. | CO3 | A | 10 |
|  | b. | Demonstrate the use of Voronoi diagrams in classification | CO4 | A | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Comment on the aspects to consider while designing K Nearest Neighbour. | CO4 | An | 10 |
|  | b. | Consider the training data in the following table where Play is a class attribute. In the table, the Humidity attribute has values “L” (for low) or “H” (for high), Sunny has values “Y” (for yes) or “N” (for no), Wind has values “S” (for strong) or “W” (for weak), and Play has values “Yes” or “No”.    What is class label for the following day (Humidity=L, Sunny=N, Wind=W), according to naïve Bayesian classification? | CO4 | A | 10 |
|  |  |  |  |  |  |
| 7. | a. | The multivariate Iris flower data collection contains the morphological differences of Iris flowers from three closely related species, including Setoso, Virginica and Verscicolor. Each sample is used to collect two characteristics: petal width and petal length. Categorize three species using the KNN Classifier algorithm.   |  |  |  | | --- | --- | --- | | Sepal Length | SepalWidth | Species | | 5.3 | 3.7 | Setosa | | 5.1 | 3.8 | Setosa | | 7.2 | 3.0 | Virginica | | 5.4 | 3.4 | Setosa | | 5.1 | 3.3 | Setosa | | 5.4 | 3.9 | Setosa | | 7.4 | 2.8 | Virginica | | 6.1 | 2.8 | Versicolor | | 7.3 | 2.9 | Virginica | | 6.0 | 2.7 | Versicolor | | 5.8 | 2.8 | Virginica | | 6.3 | 2.3 | Versicolor | | 5.1 | 2.5 | Versicolor | | 6.3 | 2.5 | Versicolor | | 5.5 | 2.4 | Versicolor | | CO4 | A | 10 |
|  | b. | Comment on the use of decision tree for classification purpose with an example. | CO5 | E | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | NASA wants to be able to discriminate between Martians (M) and Humans (H) based on the following characteristics: Green ∈{N, Y} , Legs ∈{2,3} , Height ∈{S, T}, Smelly ∈{N, Y}. Training data available is given below. Develop a decision tree algorithm. | CO5 | E | 10 |
|  | b. | Describe the bagging and boosting models of random forest algorithm and the impact that it has on bias and variance. | CO5 | A | 10 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | What is meant by Association Rule Mining? Derive the mathematical model for association analysis. | CO6 | A | 10 |
|  | b. | Illustrate the concept of FP trees with an example. | CO6 | A | 10 |

**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 | 10 |  |  | 30 |
| CO2 |  |  | 10 | 20 |  |  | 30 |
| CO3 |  | 10 | 20 |  |  |  | 30 |
| CO4 |  |  | 30 | 10 |  |  | 40 |
| CO5 |  |  | 10 |  | 20 |  | 30 |
| CO6 |  |  | 20 |  |  |  | 20 |
|  | | | | | | | **180** |



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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 (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Develop a model selection strategy for a complex machine learning problem, considering various algorithms and techniques. | CO1 | A | 6 |
|  | 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 components using PCA algorithm. | CO1 | A | 10 |
|  |  |  |  |  |  |
| 2. | a. | Construct a dendrogram using the Single Linkage method for the provided data points (P1-P6) and interpret the clustering results. Analyze the clusters formed and their relationship to the data points.   |  |  |  | | --- | --- | --- | |  | X | Y | | P1 | 0.40 | 0.53 | | P2 | 0.22 | 0.38 | | P3 | 0.35 | 0.32 | | P4 | 0.26 | 0.19 | | P5 | 0.08 | 0.41 | | P6 | 0.45 | 0.30 | | CO2 | An | 16 |
| 3. | a. | Use the k-means clustering algorithm and Euclidean distance to cluster  the following 8 data into 3 clusters: A1=(2,10), A2=(2,5), A3=(8,4), A4=(5,8), A5=(7,5), A6=(6,4), A7=(1,2), A8=(4,9). The distance matrix based on the Euclidean distance is given below:    Suppose that the initial seeds (centers of each cluster) are A1, A4 and A7. Run the k-means clustering algorithm for 2 epochs only. At the end of this epoch shows: a) The new clusters (i.e. the examples belonging to each cluster). b) The centers of the new clusters. d) How many more iterations are needed to converge? Draw the result for each epoch. | CO3 | An | 16 |
|  |  |  |  |  |  |
| 4. | a. | 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 | | CO3 | A | 6 |
|  | b. | Explain the linear regression and logistic regression methods with the help of an example | CO3 | U | 10 |
|  |  |  |  |  |  |
| 5. | a. | 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 | | CO4 | A | 8 |
|  | b. | Compare and contrast the applications of Voronoi Diagrams and Delaunay Triangulations in spatial data analysis for KNN cassifier. | CO4 | U | 8 |
|  |  |  |  |  |  |
| 6. | a. | Calculate Accuracy, Specificity, Sensitivity and F1\_Score from the confusion matrix for Actual class vs Predicted Class. | CO4 | A | 6 |
|  | b. | Describe the process of building a Random Forest model. Elaborate on the steps involved in the creation of decision trees, the integration of multiple trees, and the mechanism behind the aggregation of predictions in the Random Forest algorithm. | CO5 | A | 10 |
|  |  |  |  |  |  |
| 7. | 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 | | CO5 | An | 16 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Develop a flowchart illustrating how the Apriori principle influences the decision-making process during association rule mining. | CO6 | A | 20 |

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

|  |  |
| --- | --- |
|  | **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 |  |  | 16 |  |  |  | 16 |
| CO2 |  |  |  | 16 |  |  | 16 |
| CO3 |  | 10 | 6 | 16 |  |  | 32 |
| CO4 |  | 8 | 14 |  |  |  | 22 |
| CO5 |  |  | 10 | 16 |  |  | 26 |
| CO6 |  |  | 20 |  |  |  | 20 |
|  | | | | | | | **132** |



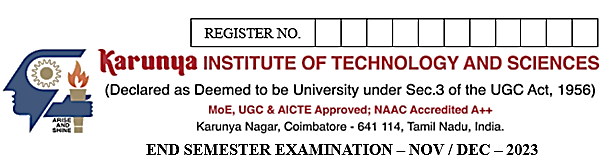
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| **Course Code** | **20RO3021** | **Duration** | **3hrs** |
| **Course Name** | **DEEP LEARNING FOR COMPUTER VISION** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Elaborate with a neat diagram about feed forward networks. | CO1 | A | 15 |
|  | b. | Enumerate the basic principles of back propagation algorithm. | CO1 | U | 5 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Elaborate with a neat block diagram the architecture of any two convolutional networks. | CO2 | A | 20 |
|  |  |  |  |  |  |
| 3. | a. | Summarize the applications of deep learning of computer vision. | CO4 | U | 15 |
|  | b. | Discuss about the attention model for computer vision. | CO4 | R | 5 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Elaborate sparse coding unsupervised deep learning. | CO3 | An | 20 |
|  |  |  |  |  |  |
| 5. |  | With neat diagram explain image generation with generative adversarial networks. | CO4 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Discuss the Vector Space Model of Semantics. | CO5 | A | 15 |
|  | b. | Write a short note on Opinion Mining using Recurrent Neural Networks | CO5 | U | 5 |
|  |  |  |  |  |  |
| 7. |  | Explain in detail about Heuristics algorithms for faster training. | CO1 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | With a neat block diagram explain the architecture of LeNet5 and  AlexNet. | CO5 | A | 15 |
|  | b. | Write a short note on encoder decoder architecture. | CO5 | U | 5 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Discuss about the Sentence Classification using Convolutional Neural Networks. | CO6 | A | 20 |

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

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|  | **COURSE OUTCOMES** |
| CO1 | Recall the introduction to neural network. |
| CO2 | Explain the concepts of convolutional neural networks. |
| CO3 | Discuss deep learning unsupervised learning. |
| CO4 | Summarize the application of deep learning to computer vision. |
| CO5 | Describe the application of deep learning to NLP. |
| CO6 | Disucss the concept of recursive neural network. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 |  | 5 | 35 |  |  |  | 40 |
| CO2 |  |  | 20 |  |  |  | 20 |
| CO3 |  |  |  | 20 |  |  | 20 |
| CO4 | 5 | 15 | 35 |  |  |  | 55 |
| CO5 |  | 10 | 15 |  |  |  | 25 |
| 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. | Discuss the types of forces acting on particles. | | CO1 | U | 1 |
| 2. | Explain Varignon’s theorem. | | CO1 | U | 1 |
| 3. | Illustrate the meaning of centroid of a plane. | | CO2 | A | 1 |
| 4. | Sketch and explain Parallel axis theorem. | | CO2 | A | 1 |
| 5. | Identify the different types of motion. | | CO3 | U | 1 |
| 6. | Illustrate the Newton’s second law of motion. | | CO3 | U | 1 |
| 7. | Give examples for translation and rotation of rigid bodies. | | CO4 | U | 1 |
| 8. | Construct the principle of Impulse momentum | | CO4 | A | 1 |
| 9. | Discuss the concept of kinematic pair. | | CO5 | U | 1 |
| 10. | Explain the term: factor of safety. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Discuss about moment of a force. | | CO1 | U | 3 |
| 12. | Establish polar moment of area. | | CO2 | A | 3 |
| 13. | Illustrate the concept of relative motion of a body. | | CO3 | U | 3 |
| 14. | Interpret linear momentum with an illustration. | | CO4 | A | 3 |
| 15. | Illustrate the Kutzbach criteria. | | CO5 | U | 3 |
| 16. | Establish the factors to be considered for selection of materials. | | 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 types of supports and their reactions. | CO1 | An | 6 |
|  | b. | Appraise free body diagram with neat sketches. | CO1 | E | 6 |
|  |  |  |  |  |  |
| 18. | a. | Interpret the concept of equivalent system of forces with neat sketches. | CO1 | U | 6 |
|  | b. | Illustrate the resolution of forces with suitable examples. | CO1 | A | 6 |
|  |  |  |  |  |  |
| 19. | a. | Derive an expression of moment of inertia of a triangular section, about an axis passing through the C.G. of the section and parallel to the base. | CO2 | E | 12 |
|  |  |  |  |  |  |
| 20. | a. | Analyze the swinging of a simple pendulum using the D’Alembert‘s principle, with neat sketch. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 21. | a. | Describe the mechanism behind the braking of an automobile using the work energy principle. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 22. | a. | Construct the four bar chain mechanism and its inversions with neat sketches. | CO5 | C | 12 |
|  |  |  |  |  |  |
| 23. | a. | Formulate and derive an expression for the perpendicular axis theorem. | CO2 | C | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Discuss the basic procedure of machine design with suitable case study. | CO6 | U | 12 |

**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 | **-** | 11 | 6 | 6 | 6 | - | 29 |
| CO2 | **-** | **-** | 5 | - | 12 | 12 | 29 |
| CO3 | **-** | 5 | - | 12 | - | - | 17 |
| CO4 | **-** | 13 | 4 | - | - | - | 17 |
| CO5 | **-** | 4 | - | - | - | 12 | 16 |
| CO6 | **-** | 13 | 3 | - | - | - | 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. | Identify the characteristics of negative feedback in control system. | | CO1 | U | 1 |
| 2. | Define transfer function. | | CO1 | R | 1 |
| 3. | Name the test signals used in control system. | | CO2 | R | 1 |
| 4. | Sketch the response of a second order underdamped system. | | CO2 | U | 1 |
| 5. | Mention the advantages of state space modelling using physical variable. | | CO3 | R | 1 |
| 6. | List the basic elements used to construct the state diagram. | | CO3 | U | 1 |
| 7. | Give the frequency domain specifications. | | CO4 | R | 1 |
| 8. | State BIBO stability. | | CO5 | U | 1 |
| 9. | Define cut off rate. | | CO5 | U | 1 |
| 10. | Sketch the step response of a P and PI-controller. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Write the force balance equation of ideal dashpot element. | | CO1 | U | 3 |
| 12. | Describe about velocity error constant. | | CO2 | U | 3 |
| 13. | Define impulse signal. | | CO3 | U | 3 |
| 14. | Sketch the basic elements used to construct the block diagram of discrete time system. | | CO4 | U | 3 |
| 15. | Define gain margin. | | CO5 | U | 3 |
| 16. | List the advantages of PID controller. | | 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. | Differentiate open loop and closed loop control system with suitable examples. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 18. | a. | Apply Mason’s gain formula for determining the overall transfer function of the system shown in Fig1.  Fig1 | CO1 | A | 12 |
|  |  |  |  |  |  |
| 19. | a. | A unity feedback control system has an open loop transfer function G(s)=10/(s(s+2)) . Determine the rise time, Percentage overshoot, peak time and settling time for a step input. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 20. | a. | Calculate the state model of the electrical network shown below, by choosing minimal number of state variables. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 21. | a. | Sketch Bode plot for the following transfer function  .   1. Determine the gain cross over frequency 2. Determine the phase cross over frequency | CO4 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | Determine the stability of the system whose characteristic equation is given by   1. Comment on the location of the roots of characteristic equation. 2. Comment on the stability of the system. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 23. | a. | Enumerate the step by step procedure for design PID controller in frequency domain. | CO6 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | The open loop transfer function of a unity feedback control system is given by.   1. Sketch the polar plot 2. Determine the phase margin and gain 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 | 1 | 16 | 12 |  |  |  | 29 |
| CO2 | 1 | 4 | 12 |  |  |  | 17 |
| CO3 | 1 | 4 | 12 |  |  |  | 17 |
| CO4 | 1 | 3 | 24 |  |  |  | 28 |
| CO5 |  | 5 | 12 |  |  |  | 17 |
| CO6 | 3 | 13 |  |  |  |  | 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. | Define CMRR of an operational amplifier. | | CO1 | R | 1 |
| 2. | Design an amplifier with a gain of –20 and input resistance of 20k. | | CO1 | A | 1 |
| 3. | List the features of an instrumentation amplifier. | | CO2 | R | 1 |
| 4. | What are the advantages of active filter over passive filter? | | CO2 | R | 1 |
| 5. | Mention the applications of a current to voltage converter. | | CO3 | R | 1 |
| 6. | Draw the diagram for a peak detector circuit. | | CO3 | R | 1 |
| 7. | Choose the frequency and duty cycle for a 555 timer astable multivibrator with RA=10Kohm, RB= 5K ohm and C=0.01 µF. | | CO4 | A | 1 |
| 8. | Voltage Controlled Oscillator is called as voltage to frequency converterWhy? | | CO4 | R | 1 |
| 9. | Give the advantages of integrating type ADC. | | CO5 | U | 1 |
| 10. | Identify the issues sensor interfacing circuit in a Robotics systems. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Design an adder circuit using op-amp to get the output expression as  V0 = ( - 0.1V1 +2V2 + 3V3 ) . | | CO1 | A | 3 |
| 12. | Sketch the basic circuit using op amp to perform the mathematical operation of differentiation and explain. | | CO2 | U | 3 |
| 13. | Draw the circuit diagram of a positive clipper circuit with it’s relvant waveforms. | | CO3 | R | 3 |
| 14. | What is the function of a voltage regulator? | | CO4 | R | 3 |
| 15. | Draw the transfer characteristics of an ideal 4-bit A/D converter. | | CO5 | A | 3 |
| 16. | What do you meant by impedance matching? | | 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 non-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. | List various electrical characteristics of an ideal OP-amp. Draw and explain equivalent circuit of an OP-amp. | CO1 | U | 8 |
|  |  |  |  |  |  |
| 18. | a. | Draw an instrumentation amplifier whose gain is controlled by adjustable gain and explain its working concept. | 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 lkHz. Use capacitor value < lµF. | CO2 | A | 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. | What is a precision rectifier? With circuit schematic explain the working principle of full wave rectifier. | CO3 | U | 6 |
|  | b. | With the help of circuits and necessary equations, explain how logarithmic amplifier computations are performed using IC741 and derive an expression for the same. | CO3 | U | 6 |
|  |  |  |  |  |  |
| 21. | a. | With help of neat internal diagram explain the working of IC 555 as an astable multivibrator with mathematical analysis. | CO4 | U | 6 |
|  | b. | Explain the working principle of PLL. | CO4 | U | 6 |
|  |  |  |  |  |  |
| 22. | a. | Sketch the circuit diagram for the Wien bridge oscillator and derive an expression for the frequency of oscillation of the circuit. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 23. | a. | Discuss the binary weighted resistor and R-2R Ladder type methods for digital to analog converter techniques. | CO5 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | 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

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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 | 1 | 12 | 4 |  |  |  | 17 |
| CO2 | 2 | 27 | 4 |  |  |  | 33 |
| CO3 | 5 | 20 |  |  |  |  | 25 |
| CO4 | 4 | 12 | 1 |  |  |  | 17 |
| CO5 |  | 1 | 15 |  |  |  | 16 |
| CO6 | 4 | 12 |  |  |  |  | 16 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **21RO2004** | **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)**  **(Answer all the questions)** | | | | | |
| 1. | Determine the Manhattan norm of the vector x = (3,2,5) | | CO1 | U | 1 |
| 2. | Represent the point P(-1,0,3) in terms of unit vectors. | | CO1 | U | 1 |
| 3. | Express the general form of rotation matrix as a dot product of two unit vectors. | | CO1 | R | 1 |
| 4. | Write the vector P=3i – j + 2k in matrix form with a scaling factor of 2. | | CO2 | U | 1 |
| 5. | Specify the advantages of Denavit-Hartenberg representation of robot systems. | | CO3 | U | 1 |
| 6. | State the procedure to determine the arm equation of a robot. | | CO3 | R | 1 |
| 7. | Mention the significance of differential kinematics. | | CO4 | U | 1 |
| 8. | Define the term manipulator dexterity. | | CO4 | R | 1 |
| 9. | Differentiate Newtonian Mechanics and Lagrange Mechanics approaches of Robot Dynamics. | | CO5 | An | 1 |
| 10. | Indicate the features of a robot trajectory. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Prove that the inverse of the rotation matrix is equal to its transpose. | | CO1 | U | 3 |
| 12. | Differentiate forward and inverse kinematics of a robot manipulator. | | CO3 | An | 3 |
| 13. | List the DH parameters used in kinematic analysis of robots and define each parameter. | | CO3 | U | 3 |
| 14. | Outline the concept of resolved motion rate control. | | CO4 | U | 3 |
| 15. | Derive the force-acceleration relationship of a simple cart spring system using Lagrange mechanics. | | CO5 | A | 3 |
| 16. | Compare normalized and non-normalized methods of trajectory planning. | | 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. | A pair of co-ordinate frames A and B is initially coincident. Eventually, the frames B undergoes rotation by an angle φ about the y axis of the reference frame A. Represent the transformation using a vector diagram and derive the rotation transformation matrix for the given transformation. | CO1 | A | 6 |
|  | b. | A point p(1,2,1)T is attached to a rotating frame. The frame rotates 900 about the x-axis of the reference frame. Find the coordinates of the point relative to the reference frame after the rotation. | CO1 | A | 6 |
|  |  |  |  |  |  |
| 18. | a. | Derive the forward kinematic equations of a 2 link RR manipulator. | CO2 | A | 6 |
|  | b. | A frame B was moved along its own o-axis a distance of 6 units, then rotated about its n-axis an angle of 600, then translated about the z-axis for 3 units, followed by a rotation of 600 about the z-axis, and finally rotated about x-axis for 450. Calculate the total transformation performed. | CO2 | A | 6 |
|  |  |  |  |  |  |
| 19. | a. | Determine the DH parameters of the SCARA robot from the kinematic diagram given in Fig.1  30-base-kinematic-diagram-scara-robotJPG  Fig.1 | CO3 | A | 6 |
|  | b. | It is desired to place the origin of the hand frame of a cylindrical robot at [2,3,5]T . Calculate the joint variables of the robot. | CO3 | An | 6 |
|  |  |  |  |  |  |
| 20. | a. | Highlight the use of Jacobian matrix to analyse differential kinematics of a robot manipulator. | CO4 | An | 6 |
|  | b. | Comment on the Joint space singularity condition of a robot joint, types of singularity and the methods used to resolve the joint from its singularity state. | CO4 | An | 6 |
|  |  |  |  |  |  |
| 21. | a. | Derive the equation of motion of a 2 link planar manipulator with concentrated masses. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | Derive the forward and inverse kinematic equations of a 2 link RR manipulator. | CO2 | A | 6 |
|  | b. | The frame B whose position and orientation represented in the form of a matrix as given below is rotated 900 about the a-axis,  then translated 2 and 4 units relative to the x- and y-axes respectively, then rotated another 900 about the n-axis. Find the new location and orientation of the frame. | CO2 | A | 6 |
|  |  |  |  |  |  |
| 23. | a. | For the kinematic diagram shown in Fig.2, find the DH parameters.    Fig.2 | CO3 | A | 6 |
|  | b. | State the sequence of motions involved in the DH algorithm to transform one frame to the next. Write the general expression for the transformation matrix and hence derive the arm equation. | CO3 | U | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Compare the salient features of trajectory description using joint space and cartesian space coordinates. | CO6 | An | 6 |
|  | b. | It is desired to have the third joint of a 6-axis robot go from an initial angle of 200 to a final angle of 800 in 4 seconds. Calculate the coefficients for a third-order polynomial joint-space trajectory. The robot starts from rest but should have a final velocity of 50/sec | CO6 | An | 6 |

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

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the mathematical concepts of kinematics |
| 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 | 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 Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 5 | 12 | - | - | - | 18 |
| CO2 | - | 1 | 24 | - | - | - | 25 |
| CO3 | 1 | 10 | 12 | 9 | - | - | 32 |
| CO4 | 1 | 4 | - | 12 | - | - | 17 |
| CO5 | - | - | 15 | 1 | - | - | 16 |
| CO6 | - | 1 | - | 15 | - | - | 16 |
|  | | | | | | | **124** |



|  |  |  |  |
| --- | --- | --- | --- |
| **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)** | | | | | |
| 1. | Name the performance characteristic that indicates the maximum weight that can be handled by a robot. | | CO1 | U | 1 |
| 2. | Identify the gripper suitable for heavyweight objects. | | CO1 | U | 1 |
| 3. | Give an example of position sensors used in robotic systems. | | CO2 | U | 1 |
| 4. | Specify the type of actuator that is suitable for lifting heavy objects. | | CO2 | U | 1 |
| 5. | Name the gripper suitable for separating ferrous material. | | CO3 | U | 1 |
| 6. | Mention the sensors which are used in industrial applications. | | CO3 | R | 1 |
| 7. | Give an example of velocity sensors used in robotic systems. | | CO4 | U | 1 |
| 8. | Give an example of serial robots. | | CO4 | R | 1 |
| 9. | Classify degrees of freedom would the functional industrial robot have. | | CO5 | U | 1 |
| 10. | Distinguish the various coordinate systems used to represent the position and orientation of robot. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | State Asimov’s laws of Robotics. | | CO1 | U | 3 |
| 12. | Bring out the difference between internal and external state sensors | | CO2 | U | 3 |
| 13. | Write the properties of piezo-electric crystal. | | CO3 | R | 3 |
| 14. | A closed loop control system is the fundamental building block of an automation system. Justify. | | CO4 | U | 3 |
| 15. | Specify the significant features of collaborative robots. | | CO5 | R | 3 |
| 16. | Compare the three types of industrial automation. | | 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. | Specify the type of end effectors used in a robot and explain in detail about any one type of gripping mechanism with neat diagrams and explanation. | CO1 | An | 12 |
|  |  |  |  |  |  |
| 18. | a. | Explain position measurement in robotic applications with neat diagrams. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. | a. | With neat diagram briefly explain the working principle of acceleration sensor. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. | a. | Classify the types of industrial robots and elaborate upon their design aspects. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. | a. | Highlight the features of a house hold robotic systems and describe the technical aspects involved in these features. | CO5 | An | 12 |
|  |  |  |  |  |  |
| 22. | a. | Summarize the application of robots in the health care sector. | CO6 | An | 12 |
|  |  |  |  |  |  |
| 23. | a. | Describe the machine loading and unloading application of robot in any three production operations with their design features. | CO5 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Describe the application of robot in arc welding and state the technical considerations in arc- welding applications | CO6 | A | 12 |

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|  | **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 Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | - | 5 | - | 12 | - | - | 17 |
| CO2 | - | 5 | 12 | - | - | - | 17 |
| CO3 | 4 | 1 | 12 | - | - | - | 17 |
| CO4 | 1 | 4 | 12 | - | - | - | 17 |
| CO5 | 3 | 1 | 12 | 12 | - | - | 28 |
| CO6 | - | 4 | 12 | 12 | - | - | 28 |
|  | | | | | | | **124** |



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| **Course Code** | **21RO3001** | **Duration** | **3hrs** |
| **Course Name** | **INDUSTRIAL 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. | Explain various types of automation. | CO1 | U | 8 |
|  | b. | Write down the Common reasons for downtime on an Automated Production line. | CO1 | R | 8 |
|  |  |  |  |  |  |
| 2. | a. | A 20-station transfer line is divided into two stages of 10 stations each. The ideal cycle time of each stage is *Tc* = 1.2 min. All of the stations in the line have the same probability of stopping, p = 0.005. We assume that the downtime is constant when a breakdown occurs, *Td* = 8.0 min. Using the upper-bound approach, compute the line efficiency and the production rates for the following buffer capacities: (a) *b* = 0, (b) *b* =∞, (c) *b* = 10, (d) *b* = 100. | CO1 | An | 16 |
|  |  |  |  |  |  |
| 3. | a. | Explain the elements of the parts delivery system in detail with relevant diagrams. | CO2 | U | 16 |
|  |  |  |  |  |  |
| 4. | a. | The following list defines the precedence relationships and element times for a new model toy:      (a) Construct the precedence diagram for this job. (b) If the ideal cycle time is to be 1.0 min, what is the theoretical minimum number of stations required to minimize the balance delay? (c) Compute the balance delay. (d) Determine the assignment of work elements to stations using the Ranked positional weights method.  (e) How many stations are required? (f) Compute the balance delay | CO2 | An | 16 |
|  |  |  |  |  |  |
| 5. | a. | Explain the functions and components of Automated Guided Vehicles. Explain its types. | CO3 | U | 10 |
|  | b. | List out the objectives and benefits of Material Handling system. | CO3 | U | 6 |
|  |  |  |  |  |  |
| 6. | a. | Explain the components and Terminology used in Automatic Storage/Retrieval system. | CO4 | A | 8 |
|  | b. | Describe the Fixed Aisle storage system in detail. | CO4 | U | 8 |
|  |  |  |  |  |  |
| 7. | a. | Describe Automated Inspection Principles and Methods in detail. | CO5 | U | 10 |
|  | b. | Write down various Machine Vision methods used for Automated Inspection. | CO5 | A | 6 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Describe the working of Robotic Arm for pick and place of Light Objects in detail. | CO6 | A | 10 |
|  | b. | Explain the Conveyor system for transferring Granular Material with Weight control in detail. | CO6 | A | 10 |

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the basics of Industrial Automation |
| CO2 | Familiarize the concepts of Assembly systems and Line Balancing |
| CO3 | Explain the concepts of Material Handling systems |
| CO4 | Understand the in-depth concepts of Automated Storage and Retrieval System |
| CO5 | Apply the concept to automate the industrial inspection |
| CO6 | Create solutions to automate the industrial robotics |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 8 | 8 |  | 16 |  |  | 32 |
| CO2 |  | 16 |  | 16 |  |  | 32 |
| CO3 |  | 16 |  |  |  |  | 16 |
| CO4 |  | 8 | 8 |  |  |  | 16 |
| CO5 |  | 8 | 8 |  |  |  | 16 |
| CO6 |  |  | 20 |  |  |  | 20 |
|  | | | | | | | **132** |



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| **Course Code** | **21RO3002** | **Duration** | **3hrs** |
| **Course Name** | **MOBILE ROBOTICS** | **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. | Differentiate Internal and External sensing mechanisms in a mobile robot with relevant examples. | CO2 | R | 8 |
|  | b. | Briefly describe the process to calculate the degree of Maneuverability in different types of mobile robots. | CO1 | R | 8 |
|  |  |  |  |  |  |
| 2. | a. | Illustrate the wheel configurations in rolling vehicles and their applications with the relevant diagram. | CO1 | U | 8 |
|  | b. | Mention the significance of Kinematic Model in representing the robot position with appropriate equations. | CO1 | A | 8 |
|  |  |  |  |  |  |
| 3. | a. | Specify the factors that affect the use of GPS system in Mobile robot localization. | CO2 | R | 8 |
|  | b. | Explain the working principle of optical encoder and mention how the resolution can be improved in the encoder. | CO2 | R | 8 |
|  |  |  |  |  |  |
| 4. | a. | Describe the formula and process used to calculate the time of flight for an ultrasonic sensor in a specific distance measurement application. | CO2 | U | 8 |
|  | b. | Summarize the various methods used for feature extraction in vision system application of a mobile robot. | CO2 | U | 8 |
|  |  |  |  |  |  |
| 5. | a. | Outline the application of Induction motors in mobile robot locomotion highlighting the constructional features. | CO3 | R | 8 |
|  | b. | Design an actuation mechanism of mobile robot that operate at speed of 25 rps if a stepper motor with step angle of 2.5 degree is used for actuation. Determine the stepping frequency of stepper motor. | CO3 | R | 8 |
|  |  |  |  |  |  |
| 6. | a. | Apply grid mapping techniques to create a map for Figure 1, which represents an indoor environment with obstacles and open spaces.    Figure 1 | CO4 | A | 8 |
|  | b. | Demonstrate the use of the Kalman filter estimation algorithm in mobile robot localization. | CO4 | A | 8 |
|  |  |  |  |  |  |
| 7. | a. | Distinguish between Road Map Approach and Cell Decomposition Approach in Mobile Robot Path Planning. | CO5 | An | 16 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Classify the types of Societal Robots emphasizing the features corresponding to specific applications. | CO6 | U | 10 |
|  | b. | Sketch the functional components of a Telerobot and specify its applications in space research. | CO6 | U | 10 |

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

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Classify and describe the various types of Mobile Robots, kinematics and dynamic analysis |
| CO2 | Identify different sensor for mobile robots |
| CO3 | Describe the actuators of Robots |
| CO4 | Classify different localization and mapping of mobile robots |
| CO5 | Create solutions to plan and navigate the mobile robots using various techniques |
| CO6 | Apply the concept of mobile robots in various applications |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 8 | 8 | 8 | - | - | - | 24 |
| CO2 | 24 | 16 | - | - | - | - | 40 |
| CO3 | 16 | - | - | - | - | - | 16 |
| CO4 | - | - | 16 | - | - | - | 16 |
| CO5 | - | - | - | 16 | - | - | 16 |
| CO6 | - | 20 | - | - | - | - | 20 |
|  | | | | | | | **132** |



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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. | A phase diagram is a two dimensional plot representing …………… on vertical axis versus ……………….on horizontal axis  a) pressure, temperature b) volume, temperature c) stress, pressure  d) strain, pressure | | CO1 | U | 1 |
| 2. | Fick’s Second Law states that the prediction of change in concentration along with time due to…………  a) Diffusion b) Scattering c) Absorption d) Emission | | CO1 | R | 1 |
| 3. | Temperature-Time-Transformation diagram is also called as …………..transformation a) isothermal b) phase c) volume d) surface | | CO2 | U | 1 |
| 4. | Cite any one applications of Fick’s law from the following.  a) Pharmaceutics b) Food industries c) Fabrication of Semiconductors  d) All of the choices | | CO2 | R | 1 |
| 5. | Recall the material, which possesses good electrical properties is……….  a) Copper b) Glass c) Ceramics d) Mica | | CO3 | U | 1 |
| 6. | In electron beam machining, the essential constituents of the electron gun are cathode, …….and bias grid | | 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. | The type of material if the loop thickness is more based on hysteresis curve is called as …….. magnetic material. | | CO5 | U | 1 |
| 10. | The particles of size 10-9m are called as ……………. Materials  a) Micro b) Macro c) Nano d) Bulk | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Describe covalent bonding in solids with an example. | | CO1 | U | 3 |
| 12. | Illustrate ferrite phases and its properties from iron carbide diagram | | CO2 | U | 3 |
| 13. | Define the principle of electron beam machining and mention its uses. | | CO3 | A | 3 |
| 14. | Compare and contrast the terms stress and strain in solids. | | CO4 | A | 3 |
| 15. | Differentiate retentivity and coercivity in hysteresis curve. | | CO5 | An | 3 |
| 16. | Describe any three applications of liquid crystals 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 atomic bonds present in solid. | CO1 | U | 4 |
|  | b. | Explain 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 pearlite and austenite structures in iron-carbide phase diagram. | CO2 | U | 4 |
|  | b. | Illustrate 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 principle of electron beam machining system and its uses. | CO3 | U | 4 |
|  | b. | Explain the characteristics of electron beam machining system in detail with its schematic diagram and discuss its vacuum system in brief. | CO3 | A | 8 |
|  |  |  |  |  |  |
| 20. | a. | Distinguish the properties of elastic and plastic deformation in brief. | CO4 | An | 4 |
|  | b. | Illustrate the details involved in Vickers hardness test in analyzing the hardness of a given material with necessary diagram. | CO4 | An | 8 |
|  |  |  |  |  |  |
| 21. | a. | Appraise the term deformation in the analysis of hardness of materials. | CO4 | An | 4 |
|  | b. | Illustrate the soft and hard magnetic materials based on magnetization curve in detail along with its properties and application. | CO5 | An | 8 |
|  |  |  |  |  |  |
| 22. | a. | Describe polar and non-polar molecule in dielectrics with an example. | CO5 | U | 4 |
|  | b. | Illustrate 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 and lyotropic liquid crystal 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 any two standard data types in python | | CO1 | R | 1 |
| 2. | Write the syntax for print statement | | CO1 | R | 1 |
| 3. | Identify the operator used in the given code and write the output  >> 7//3 | | CO2 | An | 1 |
| 4. | Find the output of the following code  for x in range(2, 6):   print(x) | | CO2 | R | 1 |
| 5. | Identify the function used to read single line from file? | | CO3 | U | 1 |
| 6. | Name the command to list files in directory | | CO3 | R | 1 |
| 7. | Identify the function which returns largest value from a list of 10 numbers | | CO4 | U | 1 |
| 8. | Write the syntax for python function | | CO4 | U | 1 |
| 9. | What is Polymorphism in Python? | | CO5 | U | 1 |
| 10. | What is method overriding in python | | CO5 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | List the rules for python variables | | CO1 | U | 3 |
| 12. | Differentiate between: for loop and while loop | | CO2 | An | 3 |
| 13. | Explain how to create a dictionary in python? | | CO3 | U | 3 |
| 14. | Create a python function to check whether x is even or odd | | CO4 | C | 3 |
| 15. | Outline the importance of inheritance in python | | CO5 | U | 3 |
| 16. | What are the steps involved in programming hardware using 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 swap two variables | CO1 | A | 6 |
|  | b. | Outline python code to test whether a given year is leap year or not | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | Create python code to calculate the diameter, circumference, surface area and volume of a sphere | CO2 | C | 6 |
|  | b. | Summarize types of operators in python with appropriate example | CO2 | U | 6 |
|  |  |  |  |  |  |
| 19. | a. | Examine how to encrypt and decrypt strings in python. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 20. | a. | Illustrate basic list operations that can be performed in Python? | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. | a. | Explain how to define a function inside a Python class with example | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | Write a python program to reverse the given number. | CO2 | C | 6 |
|  | b. | Develop a python program which accepts the radius of a circle from the user and compute the area | CO2 | A | 6 |
|  |  |  |  |  |  |
| 23. | a. | Design the following pattern using Fibonacci series with python code  1  1 1  1 1 2  1 1 2 3  1 1 2 3 5  1 1 2 3 5 8 | CO4 | C | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Develop an algorithm for Pick and Place Robot with Micropython | 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** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 9 | 6 |  |  |  | 17 |
| CO2 | 1 | 6 | 6 | 4 |  | 12 | 29 |
| CO3 | 1 | 4 |  | 12 |  |  | 17 |
| CO4 |  | 14 |  |  |  | 15 | 29 |
| CO5 |  | 5 | 12 |  |  |  | 17 |
| CO6 |  | 3 | 12 |  |  |  | 15 |
|  | | | | | | | 124 |



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| --- | --- | --- | --- |
| **Course Code** | **22RO2001** | **Duration** | **3hrs** |
| **Course Name** | **ELECTRICAL CIRCUIT ANALYSIS** | **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. | State Kirchhoff’s current law. | | CO1 | R | 1 |
| 2. | Determine the resistance when an electric iron draws 2 A at 120 V. | | CO1 | A | 1 |
| 3. | Identify the theorem applicable for only linear network. | | CO2 | U | 1 |
| 4. | If a network contains B branches, and N nodes, evaluate the number of mesh current equations. | | CO2 | A | 1 |
| 5. | Write the expression for total power in a three phase system. | | CO3 | U | 1 |
| 6. | For a certain load, the true power is 150W and the reactive power is 125W. Determine the apparent power | | CO3 | A | 1 |
| 7. | Identify the inverse laplace transform of | | CO5 | U | 1 |
| 8. | State Initial Value theorem. | | CO5 | R | 1 |
| 9. | Calculate the period for 60Hz frequency. | | CO4 | A | 1 |
| 10. | For a two-port bilateral network, the three transmission parameters are given by A =6/5; B =17/5 and C =1/5, Calculate the value of D. | | CO6 | A | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Determine the voltage VAB across the resistor shown in fig. | | CO1 | A | 3 |
| 12. | Evaluate the equivalent current source for the given voltage source | | CO2 | AN | 3 |
| 13. | A three phase balanced star connected load has 400v line to line voltage and 10A line current. Calculate the line to neutral voltage and phase current. | | CO3 | A | 3 |
| 14. | In the circuit shown in Fig., a voltage of v (t) = 50 sin (w t +30°) is applied. Determine the true power. | | CO4 | A | 3 |
| 15. | List the advantages of Laplace transform. | | CO5 | U | 3 |
| 16. | Write the driving-point impedance at port 1 with port 2 open circuited for the network in Fig. | | 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. | Determine the mesh current I1 in the circuit. | CO1 | A | 6 |
|  | b. | Using the node voltage equations, determine the currents in each branch for the network. | CO1 | AN | 6 |
|  |  |  |  |  |  |
| 18. | a. | Evaluate the Thevenin’s equivalent circuit across ‘AB’ for the given circuit. | CO2 | AN | 8 |
|  | b. | In the circuit shown in Fig. determine the value of load resistance when the load resistance draws maximum power. | CO2 | A | 4 |
|  |  |  |  |  |  |
| 19. | a. | A series RC circuit consists of resistor of 10 Ω and capacitor of 0.1F as shown in Fig. A constant voltage of 20 V is applied to the circuit at t = 0. Obtain the current equation. Determine the voltages across the resistor and the capacitor. | CO3 | AN | 12 |
|  |  |  |  |  |  |
| 20. | a. | For the circuit shown in Fig. determine the current i(t) at any time t > 0.  The switch is closed at t = 0. | CO5 | A | 8 |
|  | b. | Determine the poles and zeros. | CO5 | A | 4 |
|  |  |  |  |  |  |
| 21. | a. | Analyze the average and effective values of the saw tooth waveform  shown in Fig. | CO4 | AN | 6 |
|  | b. | Determine the RMS value of the full wave rectified sine wave | CO4 | A | 6 |
|  |  |  |  |  |  |
| 22. | a. | For the circuit shown in Fig., evaluate the current equation when the switch S is opened at t = 0. | CO3 | AN | 12 |
|  |  |  |  |  |  |
| 23. | a. | Develop the dual network for the following | CO2 | A | 8 |
|  | b. | Develop the reciprocity theorem for the network | CO2 | C | AN |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Determine the transmission or general circuit parameters for the circuit. | CO6 | A | 12 |

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

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Identify the various circuit elements, and their characteristics. |
| CO2 | Analyze the circuits using KVL, KCL, Mesh and Nodal analysis techniques and theorems. |
| CO3 | Solve first order and second order differential equations to obtain the transient responses |
| CO4 | Describe fundamental concepts used in single phase, three phase AC circuits and coupled circuits. |
| CO5 | Apply Laplace transform techniques to examine the behavior of resonant circuits and tuned coupled circuits |
| CO6 | Derive the parameters of two port networks |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 |  | 10 | 6 |  |  | 17 |
| CO2 |  | 1 | 17 | 11 |  |  | 29 |
| CO3 |  | 1 | 16 | 12 |  |  | 29 |
| CO4 |  |  | 10 | 6 |  |  | 16 |
| CO5 | 1 | 4 | 12 |  |  |  | 17 |
| CO6 |  |  | 16 |  |  |  | 16 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **22RO2002** | **Duration** | **3hrs** |
| **Course Name** | **ELECTRICAL MACHINES AND DRIVES** | **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. | Explain the concept of cogging in three-phase induction motors. | | CO1 | U | 1 |
| 2. | The stator core of a 3-phase induction motor is laminated in order to reduce the \_\_\_\_\_\_\_\_\_\_\_\_\_. | | CO1 | R | 1 |
| 3. | Indicate the method used to control the speed of a dc motor below rated speed. | | CO2 | U | 1 |
| 4. | Write the formula to find the resolution of a stepper motor. | | CO2 | A | 1 |
| 5. | Summarize the damages caused due to the high starting current. | | CO3 | U | 1 |
| 6. | Identify a type of electrical braking use to stop a shunt motor. | | CO3 | U | 1 |
| 7. | Classify the electric drives based on the running speed. | | CO4 | An | 1 |
| 8. | Define an electric drive. | | CO4 | R | 1 |
| 9. | Define Inverter. | | CO5 | R | 1 |
| 10. | Describe Ward-Leonard Ilgener Scheme. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | State Fleming’s right hand rule. | | CO1 | R | 3 |
| 12. | The step angle of a stepper motor is 2 degrees. If the stepping frequency is 3600 pulses per second, find the shaft speed of the stepper motor. | | CO2 | A | 3 |
| 13. | Identify the methods employed to control the speed of a three phase induction motor from the rotor side. | | CO3 | U | 3 |
| 14. | Sketch the components of an electrical drive using a block diagram. | | CO4 | A | 3 |
| 15. | Classify the different types of inverters based on the output characteristics. | | CO5 | An | 3 |
| 16. | Define VSI. Sketch the block diagram of a voltage source inverter fed induction motor drive. | | 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. | Discuss the construction and working principle of the three types of stepper motors with a neat diagram. Also, indicate how the resolution of the stepper motor can be increased? | CO1 | U | 9 |
|  | b. | Explain the torque-speed characteristics of the stepper motor with a neat diagram. | CO2 | An | 3 |
|  |  |  |  |  |  |
| 18. | a. | A 3-phase Induction motor runs at almost 1200 rpm at no load and 1150 rpm at full load when supplied with power from a 50Hz, 3 -phase line. i) How many poles does the motor have?  ii) What is the percentage slip at full load?  iii) What is the corresponding frequency of the rotor voltage?  iv) At what speed will the rotor rotate at 10% slip?  v) What is the rotor frequency at this speed? | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. | a. | Brushless DC (BLDC) motors are popular due to their efficiency, precise control, and reliability. Write the applications of a BLDC motor in the field of robotics. | CO3 | A | 7 |
|  | b. | Write the potential applications of a permanent magnet synchronous motor in the field of Robotics. | CO3 | A | 5 |
|  |  |  |  |  |  |
| 20. | a. | Determine the types of motor class duty and explain with a neat diagram. | CO4 | A | 8 |
|  | b. | Analyze the factors that govern the selection of an electric drive for a particular application. | CO4 | An | 4 |
|  |  |  |  |  |  |
| 21. | a. | Discuss the basic structure and operation of a Current Source Inverter (CSI) employing R-Load and C-Load with a neat circuit diagram and graph. | CO5 | A | 6 |
|  | b. | Explain the basic structure and operation of a Silicon Controlled Rectifier (SCR) under three modes of operation with a neat diagram. | CO5 | A | 6 |
|  |  |  |  |  |  |
| 22. | a. | Compare a squirrel cage induction motor with a wound rotor induction motor. | CO1 | An | 12 |
|  |  |  |  |  |  |
| 23. | a. | Write the potential applications of a three-phase induction motor in the field of Robotics. | CO4 | A | 6 |
|  | b. | Explain the basic structure and operation of an IGBT with a neat diagram. | CO5 | A | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | What is slip power recovery scheme? Explain the two methods of speed control of a wound rotor induction motor by slip power recovery scheme with its applications. | CO6 | A | 6 |
|  | b. | Explain the working of a chopper fed DC motor drive with a neat circuit diagram. | CO6 | A | 6 |

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

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|  | **COURSE OUTCOMES** |
| CO1 | Explain the operating principles of DC and AC motors. |
| CO2 | Explain the various method of speed control of DC and AC motors. |
| CO3 | Describe the factors for selection of drive, various load patterns and determine their power rating. |
| CO4 | Discuss the working of various power semiconductor devices. |
| CO5 | Demonstrate the working of various power converters and inverters. |
| CO6 | Apply and Analyze the control of DC and AC motors with solid state power converters and inverters. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 4 | 10 | - | 12 | - | - | 26 |
| CO2 | - | 1 | 16 | 3 | - | - | 20 |
| CO3 | - | 5 | 12 | - | - | - | 17 |
| CO4 | 1 | 3 | 14 | 5 | - | - | 23 |
| CO5 | 1 | - | 18 | 3 | - | - | 22 |
| CO6 | - | 1 | 15 | - | - | - | 16 |
|  | | | | | | | **124** |



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| **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. | Mention the need for UiPath in RPA. | | CO1 | U | 1 |
| 2. | UiPath is the most preferred RPA tool in industry. Justify. | | CO1 | R | 1 |
| 3. | Mention the different properties in UiPath. | | CO2 | U | 1 |
| 4. | Enumerate the risks of RPA in terms of security. | | CO2 | R | 1 |
| 5. | Identify the need of anchor base activity. | | CO3 | U | 1 |
| 6. | List the skills to handle RPA operations. | | CO3 | U | 1 |
| 7. | Specify the significant features of data scraping. | | CO4 | U | 1 |
| 8. | Identify the reasons that lead to the failure of RPA projects. | | CO4 | R | 1 |
| 9. | Mention the port number of SMTP Gmail. | | CO5 | U | 1 |
| 10. | List the advantages of implementing each row in data table activity. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Mention the applications of RPA. | | CO1 | U | 3 |
| 12. | List the variables available in UiPath. | | CO2 | R | 3 |
| 13. | Differentiate between robotic process automation and chatbot. | | CO3 | U | 3 |
| 14. | Classify sequences and flowchart**.** | | CO4 | U | 3 |
| 15. | Examine the applications of input dialog box. | | CO5 | R | 3 |
| 16. | Enumerate the limitations of robotic process automation. | | 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 in detail the   1. Evolution of RPA. 2. Consumer willingness for automation. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 18. | a. | Describe the automation process flow of copying data from the browser and saving in notepad. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. | a. | Explain the automation of notepad using UiPath-Recording. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 20. | a. | Explain the process flow to determine even number using Uipath. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 21. | a. | Explain the addition of two numbers by passing variables and arguments. | CO3 | A | 6 |
|  | b. | Explain orchestrator in UiPath. | CO6 | U | 6 |
|  |  |  |  |  |  |
| 22. | a. | Discuss data-scraping automation using amazon.com and UiPath. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 23. | a. | Explain 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 | 13 | 12 | - | - | - | 29 |
| CO3 | - | 17 | 6 | - | - | - | 23 |
| CO4 | 1 | 4 | 12 | - | - | - | 17 |
| CO5 | 3 | 1 | 12 | - | - | - | 16 |
| CO6 | - | 10 | 12 | - | - | - | 22 |
|  | | | | | | | **124** |



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| **Course Code** | **23RO1001** | **Duration** | **3hrs** |
| **Course Name** | **PROGRAMMING IN C** | **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 logical operator || represents \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. | | CO1 | U | 1 |
| 2. | Predict the output of the program :  #include<stdio.h>  int main()  {  char a[] = "Programming";  printf ("%s\n", a);  return 0;  } | | CO1 | A | 1 |
| 3. | Predict the output of the program :  #include <stdio.h>  int main()  {  int a = 2;  a = --a;  printf ("\nThe value of a = %d ", a);  return 0;  } | | CO2 | A | 1 |
| 4. | Predict the output of the program :  #include<stdio.h>  int main()  {  int a;  for (a = 1;a <= 5;a++)  {  if (a == 4)  {  break;  }  printf ("%d ", a);  }  return 0;  } | | CO2 | A | 1 |
| 5. | Express the syntax of a one-dimensional array. | | CO3 | U | 1 |
| 6. | An array can be initialized in C programming during \_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_ time. | | CO3 | R | 1 |
| 7. | Give an example where the concept of an array can be used. | | CO4 | U | 1 |
| 8. | Name a type of sorting algorithm in C language. | | CO4 | R | 1 |
| 9. | Identify the keyword used to declare structure in C. | | CO5 | U | 1 |
| 10. | Express the syntax of malloc() function. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Outline the structure of a C program. | | CO1 | R | 3 |
| 12. | Draw the flowchart showing the operation of a Nested-if statement. | | CO2 | A | 3 |
| 13. | Indicate the four aspects of function calling in C programming. | | CO3 | U | 3 |
| 14. | Infer the steps involved in linear search algorithm. | | CO4 | U | 3 |
| 15. | Express the syntax of ‘structures’ in C. | | CO5 | U | 3 |
| 16. | Differentiate between static memory allocation and dynamic memory allocation. | | 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. | Discuss about types of error that can occur during the compilation and  execution of the program. | CO1 | U | 6 |
|  | b. | Write a C program to perform division and multiplication of two numbers. | CO1 | A | 6 |
|  |  |  |  |  |  |
| 18. | a. | Write a program to calculate the gross salary for the conditions given below:   |  |  |  |  | | --- | --- | --- | --- | | **Basic salary (Rs.)** | **DA (Rs.)** | **HRA (Rs.)** | **Conveyance (Rs.)** | | bs>=5000 | 10% of basic | 20% of basic | 500 | | bs>=3000 &&  bs<5000 | 100% of basic | 15% of basic | 400 | | bs<3000 | 90% of basic | 10% of basic | 300 | | CO2 | A | 7 |
|  | b. | Write a C program to find the factorial of the given number. | CO2 | A | 5 |
|  |  |  |  |  |  |
| 19. | a. | Write a C program to exhibit “Function with argument and with return value” aspect of function calling. | CO3 | A | 6 |
|  | b. | Write a C program to exhibit the three different aspects of a C function. | CO3 | A | 6 |
|  |  |  |  |  |  |
| 20. | a. | Write a program to subtract two matrices using multidimensional arrays. | CO4 | A | 6 |
|  | b. | Write a C program to perform the sum of all elements stored in an array. | CO4 | A | 6 |
|  |  |  |  |  |  |
| 21. | a. | Compare the array with structure in C. | CO5 | An | 5 |
|  | b. | Write C program to accept the details of employee and display them using structure. The details consist of Employee ID, Name, Designation, Department, Salary. | CO5 | A | 7 |
|  |  |  |  |  |  |
| 22. | a. | Write a C program for passing a parameter from one place of a program to another using ‘Call by Value’ function. | CO3 | A | 7 |
|  | b. | Explain the concept of ‘Bubble Sorting Algorithm’ with an example. | CO4 | U | 5 |
|  |  |  |  |  |  |
| 23. | a. | Write a program to print the result of a student as per the following condition: a student is declared pass if he scores 50 marks and above in all subjects (Take 3 subjects) and declared to be fail otherwise (use AND operator) | CO2 | A | 8 |
|  | b. | Write a program to demonstrate the usage of increment and decrement operators. | CO1 | A | 4 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Write a C program to allocate memory dynamically using calloc() function. | CO6 | A | 8 |
|  | b. | Write a Program using pointers in C to swap two numbers without using the 3rd variable. | CO6 | A | 4 |

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

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|  | **COURSE OUTCOMES** |
| CO1 | Develop simple programs by understanding the fundamentals of C programming language. |
| CO2 | Formulate innovative solutions for the problems using the concept of branching and looping. |
| CO3 | Analyze a problem and avoid rewriting the same logic repeatedly in a program using Functions. |
| CO4 | Evaluate complex data structures and algorithms effectively with arrays. |
| CO5 | Categorize different types of items into a single type using structures. |
| CO6 | Describe arrays and structures handling methods more efficiently using pointers. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 3 | 7 | 11 | - | - | - | 21 |
| CO2 | - | 1 | 24 | - | - | - | 25 |
| CO3 | 1 | 4 | 19 | - | - | - | 24 |
| CO4 | 1 | 9 | 12 | - | - | - | 22 |
| CO5 | - | 4 | 7 | 5 | - | - | 16 |
| CO6 | - | 1 | 12 | 3 | - | - | 16 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **23RO3001** | **Duration** | **3hrs** |
| **Course Name** | **ROBOTICS: SYSTEM AND ANALYSIS** | **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. | Specify the various phases of development in the field of robotics with relevant facts and examples. | CO1 | U | 8 |
|  | b. | The telescoping arm of an industrial robot obtains its vertical motion by rotating about its horizontal axis. The total range of rotation is 900. The robot possesses a 10 bit storage capacity for this axis. From the pivot point, the telescoping arm measures 50 inches when fully extended and 30 inches when fully retracted. Determine the robot’s control resolution for the axis (i) in degrees of rotation (ii) on a linear scale in both the fully extended and fully retracted position. | CO1 | E | 8 |
|  |  |  |  |  |  |
| 2. | a. | There are three frames A, B and C that are subjected to a transformation about the fixed frame. The transformation matrices are given below.  https://lh5.googleusercontent.com/a_KW_1kBg3GIzlNpIgQp7Jd9Lh8-vsAWvfuWQc_G1tSht3J1JRT9x1QGqFwAtbtnSAYfNDbFWfOOXLaloMY1kfm-_Ww_jiVjKTi44cTWSznCT0bl5tbOZY80ep8Snoe_3vYkLgQ2i315ISHHxLaceA https://lh4.googleusercontent.com/mF_yP5gZZAN__4WmiIXQUNvfLcwSPY2owE6DQ6384F8mby8xXJUKx4939-PShCFWHy2jq2ZsvK3AIyiuLaY1HDg6ZwJtjyQEa_re1Sy7nibJexxT8lQhU2wDi9U-yL2iFZsNVPd5Jx0aojFVm4jv0Q  Determine the transformation matrix   and thereby determine the position vector if the position vector | CO2 | A | 8 |
|  | b. | A frame B is rotated 900 about the z-axis, then translated 3 and 5 units relative to the n and o axes respectively, followed by rotation of 900 about the n-axis and finally translation of 5 units along the y axis. Find the new location and orientation of the frame. | CO2 | A | 8 |
|  |  |  |  |  |  |
| 3. | a. | Outline the sequence of transformations involved in the Denavit- Hartenberg Algorithm to transform one frame to the adjacent frame and hence determine the general expression for arm equation. | CO3 | An | 8 |
|  | b. | Determine the DH parameter table of the SCARA robot shown in Fig.1  https://lh4.googleusercontent.com/zZBXeYAKnKtBe4BaBC7v8lsWO5S9jK7pO4ME8k0FVHIUih9BlfCpJsZS-sBYqntMqYmuMREF-RMACS6-uLCq_MCiYvcgiTJP49Pn3E7ayHD2klrugrGBbcS69juF0eN-xQza4gw9qnzWod1sUaYimw  Fig.1 | CO3 | A | 8 |
|  |  |  |  |  |  |
| 4. | a. | Differentiate conventional kinematic analysis and differential kinematic approach in robot modeling and control and thereby comment on the use of Jacobian Matrix for differential kinematic analysis. | CO4 | An | 8 |
|  | b. | Outline the concept of joint space singularity condition in a robot, the types of singularity conditions and the methods to resolve the issue of singularity. | CO4 | An | 8 |
|  |  |  |  |  |  |
| 5. | a. | Determine the force –acceleration equation of a cart-spring system using (i) Newtonian Mechanics  (ii) Lagrange Mechanics  and compare the approach used in both the methods. | CO5 | An | 8 |
|  | b. | Derive the Lagrange function of the 2 link planar manipulator with concentrated masses. | CO5 | A | 8 |
|  |  |  |  |  |  |
| 6. | a. | With appropriate examples, illustrate the classification of robots based on the control mechanism employed. | CO1 | U | 8 |
|  | b. | Indicate the parameters that are used to quantify the performance of a robot with relevant diagrams and expressions. | CO1 | A | 8 |
|  |  |  |  |  |  |
| 7. | a. | Determine the Arm Equation of the manipulator whose frame sequence is as shown in Fig. 2  https://lh5.googleusercontent.com/6iQABfmHkJ5wxul31urXUSi-Pon2uOe7HLYB55ysa88X3AjqUvyjXlSX1gp_EeGfPvUaeWVIflmYjKM1ia3y2289ZvGbjIDdMI6waW4g9vFJ8V4J-oA4M8xnDUJe4PXOy-iLYRGZh9j_w1t0umNLGQ  Fig. 2 | CO3 | A | 8 |
|  | b. | Derive the forward kinematic equations of a 2 link RR Manipulator and thereby compute the cartesian coordinates for the end of the arm, given that the length of joints L1 = 15 in, L2 = 12 in, angles θ1 =600 and θ2 = 450 | CO2 | A | 8 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Compare joint space and cartesian space trajectory planning approaches. | CO6 | An | 10 |
|  | b. | It is desired to have the third joint of a 6-axis robot go from an initial angle of 200 to a final angle of 800 in 4 seconds. Calculate the coefficients for a third-order polynomial joint-space trajectory and determine the joint angles, velocities, and accelerations. The robot starts from rest but should have a final velocity of 5/sec. | CO6 | A | 10 |

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

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Compare the anatomy of robot configurations |
| CO2 | Analyze the representation of a point in space |
| CO3 | Solve forward and inverse kinematic problems |
| CO4 | Perform differential kinematic analysis using Jacobian matrix |
| CO5 | Determine the robot dynamic equations |
| CO6 | Develop path and trajectory planning applications |

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