**Graphical user interface, application

Description automatically generated with medium confidence**

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

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| **Q. No.** | **Questions** | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | |
| 1. | Design an amplifier with a gain of –10 and input resistance of 10k. | CO1 | A | 1 |
| 2. | Compare the performance of inverting and non- inverting operational amplifier configurations. | CO1 | A | 1 |
| 3. | List the features of an instrumentation amplifier | CO2 | R | 1 |
| 4. | Mention the applications of a current to voltage converter. | CO2 | A | 1 |
| 5. | How does a zero crossing detector circuit works? | CO3 | R | 1 |
| 6. | Draw the circuit diagram for a clamper circuit? | CO3 | U | 1 |
| 7. | Voltage Controlled Oscillator is called as voltage to frequency converter? Why? | CO4 | R | 1 |
| 8. | Choose the frequency and duty cycle for a 555 timer astable multivibrator with R1=10Kohm, R2= 5K ohm and C-0.01 µF. | CO4 | R | 1 |
| 9. | What is the largest value of output voltage from an 8 bit DAC that produces 1.0V for a digital input of 00110010? | CO5 | R | 1 |
| 10. | Draw a sample and hold circuit diagram. | CO6 | U | 1 |

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| **PART – B (6 X 3 = 18 MARKS)** | | | | |
| 11. | Calculate the maximum distorted amplitude that a sine wave input of 10 kHz, can produce at the output of an op-amp whose slew-rate is 0.5v/μsec. | CO1 | A | 3 |
| 12. | Sketch the basic circuit using op amp to perform the mathematical operation of Integrator and explain. | CO2 | A | 3 |
| 13. | Draw the circuit diagram for a triangular wave generator. | CO3 | U | 3 |
| 14. | Define lock in range and capture range? | CO4 | R | 3 |
| 15. | Find the number of resistances required for an 8 bit weighted DAC converter. Consider the smallest resistance is R and obtain those resistance values. | CO5 | R | 3 |
| 16. | Define resolution and conversion time of DAC. | CO6 | R | 3 |

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| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.no 17 to 23)** | | | | | | |
| 17. |  | Discuss the DC characteristics of an operational amplifier. | | CO1 | A | 12 |
|  |  |  | |  |  |  |
| 18. |  | Draw an instrumentation amplifier whose gain is controlled by adjustable gain and explain its working concept. | | CO2 | A | 12 |
|  |  |  | |  |  |  |
| 19. |  | Draw the circuit diagram of a second order Butterworth active Low Pass Filter and derive its transfer function. | | CO2 | An | 12 |
|  |  |  | |  |  |  |
| 20. |  | What is a precision rectifier? With circuit schematic explain the working principle of full wave rectifier. | | CO3 | R | 12 |
|  |  |  | |  |  |  |
| 21. |  | With a neat diagram explain the astable multivibrator using IC 741 and derive an expression for the frequency of oscillation with relevant waveforms. | | CO3 | U | 12 |
|  |  |  | |  |  |  |
| 22 |  | Explain the applications of Phase Locked Loop( PLL) for Amplitude Modulation(AM) detection, Frequency Shift Key(FSK) demodulation. | | CO4 | An | 12 |
|  |  |  | |  |  |  |
| 23. | a. | With a neat block diagram explain the working of R-2R method using digital to analogconverter(DAC) and state its merits and demerits.?. | | CO5 | U | 6 |
|  | b. | With a neat block diagram explain the flash type analog to digital converter (ADC) and state its merits and demerits. | | CO5 | U | 6 |
|  | **COMPULSORY QUESTION** | | | | | |
| 24. |  | | Discuss in detail about the grounding and shielding effects in strain gauge and thermocouple sensors. | CO6 | A | 12 |

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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 | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | - | - | 16 | 1 | - |  | 17 |
| CO2 | 1 | - | 16 | 12 | - | - | 29 |
| CO3 | 13 | 16 | - | - |  | - | 29 |
| CO4 | 5 |  | - | 12 | - | - | 17 |
| CO5 | 4 | 12 | - | - | - | - | 16 |
| CO6 | 3 | 1 | 12 | - | - | - | 16 |
|  | | | | | | | **124** |

**Graphical user interface, application

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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** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Specify the 6 degrees of freedom commonly present in an industrial manipulator. | | CO1 | R | 1 |
| 2. | Determine the control resolution of a robot manipulator that has a range of 800if the control memory has 10 bit capacity. | | CO1 | A | 1 |
| 3. | Identify the type of transformation represented by “T” in the Fig.1below.    Fig. 1 | | CO2 | U | 1 |
| 4. | Mention the characteristics of a non-holonomic robot. | | CO2 | R | 1 |
| 5. | List the factors that determine the speed of a robot. | | CO3 | R | 1 |
| 6. | Give the primary functions of robot vision system. | | CO3 | U | 1 |
| 7. | Outline the concept of boundary singularity in robot manipulator. | | CO4 | U | 1 |
| 8. | Relate the centripetal forces acting at a joint with the equations of motion of a robot. | | CO4 | U | 1 |
| 9. | Mention the two approaches of robot dynamic analysis. | | CO5 | R | 1 |
| 10. | Describe joint interpolated motion of a robot. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Differentiate serial and parallel manipulators with examples. | | CO1 | An | 3 |
| 12. | Find the resultant position is the vector P = 2i -4j + 3k, when it is rotated by an angle of 900 about the *y* axis of the reference frame. | | CO2 | A | 3 |
| 13. | Mention the need for structured illumination techniques for robot | | CO3 | An | 3 |
| 14. | Illustrate the concept of resolved motion rate control with relevant sketches. | | CO4 | A | 3 |
| 15. | Derive the force-acceleration relationship of the cart spring system shown in Fig.2. using Lagrange Mechanics.    Fig.2 | | CO5 | U | 3 |
| 16. | Highlight the difference between non-normalized and normalized movements of a 1 DoF robot in joint space description. | | CO6 | An | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. | a | Illustrate the performance characteristics of a robot with necessary examples and explanation. | CO1 | U | 6 |
|  | b | Classify robots based on the path control techniques adopted to manipulate the end effector with relevant diagrams. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | For the 2 link RR manipulator shown in Fig. 3 below, it is desired to determine the values to which the joint angles θ1 and θ2 must be set in order to attain the position specified by the coordinates x = 15.7 and y = 12.6. Given that the link length L1­ = 12 inches and L2 = 10 inches.    Fig. 3 | CO2 | An | 8 |
|  | b. | Write the general form of Homogeneous Transformation Matrix and indicate the significance of each component. | CO2 | R | 4 |
|  |  |  |  |  |  |
| 19. |  | Draw the building blocks of machine vision system and briefly discuss about the function of each block. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. |  | Mention the significance of Jacobian matrix for differential kinematic analysis and hence derive the Jacobian of 3R planar manipulator. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. |  | Determine the Lagrange function of the 2 DoF manipulator shown in Fig. 4 and hence derive the equations of motion.    Fig. 4 | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | It is required to design a robot that can be used to segregate and pick up objects of arbitrary shape from a table and place it inside specific boxes. What is the minimum number of degrees of freedom required? Sketch the complete system with the functional components. | CO1 | An | 4 |
|  | b. | Sketch the manipulator configuration of the following robots and specify their characteristics.   * Cartesian * Cylindrical * Spherical | CO1 | A | 8 |
|  |  |  |  |  |  |
| 23. | a. | Elaborate the steps to arrive at the Denavit-Hartenbergre presentation for forward kinematic analysis of robots. | CO2 | U | 6 |
|  | b. | Determine the DH parameters of the 2 axis articulated robotic arm shown in Fig. 5 below.    Fig. 5 | CO2 | A | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Elaborate the different modes of joint space description trajectory planning technique. | CO6 | U | 4 |
|  | 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 plot the joint angles, velocities, and accelerations. The robot starts from rest but should have a final velocity of 50/sec. | CO6 | A | 8 |

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

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 12 | 9 | 7 |  |  | 29 |
| CO2 | 5 | 7 | 9 | 8 |  |  | 29 |
| CO3 | 1 | 13 | - | 3 |  |  | 17 |
| CO4 |  | 14 | 3 |  |  |  | 17 |
| CO5 | 1 | 3 | 12 |  |  |  | 16 |
| CO6 |  | 5 | 8 | 3 |  |  | 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** | **Course Outcome / Bloom’s level** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | |
| 1. | Give the wavelength for visible light spectrum. | CO1/ R | 1 |
| 2. | Which shutter is preferred for capturing the image of a moving object? | CO1/A | 1 |
| 3. | \_\_\_\_\_\_\_\_\_\_\_ point processing technique is used in Magnetic Resonance Images. | CO2/A | 1 |
| 4. | The given equation is for \_\_\_\_\_\_\_\_\_\_ filtering. | CO2/R | 1 |
| 5. | \_\_\_\_\_\_\_\_\_\_\_\_\_ is used to separate a foreground object from its background. | CO3/A | 1 |
| 6. | \_\_\_\_\_\_\_\_\_ kernels are designed to detect edge magnitude and direction in all eight compass directions. | CO3/R | 1 |
| 7. | Under vertical rotation of an object, only the \_\_\_\_\_\_\_ x-coordinates are changed from view to view. | CO4/U | 1 |
| 8. | The alignment key is the information used to bring the viewed object and internal models into \_\_\_\_\_\_\_\_\_\_\_. | CO4/R | 1 |
| 9. | The two points P1 and P2 in two images representing the same point P in world coordinates are called \_\_\_\_\_\_\_\_\_\_\_\_\_\_. | CO5/R | 1 |
| 10. | A histogram with additional spatial information is called \_\_\_\_\_\_\_\_\_\_\_\_. | CO5/R | 1 |

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| **PART – B (6 X 3 = 18 MARKS)** | | | |
| 11. | Explain the components of the general purpose image processing system. | CO1/ R | 3 |
| 12. | Explain some gray level transformation functions. | CO2/R | 3 |
| 13. | Explain global thresholding with an example. | CO3/R | 3 |
| 14. | Briefly discuss the methods for recognition of objects with sharp edges. | CO4/U | 3 |
| 15. | Illustrate the Stereo Geometry of two cameras. | CO5/U | 3 |
| 16. | Explain the process of communication between two ROS nodes. | CO6/A | 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. | How is image formed in the eye? | CO1/U | 4 |
| b. | Explain any two sensor technologies used in cameras. | CO1/R | 4 |
| c. | Explain why a lens is required in an imaging system. | CO1/A | 4 |
|  |  |  |  |  |
| 18. | a. | Perform histogram Equalization and give new distribution of gray level. Show plots of histogram of original and equalized image.   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Gray levels** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | **No. of pixels** | 8 | 10 | 10 | 2 | 12 | 16 | 4 | 2 | | CO2/An | 6 |
| b. | Explain any one application of a smoothing filter. | CO2/A | 3 |
| c. | Give the transfer functions of a Butterworth low pass and high pass filter used for image smoothing and sharpening. | CO2/R | 3 |
|  |  |  |  |  |
| 19. | a. | Explain Region growing on the following image with seed point as 6 and threshold as 2.   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | 5 | 6 | 6 | 7 | 6 | 7 | 6 | 6 | | 6 | 7 | 6 | 7 | 5 | 5 | 4 | 7 | | 6 | 6 | 4 | 4 | 3 | 2 | 5 | 6 | | 5 | 4 | 5 | 4 | 2 | 3 | 4 | 6 | | 0 | 3 | 2 | 3 | 3 | 2 | 4 | 7 | | 0 | 0 | 0 | 0 | 2 | 2 | 5 | 6 | | 1 | 1 | 0 | 1 | 0 | 3 | 4 | 4 | | 1 | 0 | 1 | 0 | 2 | 3 | 5 | 4 | | CO3/A | 5 |
| b. | Draw 8 directional chain code and shape number for the image given below. | CO3/U | 4 |
| c. | Explain Canny Edge Detection. | CO3/R | 3 |
|  |  |  |  |  |
| 20. | a. | What are the main classes for approaches to object recognition? Briefly discuss any one of them. | CO4/R | 5 |
| b. | How can you use depth values to recognize an object? | CO4/U | 4 |
| c. | Is it possible to recognize an object with single view? If yes, under what conditions? | CO4/A | 3 |
|  |  |  |  |  |
| 21. | a. | Explain the process of Single Image Camera Calibration. | CO5/A | 5 |
| b. | Explain how K means clustering is used in learning landmarks. | CO5/U | 3 |
| c. | Show the epipolar geometry with epipolar plane, epipolar line and epipole and define them. | CO5/U | 4 |
|  |  |  |  |  |
| 22. | a. | Illustrate the method of image sharpening using Laplacian with the help of equation and kernel. | CO2/U | 5 |
| b. | Find D4 and D8 between pixels p & q, for the image segment given below with set of gray level values V= {2,3}.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | 2 **p** | 3 | 2 | 6 | 1 | | 6 | 2 | 3 | 6 | 2 | | 5 | 2 | 3 | 2 | 1 | | 5 | 6 | 2 | 3 | 1 | | 2 | 2 | 3 | 3 | 3 **q** | | CO2/A | 5 |
| c. | Mention any two applications of filtering in image processing. | CO2/R | 2 |
|  |  |  |  |  |
| 23. | a. | Compare Human eye with a Camera. | CO1/U | 4 |
| b. | Explain any two factors affecting the performance of a Camera. | CO1/U | 3 |
| c. | Derive the equation for Depth of Field. | CO1/An | 5 |
|  |  | **COMPULSORY** | | |
| 24. | a. | What are the three pillars of computer vision in ROS community? Mention their applications. | CO6/U | 4 |
| b. | How to use the cv\_bridge package to convert ROS to openCV image? | CO6/A | 5 |
| c. | Mention the simulators and visualization tools for robots in ROS. | CO6/R | 3 |

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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 Open CV for Robotic vision |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 8 | 11 | 5 | 5 | - | - | 29 |
| CO2 | 9 | 5 | 9 | 6 |  |  | 29 |
| CO3 | 7 | 4 | 6 | - | - | - | 17 |
| CO4 | 6 | 8 | 3 | - | - | - | 17 |
| CO5 | 2 | 10 | 5 | - | - | - | 17 |
| CO6 | 3 | 4 | 8 | - | - | - | 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** | | **Course Outcome** | **Bloom’s Level** | | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | Define the term automation. | | CO1 | R | | 1 |
| 2. | Identify the process of finding the replica of the original system in terms of mathematical equation. | | CO1 | R | | 1 |
| 3. | Mention any two mechanical components which are used for speed transmission in the motion control applications. | | CO2 | R | | 1 |
| 4. | List out any two applications of leadscrew. | | CO2 | R | | 1 |
| 5. | Name the rolling elements in the linear guideway. | | CO3 | R | | 1 |
| 6. | Give the unit for friction. | | CO3 | R | | 1 |
| 7. | Mention the maximum recommended weight for manual lifting. | | CO4 | R | | 1 |
| 8. | Sketch the basic diagram of floor hand truck. | | CO4 | R | | 1 |
| 9. | Give explanation of CEMA. | | CO5 | R | | 1 |
| 10. | Identify the equipment which is used to measure the weight of the transferred material. | | CO5 | R | | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | Draw the general scheme of hardware and software integration. | | CO1 | | U | 3 |
| 12. | Demonstrate the lifecycle of an electrical motor. | | CO2 | | U | 3 |
| 13. | Familiarize the concept of nominal life. | | CO3 | | U | 3 |
| 14. | Discuss the ergonomic principle of material handling. | | CO4 | | U | 3 |
| 15. | Write short notes on tripper. | | CO5 | | R | 3 |
| 16. | Explain the need of effective planning for automation system design. | | 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. |  | Describe the various applications of mechatronic system. | CO1 | | U | 12 |
|  |  |  |  | |  |  |
| 18. | a. | Demonstrate the concept of choosing the best motor for the motion control application. | CO2 | | U | 6 |
|  | b. | Illustrate the concept of selecting the mechanical components for the motion control applications. | CO2 | | U | 6 |
|  |  |  |  | |  |  |
| 19. | a. | Illustrate the concept of lubrication in linear guideways. | CO3 | | U | 6 |
|  | b. | Calculate the load on one block of LM guideways. | CO3 | | A | 6 |
|  |  |  |  | |  |  |
| 20. | a. | Illustrate the concept of ASRS in detail. | CO4 | | U | 6 |
|  | b. | Explain the working of different types of cranes which are used in Industries. | CO4 | | U | 6 |
|  |  |  |  | |  |  |
| 21. |  | Demonstrate on the construction and working of belt splices and shuttle belt conveyors in detail with necessary diagrams. | CO5 | | U | 12 |
|  |  |  |  | |  |  |
| 22. | a. | Illustrate the working procedure of training of belt on conveyor. | CO5 | | U | 6 |
|  | b. | Describe the procedure for the design of a belt conveyor. | CO5 | | U | 6 |
|  |  |  |  | |  |  |
| 23. |  | Demonstrate the necessity of material handling systems and explain the various principles of material handling in detail. | CO4 | | U | 12 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. |  | Illustrate the design and simulation of automated system using CIROS software. | 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 | 2 | 15 |  |  |  |  | 17 |
| CO2 | 2 | 15 |  |  |  |  | 17 |
| CO3 | 2 | 9 | 6 |  |  |  | 17 |
| CO4 | 2 | 27 |  |  |  |  | 29 |
| CO5 | 5 | 24 |  |  |  |  | 29 |
| CO6 |  | 15 |  |  |  |  | 15 |
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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** | | **Course Outcome** | **Bloom’s Level** | | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | The kinematic part of the robot or manipulator is called \_\_\_\_\_\_\_\_\_\_. | | CO1 | R | | 1 |
| 2. | Robot manipulators comprises combination of \_\_\_\_\_\_\_\_\_\_\_\_. | | CO1 | R | | 1 |
| 3. | Histogram Equalisation is used for \_\_\_\_\_\_\_\_\_\_ in Mobile Robot. | | CO1 | R | | 1 |
| 4. | The previous probabilities in Bayes theorem that are changed with the help of information are classified as \_\_\_\_\_\_\_\_. | | CO2 | R | | 1 |
| 5. | Behavior-based robotics work is based on \_\_\_\_\_\_\_\_\_\_. | | CO2 | U | | 1 |
| 6. | A car-like robot is subjected to non-holonomic constraint, which is \_\_\_\_\_\_\_\_\_\_\_\_. | | CO3 | U | | 1 |
| 7. | The method of Path Velocity Decomposition is used to solve \_\_\_\_\_\_\_\_\_. | | CO4 | U | | 1 |
| 8. | Heuristic function h(n) is \_\_\_\_\_\_\_\_. | | CO5 | R | | 1 |
| 9. | Mention the sensors used in tactile sensing. | | CO5 | U | | 1 |
| 10. | List the applications of Legged Locomotion. | | CO6 | U | | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | Define Workspace. | | CO1 | | R | 3 |
| 12. | Write the Kinematic models and constraints. | | CO2 | | U | 3 |
| 13. | Define SLAM. | | CO3 | | U | 3 |
| 14. | Mention the framework in Bayes Filter. | | CO4 | | A | 3 |
| 15. | Define Local Path Planning. | | CO5 | | U | 3 |
| 16. | Write Short note on Wheeled Locomotion. | | 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. |  | Illustrate in detail on the various types of field and service robots. | CO1 | | R | 12 |
|  |  |  |  | |  |  |
| 18. |  | Describe in detail the history of service robots in detail. | CO2 | | A | 12 |
|  |  |  |  | |  |  |
| 19. |  | Explain in detail the mobile robot localization. | CO3 | | An | 12 |
|  |  |  |  | |  |  |
| 20. |  | Describe in detail the Indoor Positioning system. | CO3 | | E | 12 |
|  |  |  |  | |  |  |
| 21. |  | Summarize the following in detail.  a. Grid Map.  b. Metrical Map. | CO4 | | U | 12 |
|  |  |  |  | |  |  |
| 22. |  | Explain in detail the Monte-Carlo Localization. | CO4 | | U | 12 |
|  |  |  |  | |  |  |
| 23. |  | Describe the A\* Algorithm with neat diagram. | CO5 | | U | 12 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. |  | Explain in detail on touch, sound and vision sensors in Field Robots. | CO6 | | C | 12 |

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the applications and current trend in field and service robot. |
| CO2 | Explain 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 Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 18 | - | - | - | - | - | 18 |
| CO2 | 1 | 4 | 12 | - | - | - | 17 |
| CO3 | - | 4 | - | 12 | 12 | - | 28 |
| CO4 | - | 25 | 3 | - | - | - | 28 |
| CO5 | 1 | 4 | - | 12 | - | - | 17 |
| CO6 | - | 16 | - | - | - | - | 16 |
|  | | | | | | | **124** |

**Graphical user interface, application

Description automatically generated with medium confidence**

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

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| **Q. No.** | **Questions** | | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | The material which is more resistant to high temperatures and harsh environments is \_\_\_\_\_\_\_\_\_\_\_\_\_. | | | CO1 | R | 1 |
| 2. | Unit cell of polyethylene has \_\_\_\_\_\_\_\_\_\_\_\_\_ geometry. | | | CO1 | U | 1 |
| 3. | The elements or compounds present in an alloy are known as \_\_\_\_\_\_\_\_\_\_\_\_\_. | | | CO2 | U | 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 | R | 1 |
| 6. | Fermi–Dirac statistics describe distribution of particles over energy states in systems consisting of many identical particles that obey the \_\_\_\_\_\_\_\_\_\_\_\_\_. | | | CO3 | U | 1 |
| 7. | \_\_\_\_\_\_\_\_\_\_\_\_\_ in non-crystalline solids and liquids occurs by a viscous flow mechanism. | | | CO4 | U | 1 |
| 8. | A material that experiences very little or no plastic deformation upon fracture is named as \_\_\_\_\_\_\_\_\_\_\_\_\_. | | | CO4 | R | 1 |
| 9. | Debye Langevin equation is given by \_\_\_\_\_\_\_\_\_\_\_\_\_. | | | CO5 | R | 1 |
| 10. | \_\_\_\_\_\_\_\_\_\_\_\_\_ is an example of Bio-mimetic materials.. | | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | Explain in short the simple crystal structures found in most of the common metals. | | | CO1 | A | 3 |
| 12. | Compare vacancy diffusion with interstitial diffusion. | | | CO2 | An | 3 |
| 13. | Explain Bloch Walls. | | | CO3 | A | 3 |
| 14. | Write a short note on the techniques used to increase the fatigue life. | | | CO4 | A | 3 |
| 15. | Discuss the effect of frequency on dielectric polarization. | | | CO5 | An | 3 |
| 16. | List the types of liquid crystals and applications. | | | 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 Secondary Bonding or Van Der Waals Bonding with a neat sketch of their bonding structure. | CO1 | | An | 6 |
|  | b. | Write a short note on the ionic bonding found in compounds that are composed of both metallic and non-metallic element. | CO1 | | A | 6 |
| 18. | a. | Discuss in detail the Martensite transformation in Steel. | CO2 | | A | 6 |
|  | b. | Explain the effects of alloying elements on Fe-C system. | CO2 | | An | 6 |
| 19. | a. | Explicate the working principle and construction of Electron gun with a neat sketch. | CO3 | | A | 6 |
|  | b. | Describe the different types of unique and conventional Electrical discharge machining process. | CO3 | | An | 6 |
| 20. | a. | Illustrate the Brinell hardness test method used to test materials that have a coarse or rough structure with a neat diagram. | CO4 | | A | 6 |
|  | b. | Discuss in detail the Griffith’s criterion for propagation of crack into a brittle fracture. | CO4 | | An | 6 |
| 21. | a. | Point out the types of Ferroelectric materials with their advantages and applications | CO5 | | A | 6 |
|  | b. | Explain in detail the concept of Super conductivity. | CO5 | | A | 6 |
| 22. | a. | Write short notes on Multiferroic materials. | CO6 | | A | 6 |
|  | b. | Define composite materials and explain the different types of composite materials with their applications. | CO6 | | A | 6 |
| 23. | a. | Classify the materials used in high technology applications. | CO1 | | A | 6 |
|  | b. | Recall how Bainite transformation begins in eutectoid steel with the TTT diagram. | CO2 | | An | 6 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. | a. | Explain the nanophase materials and mention the various types of nanophase materials with their applications. | CO6 | | A | 6 |
|  | b. | Describe any one method of fabricating composite materials. | CO6 | | A | 6 |

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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 Level** | | | | | | | | |
| CO / P | | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | | 1 | 1 | 15 | 6 | - | - | 23 |
| CO2 | | 1 | 1 | 6 | 15 | - | - | 23 |
| CO3 | | 1 | 1 | 9 | 6 | - | - | 17 |
| CO4 | | 1 | 1 | 9 | 6 | - | - | 17 |
| CO5 | | 1 | - | 12 | 3 | - | - | 16 |
| CO6 | | 1 | - | 27 | - | - | - | 28 |
|  | | | | | | | | **124** |

**Graphical user interface, application

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

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | Name the important tool in the drilling machine. | | CO1 | R | | 1 |
| 2. | Expand LabVIEW. | | CO1 | R | | 1 |
| 3. | Indicate the specific operation of boring. | | CO2 | R | | 1 |
| 4. | Expand PCB. | | CO2 | R | | 1 |
| 5. | State the material used for processing the etching solution. | | CO3 | R | | 1 |
| 6. | Identify any one PCB design software. | | CO3 | R | | 1 |
| 7. | Name the single device to find resistance, voltage, current. | | CO4 | R | | 1 |
| 8. | Mention the type of steel used for making scriber. | | CO4 | R | | 1 |
| 9. | Interpret the term condition terminal in for loop. | | CO5 | R | | 1 |
| 10. | Identify any one application of robotics in healthcare industry. | | CO5 | R | | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | Write short notes on carpentry. | | CO1 | | U | 3 |
| 12. | Mention the use of Vernier calipers in fitting shop. | | CO2 | | U | 3 |
| 13. | Interpret the term drilling. | | CO3 | | U | 3 |
| 14. | Sketch the while loop of LabVIEW software. | | CO4 | | U | 3 |
| 15. | Write short notes on measurement. | | CO5 | | R | 3 |
| 16. | Discuss on the application of automation in healthcare industries. | | 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. |  | Describe the construction and working of various carpentry tools with necessary diagrams. | CO1 | | U | 12 |
|  |  |  |  | |  |  |
| 18. |  | Demonstrate the operations of fitting process in detail with necessary diagrams. | CO1 | | U | 12 |
|  |  |  |  | |  |  |
| 19. | a. | Explain the working of types of drilling machine in detail with necessary diagrams. | CO2 | | U | 8 |
|  | b. | Illustrate the concepts of the drill types. | CO2 | | U | 4 |
|  |  |  |  | |  |  |
| 20. |  | Describe the various elements in the block diagram of the Virtual Instrumentation software. | CO3 | | U | 12 |
|  |  |  |  | |  |  |
| 21. |  | Illustrate the working of digital storage oscilloscope with necessary diagrams. | CO4 | | U | 12 |
|  |  |  |  | |  |  |
| 22. |  | Create a virtual instrument to simulate the traffic signal control application. | CO5 | | U | 12 |
|  |  |  |  | |  |  |
| 23. |  | With necessary diagrams, explain the procedure for PCB etching process. | CO6 | | U | 12 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. | a. | Demonstrate the PCB designing procedure using a designing software. | CO6 | | U | 6 |
|  | b. | Illustrate the importance of PCB boards in the healthcare projects. | CO6 | | U | 6 |

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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 | 2 | 27 |  |  |  |  | 29 |
| CO2 | 2 | 15 |  |  |  |  | 17 |
| CO3 | 2 | 15 |  |  |  |  | 17 |
| CO4 | 2 | 15 |  |  |  |  | 17 |
| CO5 | 5 | 12 |  |  |  |  | 17 |
| CO6 |  | 27 |  |  |  |  | 27 |
|  | | | | | | | **124** |

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

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Give one example for G-code in part program. | | CO1 | U | 1 |
| 2. | The purpose of an encoder in a CNC lathe machine is \_\_\_\_\_\_\_\_\_\_\_. | | CO1 | U | 1 |
| 3. | List out few functions of PLC. | | CO2 | R | 1 |
| 4. | Name the components of PLC controller. | | CO2 | R | 1 |
| 5. | State the frictional force. | | CO3 | U | 1 |
| 6. | The function of a relay is \_\_\_\_\_\_\_\_\_. | | CO4 | R | 1 |
| 7. | Draw the circuit for miniature circuit breaker. | | CO4 | U | 1 |
| 8. | CAPP stands for \_\_\_\_\_\_\_\_\_\_\_. | | CO5 | R | 1 |
| 9. | The use of G03 code is \_\_\_\_\_\_\_\_\_\_\_\_\_. | | CO5 | U | 1 |
| 10. | State the machining cost. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Analyze the merits of CNC machines over NC machine tools. | | CO1 | A | 3 |
| 12. | List out the use of controllers of CNC machines. | | CO2 | U | 3 |
| 13. | Tabulate the differences between AC and DC motors. | | CO3 | An | 3 |
| 14. | Discuss the differences between circuit breakers and Isolators. | | CO4 | An | 3 |
| 15. | Elaborate the use of is cutter compensation in CNC machine programming. | | CO5 | A | 3 |
| 16. | Discuss the three major heading 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. | List out the merits, demerits and applications of a CNC machine tool. | CO1 | U | 6 |
|  | b. | Describe the working of CNC Milling with a neat diagram. | CO1 | A | 6 |
|  |  |  |  |  |  |
| 18. | a. | Elaborate the important features and the principle of operation of a CNC machine tool. | CO2 | An | 6 |
|  | b. | Discuss the principle of operation of an automatic tool changer. | CO2 | U | 6 |
|  |  |  |  |  |  |
| 19. | a. | Describe the working principle of AC motor with neat diagram with one industrial application. | CO3 | A | 6 |
|  | b. | Discuss the working of PM type stepper motor. | CO3 | A | 6 |
|  |  |  |  |  |  |
| 20. | a. | Illustrate the following with neat sketches: MCB, MCCB, RCCB, ELCB. | CO4 | U | 8 |
|  | b. | Discuss the control relays used in a CNC machine, explain it’s working with a neat sketch? | CO4 | A | 4 |
|  |  |  |  |  |  |
| 21. | a. | Illustrate G84 Threaded Canned Cycle. | CO5 | An | 2 |
|  | b. | For the following part geometry:   1. Define the points in absolute and incremental coordinate systems. 2. Write the part program for the geometry.   To prepare a CNC part program to mill the component as per the drawing.  Assume thickness = 20mm | CO5 | E | 10 |
|  |  |  |  |  |  |
| 22. | a. | Name few functions of preventive maintenance of CNC machines. | CO6 | R | 4 |
|  | b. | Discuss the practical aspects to consider during the introduction of CNC. | CO6 | An | 4 |
|  | c. | Discuss the benefits of properly installed earthing for CNC machines. | CO6 | A | 4 |
|  |  |  |  |  |  |
| 23. | a. | State the machining cost and the costs involved in carrying out a machining operation. | CO6 | U | 6 |
|  | b. | Describe the prominent factors involved in the economics of CNC machine tools. | CO6 | A | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Describe the working of potentiometer in CNC machines with neat diagram. | CO4 | An | 4 |
|  | b. | Illustrate the working of Capacitive and Inductive type proximity sensors with neat sketches. | CO4 | An | 8 |

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

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

**Graphical user interface, application

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

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| **Q. No.** | **Questions** | | | **Course Outcome** | **Bloom’s Level** | | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | | |
| 1. | The breaking valves are actuated and turned on and off through \_\_\_\_\_\_\_\_\_\_\_. | | | CO1 | U | | 1 |
| 2. | The fuel supply of the engine in the engine management system is controlled by \_\_\_\_\_. | | | CO1 | R | | 1 |
| 3. | Kalman Filter Developed in the year \_\_\_\_\_\_\_\_\_\_\_ | | | CO2 | R | | 1 |
| 4. | Give the accuracy of GPS system. | | | CO2 | R | | 1 |
| 5. | The half engine is fitted inside the driver's cabin and remaining in the front of the driver's Cabin is known as \_\_\_\_\_\_\_, | | | CO3 | U | | 1 |
| 6. | Derivative controller takes the actions based on \_\_\_\_\_\_\_ Error of the system. | | | CO3 | R | | 1 |
| 7. | In Airbag system, an electric current heat the filament which ignites the capsule containing \_\_\_\_\_. | | | CO4 | U | | 1 |
| 8. | The skidding of vehicles, while sudden brakes are applied, is avoided through \_\_\_\_\_\_. | | | CO4 | R | | 1 |
| 9. | As of May 2017, \_\_\_\_\_\_\_\_\_\_ car and car parts manufacturers have announced that they are working to develop autonomous cars. | | | CO5 | U | | 1 |
| 10. | System processor works as a central intelligence system in a autonomous system. True/False. | | | CO6 | U | | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | | |
| 11. | Mention the Entertainment services available in Car. | | | CO1 | | An | 3 |
| 12. | Mention the applications of LIN protocol. | | | CO2 | | U | 3 |
| 13. | Write the Components of Machine Vision System. | | | CO3 | | An | 3 |
| 14. | Define DSRC. | | | CO4 | | U | 3 |
| 15. | List the levels of automation in autonomous vehicle. | | | CO5 | | An | 3 |
| 16. | List the ethics as an Engineering Challenge. | | | 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. | |  | Briefly discuss the operation of Electronic Control Unit. | CO1 | | R | 12 |
|  | |  |  |  | |  |  |
| 18. | |  | Explain the working of RADAR with an Adaptive Cruise Control Interfaces. | CO2 | | U | 12 |
|  | |  |  |  | |  |  |
| 19. | |  | Discuss the Neural network architectures with its method to classify the Image. | CO3 | | A | 12 |
|  | |  |  |  | |  |  |
| 20. | |  | Explain in detail the Vehicle to vehicle, Vehicle to Infrastructure and Vehicle to Road-side. | CO4 | | An | 12 |
|  | |  |  |  | |  |  |
| 21. | |  | Discuss in detail the Model Predictive Controller. | CO3 | | E | 12 |
|  | |  |  |  | |  |  |
| 22. | |  | Discuss in detail the operation of Airbag system with a neat diagram. | CO3 | | C | 12 |
|  | |  |  |  | |  |  |
| 23. | |  | Discuss the different methods used in Advanced Driver Assistance Systems to maximize the driver safety. | CO5 | | C | 12 |
| **COMPULSORY QUESTION** | | | | | | | |
| 24. | |  | Summarize the challenges in AV in the aspects of Technical, Security and Legal issues. | CO6 | | E | 12 |

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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 Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 13 | 1 | - | 3 | - | - | 17 |
| CO2 | 2 | 15 | - | - | - | - | 17 |
| CO3 | 1 | 1 | 12 | 3 | 12 | 12 | 41 |
| CO4 | 1 | 4 | - | 12 | - | - | 17 |
| CO5 | - | 1 | - | 3 | - | 12 | 16 |
| CO6 | - | 4 | - | - | 12 | - | 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** | **Course Outcome**  **/ Bloom’s level** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | |
| 1. | List the main types of medical robots. | CO1 / R | 1 |
| 2. | Specify the characteristics of medical robots. | CO1 / U | 1 |
| 3. | What are the control modes used in robotic surgery? | CO2 / R | 1 |
| 4. | State the requirements of position sensor. | CO2 / U | 1 |
| 5. | Write the principle of in-bore MRI tracking system. | CO3 / U | 1 |
| 6. | What are the components of Da Vinci system robotic tele surgery? | CO3 / R | 1 |
| 7. | Mention four types of brain-machine interface (BMI). | CO4 / R | 1 |
| 8. | How the neurosurgeon controls the position of the needle tip? | CO4 / U | 1 |
| 9. | Classify the types of assistive robots. | CO5 / R | 1 |
| 10. | What is assistive robots? | CO5 / R | 1 |

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| **PART – B (6 X 3 = 18 MARKS)** | | | |
| 11. | Write short notes on motion replication. | CO1 / U | 3 |
| 12. | Summarize the sound based MRI system. | CO2 / R | 3 |
| 13. | Outline the steps for stereotaxic navigation in neurosurgery. | CO3 / R | 3 |
| 14. | Show, how Parkinson’s disease can be treated with deep brain stimulation? | CO4 / U | 3 |
| 15. | Discuss the importance of assistive robots in health care. | CO5 / A | 3 |
| 16. | Write down the security issues in medical robots. | CO6 / U | 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. | The input data for reconstruction and the projection image is shown in the Fig.1. Compute a gray level for each voxel using Algebraic Reconstruction Technique Algorithm.    Fig.1 | CO1/An | 12 |
|  |  |  |  |  |
| 18. | a. | Explain the fiber optic tracking systems. | CO2 / A | 5 |
| b. | Discuss about GPS and hybrid based system used in localization and  navigation. | CO2 / A | 7 |
|  |  |  |  |  |
| 19 | a. | Explain the five-joint kinematics for a LINAC radiosurgery system. | CO3 / U | 12 |
|  |  |  |  |  |
| 20. | a. | Discuss any one case study in robotic endoscope support system. | CO5 / A | 12 |
|  |  |  |  |  |
| 21. | a. | With an example, explain robotics in rehabilitation. | CO4 / U | 5 |
| b. | Illustrate, how patients can control robotic hand-arm prostheses using the  procedure ‘Targeted Muscle Re-Innervation’ (TMR) | CO4 / A | 7 |
|  |  |  |  |  |
| 22. | a. | Describe the difference between radiologic navigation and stereotaxic  navigation | CO1 / U | 6 |
| b. | Explain the principle of proton-therapy robot. | CO2 / U | 6 |
|  |  |  |  |  |
| 23. | a. | Explain the maze procedure for treating atrial fibrillation in cardiac  surgery. | CO3 / An | 12 |
|  |  | **Compulsory:** | | |
| 24. | a. | Explain the kinematic architectures with a remote center of motion. | CO6 / A | 6 |
| b. | Discuss the choice of actuators and sensors in designing medical robots. | CO6 / U | 6 |

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|  | **COURSE OUTCOMES** | | | | | | | | |
| CO1 | Describe the types of medical robots and the concepts of navigation and motion replication. | | | | | | | | |
| CO2 | Discuss about the sensors used for localization and tracking | | | | | | | | |
| CO3 | Summarize the applications of surgical robotics | | | | | | | | |
| CO4 | Outline the concepts in Rehabilitation of limbs and brain machine interface | | | | | | | | |
| CO5 | Classify the types of assistive robots. | | | | | | | | |
| CO6 | Analyze the design characteristics, methodology and technological choices for medical robots. | | | | | | | | |
| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | | |
| CO / P | | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | | 1 | 10 | - | 12 | - | - | 23 |
| CO2 | | 4 | 7 | 12 | - | - | - | 23 |
| CO3 | | 16 | 1 | - | 12 | - | - | 29 |
| CO4 | | 6 | 4 | 7 | - | - | - | 17 |
| CO5 | | 2 | - | 15 | - | - | - | 17 |
| CO6 | | - | 9 | 6 | - | - | - | 15 |
|  | | | | | | | | **124** |

**Graphical user interface, application

Description automatically generated with medium confidence**

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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** | | **Course Outcome** | **Bloom’s Level** | | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | What do you mean by a well–posed learning problem? | | CO1 | U | | 1 |
| 2. | Brief the following: (i) Joint probability (ii) Conditional probability. | | CO1 | R | | 1 |
| 3. | What are tree based classifiers? | | CO2 | R | | 1 |
| 4. | Why is the KNN Algorithm known as Lazy Learner? | | CO2 | R | | 1 |
| 5. | How can a decision tree can be pruned? | | CO3 | U | | 1 |
| 6. | Define prior probability in Naïve Bayesian Classifier. | | CO3 | R | | 1 |
| 7. | Write down the formulas for Manhattan distance and Euclidean distance. | | CO4 | U | | 1 |
| 8. | List the different methods of Hierarchical Clustering. | | CO4 | R | | 1 |
| 9. | Point out the significance of various activation functions with  Mathematical equations. | | CO5 | U | | 1 |
| 10. | Define Hebbian Learning rule. | | CO6 | U | | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | Summarize the differences between the machine learning and Big Data. | | CO1 | | R | 3 |
| 12. | Suppose 10000 patients get tested for flu; out of them, 9000 are actually healthy and 1000 are actually sick. For the sick people, a test was positive for 620 and negative for 380. For the healthy people, the same test was positive for 180 and negative for 8820. Construct a confusion matrix for the data and compute the accuracy, sensitivity and specificity for the data. | | CO2 | | U | 3 |
| 13. | Elaborate the linear regression model with an example. | | CO3 | | An | 3 |
| 14. | Outline the similarities and differences between hierarchical clustering and agglomerative clustering. | | CO4 | | U | 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 | | An | 3 |
| 16. | Explain the bias variance tradeoff with an example. | | CO6 | | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | | |
| 17. | a. | Define machine learning. Mention its application in various fields. | CO1 | | U | 8 |
|  | b. | Distinguish supervised learning and Unsupervised learning. Illustrate with an example. | CO1 | | U | 4 |
|  |  |  |  | |  |  |
| 18. | a. | The decision on whether tennis can be played or not is based on the following features: Outlook E {Sunny, Overcast, Rain}, Temperature E {Hot, Mild, Cool}, Humidity E {High, Normal} and Wind E {Weak, Strong}. The training data is given in the table. Which attribute will be the root of the decision tree and how much is the information gain due to Outlook{Sunny, Overcast, Rain},Temperature{Hot, Mild, Cool}, Humidity{High, Normal} and Wind attributes {High, Normal}.   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **Day** | **Outlook** | **Temperature** | **Humidity** | **Wind** | **Play Tennis** | | 1 | Sunny | Hot | High | Weak | No | | 2 | Sunny | Hot | High | Strong | No | | 3 | Overcast | Hot | High | Weak | Yes | | 4 | Rain | Mild | High | Weak | Yes | | 5 | Rain | Cool | Normal | Weak | Yes | | 6 | Rain | Cool | Normal | Strong | No | | 7 | Overcast | Cool | Normal | Strong | Yes | | 8 | Sunny | Mild | High | Weak | No | | 9 | Sunny | Cool | Normal | Weak | Yes | | 10 | Rain | Mild | Normal | Weak | Yes | | 11 | Sunny | Mild | Normal | Strong | Yes | | 12 | Overcast | Mild | High | Strong | Yes | | 13 | Overcast | Hot | Normal | Weak | Yes | | 14 | Rain | Mild | High | Strong | No | | CO2 | | An | 12 |
|  |  |  |  | |  |  |
| 19. |  | Consider the two dimensional patterns (2, 1), (3, 5), (4, 3), (5, 6), (6, 7), (7, 8), (8,9). Compute the principal component using PCA Algorithm. | CO3 | | An | 12 |
|  |  |  |  | |  |  |
| 20. |  | Describe k-nearest neighbor algorithm with an example and explain why is it called instance based learning. | CO4 | | U | 12 |
|  |  |  |  | |  |  |
| 21. |  | 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. |  | 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 | 12 |
|  |  |  |  | |  |  |
| 23. |  | Explain the support vector machine from the perspective of the nonlinear Kernel by means of an algorithm. Derive the margin of the support vectors with an example and depict it with necessary diagrams. | CO3 | | U | 12 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. |  | Discuss the application of the neural network which is used for learning to steer an autonomous vehicle. | CO6 | | A | 12 |

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

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 4 | 13 |  |  |  |  | 17 |
| CO2 | 2 | 3 |  | 12 |  |  | 17 |
| CO3 | 1 | 13 |  | 15 |  |  | 29 |
| CO4 | 1 | 16 | 12 |  |  |  | 29 |
| CO5 |  | 13 |  | 3 |  |  | 16 |
| CO6 |  | 4 | 12 |  |  |  | 16 |
|  | | | | | | | **124** |

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| **Course Code** | **19RO2011** | **Duration** | **3hrs** |
| **Course Name** | **ROBOT OPERATING SYSTEMS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | | | | | | | **Course Outcome** | | **Bloom’s Level** | | | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | | | | | | | | | |
| 1. | Name the four major robot operating systems. | | | | | | | | CO1 | | R | | | 1 |
| 2. | Write about virtual machine software. | | | | | | | | CO1 | | U | | | 1 |
| 3. | Write the command to reboot the Ubuntu OS. | | | | | | | | CO2 | | R | | | 1 |
| 4. | Write the main four Ubuntu repositories. | | | | | | | | CO2 | | A | | | 1 |
| 5. | Write the command used to visualize the node graph. | | | | | | | | CO3 | | R | | | 1 |
| 6. | Mention the ROS bag concepts. | | | | | | | | CO3 | | U | | | 1 |
| 7. | In the following “*rospy.init\_node('talker', anonymous=True*)”, what is the talker signifies. | | | | | | | | CO4 | | U | | | 1 |
| 8. | Write the command to run the talker node that uses **C++** client libraries. | | | | | | | | CO4 | | R | | | 1 |
| 9. | List the advantages of gazebo debugging tool. | | | | | | | | CO5 | | U | | | 1 |
| 10. | Draw the ***rqt\_graph*** output for the talker and listener node | | | | | | | | CO6 | | A | | | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | | | | | | | | | |
| 11. | Discuss two widely used virtual machine software. | | | | | | | | CO1 | | | U | | 3 |
| 12. | Draw a flow diagram that shows the location of the twist message in the ROS folder. | | | | | | | | CO2 | | | An | | 3 |
| 13. | Note down the commands used to run the talker and listener node. | | | | | | | | CO3 | | | R | | 3 |
| 14. | Write down the syntax used to create a ROS package and explain it with suitable examples. | | | | | | | | CO4 | | | R | | 3 |
| 15. | Explain ***rostopic echo*** and ***rqt\_graph*** with suitable examples. | | | | | | | | CO5 | | | U | | 3 |
| 16. | Differentiate map frame and Odom frame. | | | | | | | | CO6 | | | A | | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions fromQ.No 17 to 23, Q.No 24 is Compulsory)** | | | | | | | | | | | | | | |
| 17. | a. | | | Explain the need of an operating system in a robot. List out four operating systems that are used in robotics. | | | | | CO1 | | | An | | 6 |
|  | b. | | | Why do we use ROS for robot programming? | | | | | CO1 | | | An | | 6 |
| 18. | a. | | | Discuss repositories and Explain the ubuntu repositories. | | | | | CO2 | | | U | | 6 |
|  | b. | | | Write down the Linux commands for the following operations:   1. Moving to the root directory. 2. Navigation to opt file system. 3. Create a folder catkin\_ws in the home file system. 4. Delete an empty folder catkin\_ws. | | | | | CO2 | | | R | | 6 |
| 19. | a. | | | Explain the following ROS terminologies.   1. ROS Nodes. 2. ROS Master. 3. ROS Messages. 4. ROS Topics. | | | | | CO3 | | | R | | 6 |
|  | b. | | | Explain ROS messages. List out four command-line tools associated with ROS messages and explain their roles. | | | | | CO3 | | | U | | 6 |
| 20. | a. | | | Define a ROS node. What are the client libraries used to write the ROS node. Give some examples of ROS nodes. | | | | | CO4 | | | R | | 6 |
|  | b. | | | Describe the concepts of publisher and subscribers with suitable examples. Draw the sketch that explains the inter-process communication between publishers and subscribers through ROS master nodes. | | | | | CO4 | | | An | | 6 |
| 21. |  | | | Explain rqt\_console and its sublevels. Which debugging tools are used to visualize and plot the data. Analyze the issues in hardware interfacing. | | | | | CO5 | | | An | | 12 |
| 22. |  | | | Differentiate the ROS publisher and ROS subscriber. Explain its inter-process communication with a suitable example. Write a simple publisher node using a python programming language. | | | | | CO3 | | | A | | 12 |
| 23. | a. | | | Describe ROS Build System. Give four popular build systems that are used widely in software development. Which type of build system is used in ROS. | | | | | CO4 | | | A | | 6 |
|  | b. | | | Explain ROS packages. Explain about catkin workspace and how many numbers of catkin workspace can be created in a PC. | | | | | CO3 | | | U | | 6 |
| **COMPULSORY QUESTION** | | | | | | | | | | | | | | |
| 24. |  | | | Describe the coordinate frame. Specify the reason for the need of coordinate frames. Elaborate the reason to specify the multiple frames in robotic system. Describe the reason behind the transformation between frames. | | | | | CO6 | | | An | | 12 |
|  | | **COURSE OUTCOMES** | | | | | | | | | | | | |
| CO1 | | Describe the need for ROS and its significance | | | | | | | | | | | | |
| CO2 | | Summarize the Linux commands used in robotics | | | | | | | | | | | | |
| CO3 | | Discuss about the concepts behind navigation through file system | | | | | | | | | | | | |
| CO4 | | Explain the concepts of Node debugging | | | | | | | | | | | | |
| CO5 | | Analyze the issues in hardware interfacing | | | | | | | | | | | | |
| CO6 | | Discuss about the applications of ROS | | | | | | | | | | | | |
| **Assessment Pattern as per Bloom’s Level** | | | | | | | | | | | | | | |
| CO / P | | | **Remember** | | **Understand** | **Apply** | **Analyze** | **Evaluate** | | **Create** | | | **Total** | |
| CO1 | | | 1 | | 4 | - | 12 | - | | - | | | 17 | |
| CO2 | | | 7 | | 6 | 1 | 3 | - | | - | | | 17 | |
| CO3 | | | 10 | | 13 | 12 | - | - | | - | | | 35 | |
| CO4 | | | 10 | | 1 | 12 | 6 | - | | - | | | 29 | |
| CO5 | | | 3 | | 1 |  | 6 | - | | - | | | 10 | |
| CO6 | | | - | | - | 4 | 12 | - | | - | | | 16 | |
|  | | | | | | | | | | | | | **124** | |

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

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | Define the structure of an agent. | | CO1 | R | | 1 |
| 2. | Reproduce the functionality of an AI system to act humanly. | | CO1 | R | | 1 |
| 3. | Recall the components used to define a problem. | | CO2 | R | | 1 |
| 4. | Name the informed search strategies. | | CO2 | R | | 1 |
| 5. | Interpret the states in Graph Plan algorithm. | | CO3 | U | | 1 |
| 6. | Quote the admissible heuristic estimate for State-Space Search. | | CO3 | R | | 1 |
| 7. | List the advantages of Bayesian view of learning. | | CO4 | R | | 1 |
| 8. | Indicate the key terms of statistical learning. | | CO4 | U | | 1 |
| 9. | Identify the most common unsupervised learning task in AI. | | CO5 | R | | 1 |
| 10. | Define the term “Perception”. | | CO6 | R | | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | Interpret the PEAS description of the task environment for an automated taxi. | | CO1 | | U | 3 |
| 12. | Indicate the metrics used in problem-solving algorithms. | | CO2 | | U | 3 |
| 13. | Summarize the drawbacks of minimax adversarial search algorithm. | | CO3 | | U | 3 |
| 14. | Distinguish supervised and unsupervised learning. | | CO4 | | U | 3 |
| 15. | List the various components of an autonomous machine. | | CO5 | | R | 3 |
| 16. | Summarize the ethics of computing. | | CO6 | | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | | |
| 17. | a. | Discuss in detail the simple-reflex and model-based reflex agents. | CO1 | | U | 8 |
|  | b. | Describe the components of basic artificial neuron with a suitable diagram. | CO1 | | R | 4 |
|  |  |  |  | |  |  |
| 18. |  | Explain in detail the depth first search technique with suitable examples. | CO2 | | U | 12 |
|  |  |  |  | |  |  |
| 19. |  | Discuss in detail the state-space search progression and regression planning algorithm. | CO3 | | U | 12 |
|  |  |  |  | |  |  |
| 20. | a. | Explain the Markov Decision Process with suitable examples. | CO4 | | U | 8 |
|  | b. | Classify the types of learning methods adopted in AI and brief them. | CO4 | | U | 4 |
|  |  |  |  | |  |  |
| 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. |  | Describe the Bayesian view of learning with suitable example. | CO4 | | U | 12 |
|  |  |  |  | |  |  |
| 23. |  | Discuss in detail the Propositional logic and first order logic techniques for knowledge representation with syntax and semantics. | CO2 | | U | 12 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. |  | Discuss the path planning of a robot in detail. | 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 | 6 | 11 | - | - | - | - | 17 |
| CO2 | 2 | 27 | - | - | - | - | 29 |
| CO3 | 1 | 16 | - | - | - | - | 17 |
| CO4 | 1 | 28 | - | - | - | - | 29 |
| 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. | List any two primary energy sources. | | CO1 | R | | 1 |
| 2. | Indicate the error ranges of the Volume meter. | | CO1 | U | | 1 |
| 3. | Write the percentage of energy observed by Earth from the Sun. | | CO2 | A | | 1 |
| 4. | Write the high voltage range of electric energy. | | CO2 | U | | 1 |
| 5. | Write the high-pressure range of natural gas for industrial applications. | | 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. | Write short notes on World energy resources. | | CO1 | | U | 3 |
| 12. | Discuss the importance of hydraulic energy. | | CO2 | | R | 3 |
| 13. | Explain briefly electric distribution losses | | 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. |  | What is the necessity for renewable and non-renewable energy sources? Explain in detail. | CO1 | | U | 12 |
|  |  |  |  | |  |  |
| 18. |  | What is a boiler? Explain with a neat sketch about any two types of boilers. | CO2 | | R | 12 |
|  |  |  |  | |  |  |
| 19. |  | Discuss the plant combined cycle cogeneration steam system. | CO3 | | An | 12 |
|  |  |  |  | |  |  |
| 20. |  | Explain the various types of Air compressors with neat sketches. | CO4 | | A | 12 |
|  |  |  |  | |  |  |
| 21. |  | Define waste management, discuss the detailed process of waste management. | CO5 | | An | 12 |
|  |  |  |  | |  |  |
| 22. |  | Discuss in detail the various types of energy storage systems. | CO2 | | A | 12 |
|  |  |  |  | |  |  |
| 23. |  | Explain in detail the Solar energy production. Also discuss its merits and demerits. | CO4 | | U | 12 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. |  | Write the use of computers in energy and waste management systems and also explain the working procedures. | CO6 | | An | 12 |

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

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

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

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| **Q. No.** | **Questions** | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | |
| 1. | What is the role of synapse in biological neuron? | CO1 | R | 1 |
| 2. | Write some of the applications of neural networks? | CO1 | A | 1 |
| 3. | With a neat sketch draw the multilayer feed forward network. | CO2 | U | 1 |
| 4. | Can we use CNN to perform Dimensionality Reduction? | CO2 | A | 1 |
| 5. | State thesignificance of the RELU activation function in Convolution Neural network(CNN)? | CO3 | R | 1 |
| 6. | What is Stride? What is the effect of high Stride on the feature map? | CO3 | R | 1 |
| 7. | List the operations in fuzzy sets. | CO4 | R | 1 |
| 8. | Define the core of a membership function. | CO4 | R | 1 |
| 9. | What do you meant by membership function? | CO5 | R | 1 |
| 10. | Mention the applications of neural network control system. | CO6 | U | 1 |

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| **PART – B (6 X 3 = 18 MARKS)** | | | | |
| 11. | Point out the different activation functions used in neural network. | CO1 | R | 3 |
| 12. | Illustrates the perceptron learning rule of the network. The set of input training vectors and the initial weight vector w are given in the problem. The learning constant is assumed to be c = 0.1. The teacher's desired responses for xl , x2, x3 are dl = - 1, d2 = - 1, and d3 = 1, respectively. Find the net value and the W2 weights for the given problem. | CO2 | U | 3 |
| 13. | An input image has been converted into a matrix of size 12 X 12 along with a filter of size 3 X 3 with a Stride of 1. Determine the size of the convoluted matrix. | CO3 | E | 3 |
| 14. | Mention all the properties of fuzzy sets. | CO4 | AN | 3 |
| 15. | With the help of an example, explain the union, intersection, and complement regarding fuzzy sets and classical sets. | CO5 | U | 3 |
| 16. | Draw the basic block diagram for a fuzzy logic control system. | CO6 | U | 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. | Compare the biological neural network with an artificial neural network. | CO1 | U | 6 |
| b. | Describe Mc-Culloch Pitt’s neuronal model. Design a network using this model to realize a AND gate. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18 |  | Classify the different learning rules used in neural network. Give a brief learning about each learning rule. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. |  | Draw and explain the architecture of Convolution Neural Network(CNN). | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. |  | Consider a set P= {P1, P2, P3, P4} of four varieties of paddy plants, set D={ D1, D2, D3, D4}of the various diseases affecting the plants and S={ S1, S2, S3, S4} be the common symptoms of the diseases. Let R be a relation on P\*D and S be the relation on D\*S. Find RoS for the given problem. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | Compare fuzzification with defuzzification. Explain different types of Defuzzification methods. | CO5 | E | 12 |
|  |  |  |  |  |  |
| 22. |  | Discuss about the types of associative memory network. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 23 |  | Differentiate the types of supervised learning and unsupervised learning with an example for each learning methods. | CO1 | U | 12 |
|  |  | **Compulsory Question** | | | |
| 24. |  | Design and develop a Greg-Viot fuzzy cruise controller using fuzzy logic control model. Formulate necessary membership functions and required fuzzy rules for the application. | CO6 | C | 12 |

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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 | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 4 | 28 | 1 | - |  | - | 33 |
| CO2 |  | 24 | 1 | - |  |  | 25 |
| CO3 | 2 | 12 | - | - | - | - | 14 |
| CO4 | 2 | - | 12 | 3 | - | - | 17 |
| CO5 | 1 | 3 | - | - | 15 | - | 19 |
| CO6 | - | 4 | - |  | - | 12 | 16 |
|  | | | | | | | **124** |

**Graphical user interface, application

Description automatically generated with medium confidence**

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

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | | **Marks** | |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | | |
| 1. | Mention the internal RAM capacity of 8051 microcontroller. | | CO1 | U | | 1 | |
| 2. | List the importance of Address Latch Enable (ALE) in 8051 microcontroller. | | CO1 | R | | 1 | |
| 3. | Find the 8051 instruction used to get the ones complement of a numbers. | | CO2 | R | | 1 | |
| 4. | Identify the register that hold the address of the next instruction to be fetched by the microcontroller. | | CO2 | R | | 1 | |
| 5. | Show the status of carry and parity flag after executing the following instruction  MOV  A,#9C ADD A,#64H | | CO3 | U | | 1 | |
| 6. | Define Zigbee protocol. | | CO3 | R | | 1 | |
| 7. | Illustrate with one example for arithmetic instruction used in ARM 9 Processor. | | CO4 | U | | 1 | |
| 8. | How many general purpose registers are there in ARM 9 Processor. | | CO4 | R | | 1 | |
| 9. | Mention the type of mode used for exception handling in ARM Cortex M4. | | CO5 | U | | 1 | |
| 10. | Illustrate any two types of digital sensor. | | CO6 | U | | 1 | |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | | |
| 11. | Examine the output at the address 4200 after executing the following program.  MOV A, #0B  RRC  MOV DPTR, #4200  MOVX @DPTR,A | | CO1 | An | | 3 | |
| 12. | Classify different instruction set of 8051 microcontroller. | | CO2 | U | | 3 | |
| 13. | Distinguish assembler and compiler. | | CO3 | An | | 3 | |
| 14. | Outline the function of Nested Vectored Interrupt Controller. | | CO4 | U | | 3 | |
| 15. | Determine the time taken by one machine cycle if crystal frequency is 12 MHz. | | CO5 | An | | 3 | |
| 16. | Interpret the steps followed in interfacing ultrasonic sensor with 8051. | | CO6 | U | | 3 | |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | | | |
| 17. | a. | Build a circuit which interfaces memory with 8051 microcontroller in order to fetch a data 40h from memory. | CO1 | | A | | 6 |
|  | b. | Explain the characteristics of embedded system. | CO1 | | U | | 6 |
|  |  |  |  | |  | |  |
| 18. | a. | Develop an assembly language program to find the smallest number in an array of 10 numbers. | CO2 | | A | | 6 |
|  | b. | Illustrate with example, different branch instructions in 8051 microcontroller. | CO2 | | U | | 6 |
|  |  |  |  | |  | |  |
| 19. | a. | Differentiate synchronous and asynchronous communication. | CO3 | | U | | 6 |
|  | b. | Design an interfacing circuit for 8051 microcontroller 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 features of ARM Cortex M4. | CO5 | | U | | 6 |
|  | b. | Categorize different memory regions in ARM Cortex M4. | CO5 | | An | | 6 |
|  |  |  |  | |  | |  |
| 22. | a. | Summarize 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 8 bit and 32 bit microcontroller. | CO1 | | An | | 4 |
| **COMPULSORY QUESTION** | | | | | | | |
| 24. | a. | Build an interfacing circuit which connects LCD with microcontroller and write the steps to display the character and commands. | CO6 | | A | | 6 |
|  | b. | Develop an 8051 interfacing circuit which rotates stepper motor in clockwise direction. | CO6 | | A | | 6 |

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

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 13 | 6 | 9 |  |  | 29 |
| CO2 | 1 | 10 | 6 | 6 |  |  | 23 |
| CO3 | 1 | 1 | 6 | 9 |  |  | 17 |
| CO4 | 1 | 16 |  | 6 |  |  | 23 |
| CO5 |  | 7 |  | 9 |  |  | 16 |
| CO6 |  | 4 | 12 | - |  |  | 16 |
|  | | | | | | | **124** |

**Graphical user interface, application

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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** | | **Course Outcome** | **Bloom’s Level** | | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | Compare the results of the following two expression   1. 6 % 2 b. 45 / 0 | | CO1 | An | | 1 |
| 2. | Let x = 4.66. Write the values of the following expressions:   1. round (x) b.int (x) | | CO1 | A | | 1 |
| 3. | Mention when semantic error is detected in Python code. | | CO2 | U | | 1 |
| 4. | Find the output of the following python statement  for count in range(5):  print (count+1) | | CO2 | U | | 1 |
| 5. | The \_\_\_\_\_\_\_\_loop is also called an entry-control loop. | | CO3 | U | | 1 |
| 6. | Find the output of the following python statement  "%6.5f"%3.14 | | CO3 | An | | 1 |
| 7. | Find the output of the python statement  data=[10,12,15,18]  data[1:3] | | CO4 | A | | 1 |
| 8. | Define an object. | | CO4 | R | | 1 |
| 9. | Define class variable. | | CO5 | R | | 1 |
| 10. | Indicate the function of Pick and Place Robot. | | CO6 | U | | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | Write the Program format and Structure of python programming. | | CO1 | | R | 3 |
| 12. | Write a python code to find factorial of n using ‘while’ loop. | | CO2 | | A | 3 |
| 13. | Find the output of the following python statement  data={"name":"John","age":20, "course":"Eng"}  data.keys()  data.values()  len(data) | | CO3 | | U | 3 |
| 14. | Mention the role of the \_\_init\_\_ and the \_\_str\_\_ methods in python class. | | CO4 | | U | 3 |
| 15. | Identify Temporary variables, method names, module variables and parameters in the following python code.  replacements={"I":"you","my":"your"}  def person(sentence):  words=sentence.split()  replyWords=[]  for word in words:  replyWords.append(replacements.get(word,word))  return " ".join(replyWords) | | CO5 | | An | 3 |
| 16. | Define polymorphism. Give example. | | CO6 | | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | | |
| 17. | a. | With relevant example, list out the functions related to math module. | CO1 | | R | 8 |
|  | b. | List out the different numeric data types used in Python programming. | CO1 | | U | 4 |
|  |  |  |  | |  |  |
| 18. | a. | Explain the procedure to read and write a text files using Python with suitable example. | CO2 | | U | 8 |
|  | b. | Write python code to convert binary string to decimal number. | CO2 | | A | 4 |
|  |  |  |  | |  |  |
| 19. |  | Mention the selection statements used in python programming. Explain each with relevant example. | CO2 | | U | 12 |
|  |  |  |  | |  |  |
| 20. | a. | Describe the differences between the dictionary and Tuple. | CO4 | | U | 4 |
|  | b. | Create a dictionary to store student details such as name, age, roll number, mark1, mark2, mark3, mark4, mark5. Develop a python code to create a dictionary, and sum all the marks in the student dictionary. Also display the names of students whose percentage of marks is above 75%. | CO4 | | An | 8 |
|  |  |  |  | |  |  |
| 21. | a. | Define a list. List out various methods used for python list with example. | CO4 | | U | 6 |
|  | b. | With relevant example code, explain the Caesar cipher methods of Data Encryption in python. | CO4 | | U | 6 |
|  |  |  |  | |  |  |
| 22. | a. | Differentiate recursion and iteration. Mention the advantages and disadvantages of recursion | CO3 | | U | 4 |
|  | b. | Describe various methods and attributes used to create a class and objects with relevant example. | CO3 | | A | 8 |
|  |  |  |  | |  |  |
| 23. | a. | Describe the procedure to create a ‘def’ function using python code. | CO5 | | U | 4 |
|  | b. | Describe the processes of top-down design and stepwise refinement. Where does the design start and how does it proceed? | CO5 | | A | 8 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. |  | What is Object Recognition? Develop a python code to recognize the objects available in the color image using pre-trained model and imageAI tool. Explain in detail. | CO6 | | A | 12 |

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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 | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 11 | 4 | 1 | 1 |  |  | 17 |
| CO2 |  | 22 | 7 |  |  |  | 29 |
| CO3 |  | 8 | 8 | 1 |  |  | 17 |
| CO4 |  | 19 | 1 | 8 |  |  | 28 |
| CO5 | 2 | 4 | 8 | 3 |  |  | 17 |
| CO6 |  | 4 | 12 |  |  |  | 16 |
|  | | | | | | | **124** |

**Graphical user interface, application

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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** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Find the excess 3 code for the binary number 0111. | | CO1 | R | 1 |
| 2. | Name the logic gates which produces a 1 output when the inputs are different. | | CO1 | R | 1 |
| 3. | Show the standard sum of product for the given expression  Y=A+AB. | | CO2 | U | 1 |
| 4. | Define encoder. | | CO2 | R | 1 |
| 5. | Infer the output from a D flip-flop if the clock signal is high and D=0. | | CO3 | U | 1 |
| 6. | Name the shift register, which allows serial input and produces a parallel output. | | CO3 | R | 1 |
| 7. | Determine the resolution of 8-bit ADC if the full-scale voltage is 10V. | | CO4 | U | 1 |
| 8. | Name the slowest type of Analog to Digital Converter. | | CO4 | R | 1 |
| 9. | Infer the form of digital memory that can be designed with a fixed collection of OR gates and programmable collection of AND gates. | | CO5 | U | 1 |
| 10. | Illustrate an example for input device. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Construct truth table for the 2 input AND and 2 input OR gate. | | CO1 | A | 3 |
| 12. | Develop a 1x8 Demultiplexer with truth table and logic diagram. | | CO2 | A | 3 |
| 13. | Compare Ring Counter and Johnson Counter. | | CO3 | U | 3 |
| 14. | Outline the importance of Sample and Hold circuit in ADC. | | CO4 | U | 3 |
| 15. | Distinguish between RAM and ROM. | | CO5 | U | 3 |
| 16. | Paraphrase the functionality of bus structure in 8085. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. | a. | Determine the output after the following conversion  (i)1101.011 binary to decimal number  (ii) 483.92 decimal to hexa-decimal (iii) 65 octal to binary | CO1 | An | 6 |
|  | b. | Explain the operation of Schottky TTL logic family. | CO1 | U | 6 |
| 18. | a. | Simplify the following Boolean function F, using K-Map F(A,B,C,D)= ∑m(1,5,6,8,9,11,13,14,15) | CO2 | A | 6 |
|  | b. | Interpret with truth table and logic diagram for 1 bit magnitude comparator. | CO2 | U | 6 |
| 19. | a. | Develop truth table and excitation table for S-R Flip-flop. | CO3 | A | 6 |
|  | b. | Summarize the operation of 4 bit ripple counter. | CO3 | U | 6 |
| 20. | a. | Examine the drawback of weighted binary DAC with R-2R ladder DAC. | CO4 | An | 6 |
|  | b. | Illustrate the operation of successive approximation ADC with necessary diagram. | CO4 | U | 6 |
| 21. | a. | Compare CPLD and FPGA. | CO5 | U | 6 |
|  | b. | Design a combinational circuit using a suitable PAL having four inputs, four outputs and three wide AND-OR structure for the following Boolean expression.  X(A,B,C) = Σm(2,3,5,7)  Y(A,B,C)= Σm(0,1,5)  Z(A,B,C)= Σm(0,2,3,5) | CO5 | A | 6 |
| 22. | a. | Compare and contrast Static RAM with Dynamic RAM. | CO5 | U | 6 |
|  | b. | Design 3 bit universal shift register. | CO2 | A | 6 |
| 23. | a. | Explain the working of CMOS inverter with necessary diagram. | CO1 | U | 8 |
|  | b. | Develop logic circuit for 3 to 8 decoder. | CO2 | A | 4 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain the architecture of 8085 microprocessor. | CO6 | U | 6 |
|  | b. | Discuss the steps involved in fetching an instruction from memory. | CO6 | An | 6 |

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

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 12 | 6 | 9 |  |  | 28 |
| CO2 | 2 | 9 | 6 | 6 |  |  | 23 |
| CO3 | 1 | 7 | - | 6 |  |  | 14 |
| CO4 | 1 | 16 |  | 6 |  |  | 23 |
| CO5 |  | 13 |  | 6 |  |  | 19 |
| CO6 |  | 5 | 12 | - |  |  | 17 |
|  | | | | | | | **124** |

Graphical user interface, application

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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** | **Course Outcome** | **Pattern** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | |
| 1. | Resolution is the smallest \_\_\_\_\_\_\_\_\_. | CO1 | R | 1 |
| 2. | The SI unit for Light is \_\_\_\_\_\_\_\_\_. | CO1 | R | 1 |
| 3. | Give an example of PTC type temperature sensor. | CO2 | U | 1 |
| 4. | Basic components for a resistive based pressure sensor is \_\_\_\_\_\_\_\_\_. | CO2 | U | 1 |
| 5. | Potentiometer can be used as a sensor when connected in a \_\_\_\_\_\_\_\_\_ divider circuit. | CO3 | U | 1 |
| 6. | \_\_\_\_\_\_\_\_\_ proximity sensor detects metal objects. | CO3 | R | 1 |
| 7. | Give the expression for venturi meter. | CO4 | R | 1 |
| 8. | Define Torque. | CO4 | U | 1 |
| 9. | \_\_\_\_\_\_\_\_\_\_\_ lines are utilized during the enable state of hardware flow control in DTE and DCE devices of RS232. | CO5 | R | 1 |
| 10. | RS 422 interface standard can transmit up to \_\_\_\_\_\_\_\_\_ distance. | CO5 | R | 1 |

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| **PART – B (6 X 3 = 18 MARKS)** | | | | |
| 11. | List the static characteristics of a sensor. | CO1 | R | 3 |
| 12. | Draw the various circuits used for RTD. | CO2 | R | 3 |
| 13. | List the applications of a piezoelectric sensor with respect to robotics. | CO3 | A | 3 |
| 14. | Find the sensor used in the accelerometer pedal of a car and draw the basic circuit used along with the sensor. | CO4 | A | 3 |
| 15. | Mention the necessity of 4-20mA current loop. | CO5 | U | 3 |
| 16. | Comment on the merits and demerits of Bluetooth. | 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. |  | Discuss in detail the static sensor characteristics. | CO1 | R | 12 |
|  |  |  |  |  |  |
| 18. | a. | Explain the various circuits used along with strain gauge for conversion of the generated resistance into voltage. | CO2 | A | 5 |
| b. | Relate the sensor that works on the principle of Seebeck, explain its construction and working. | CO2 | C | 7 |
|  |  |  |  |  |  |
| 19. | a. | With neat diagrams explain the construction and working of LVDT. | CO3 | R | 6 |
|  | b. | Identify the sensor used in car to find the acceleration and explain its working in detail. | CO3 | A | 6 |
|  |  |  |  |  |  |
| 20. | a. | Construct a flowmeter using faradays principle. | CO2 | U | 6 |
|  | b. | Elucidate on the noncontact type of level sensor and give its applications. | CO2 | R | 6 |
|  |  |  |  |  |  |
| 21. |  | Discuss in detail the serial protocol designed to communicate with computer and modem. | CO5 | C | 12 |
|  |  |  |  |  |  |
| 22. | a. | Find the sensor used for measurement of vibration of a material, the material being a nonconductive material. Give its principle and working. | CO4 | An | 8 |
|  | b. | Surmise the working principle of gyroscope. | CO4 | An | 4 |
|  |  |  |  |  |  |
| 23. |  | Elaborate the ethernet protocol and its word structure in detail. | CO5 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Summarize the protocol structure of Wi-Fi with relevant diagrams. | CO6 | E | 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 | 17 |  |  |  |  |  | 17 |
| CO2 | 6 | 8 | 8 |  |  | 7 | 29 |
| CO3 | 7 | 1 | 9 |  |  |  | 17 |
| CO4 | 1 | 4 |  | 12 |  |  | 17 |
| CO5 | 2 | 3 | 12 |  |  | 12 | 29 |
| CO6 |  |  |  | 3 | 12 |  | 15 |
|  | | | | | | | **124** |

Graphical user interface, application

Description automatically generated with medium confidence

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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** | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | |
| 1. | List the sensor that gives the output as change in resistance. | CO1 | R | 1 |
| 2. | Resolution is the smallest \_\_\_\_\_\_\_\_\_\_\_. | CO1 | R | 1 |
| 3. | Potentiometer can be used as sensor when connected in a \_\_\_\_\_\_\_\_\_ divider circuit. | CO2 | U | 1 |
| 4. | \_\_\_\_\_\_\_\_\_ filters are created by using resistors and capacitors or inductors and capacitors. | CO2 | U | 1 |
| 5. | For an Op-amp with negative feedback, the outputis\_\_\_\_\_\_\_\_\_\_. | CO3 | An | 1 |
| 6. | Bandwidth of an ideal op-amp is \_\_\_\_\_\_\_\_\_. | CO3 | R | 1 |
| 7. | Wi-Fi used for WSN (Wireless Sensor Network) operates at \_\_\_\_\_\_\_\_\_ frequency. | CO4 | R | 1 |
| 8. | \_\_\_\_\_\_\_\_\_ board can be used to develop a wireless sensor. | CO4 | R | 1 |
| 9. | The Fifth generation Smart Sensors uses \_\_\_\_\_\_\_\_\_\_. | CO5 | U | 1 |
| 10. | Analog signals are acquired into the microcontroller using \_\_\_\_\_\_\_\_\_. | CO5 | U | 1 |

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| **PART – B (6 X 3 = 18 MARKS)** | | | | |
| 11. | List the static characteristics of a sensor. | CO1 | R | 3 |
| 12. | Design a First Order low pass filter for with the cut off frequency of 100Hz. | CO2 | A | 3 |
| 13. | Calculate the gain of non-inverting amplifier with Ri of 1 KΩ and Rf of 100 KΩ. | CO3 | A | 3 |
| 14. | Draw the block diagram for a Wi-Fi based sensor. | CO4 | U | 3 |
| 15. | Give the advantages of Smart Sensor. | CO5 | U | 3 |
| 16. | Comment on the merits and demerits of an OSH. | CO6 | U | 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 aid of a tabular column give in detail the classifications of the sensors. | CO1 | R | 8 |
| b. | Explain the construction and working of CO2 sensor. | CO1 | U | 4 |
|  |  |  |  |  |  |
| 18. | a. | Elucidate on the potential divider circuit and the various sensors that can be used along with this circuit. | CO2 | A | 6 |
| b. | Draw and give explanation on the filter circuits used with sensors that generate signals less than 90Hz. | CO2 | C | 6 |
|  |  |  |  |  |  |
| 19. |  | Construct the circuit for the two-stage amplifier used in biomedical signals and derive the expression for the same. | CO3 | C | 12 |
|  |  |  |  |  |  |
| 20. |  | With relevant diagrams elaborate on the Wi-Fi protocol in detail. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. |  | Develop a device with self-calibrating technology that can also have a storage of these calibrated data, use relevant block diagram to explain the device. | CO5 | C | 12 |
|  |  |  |  |  |  |
| 22. | a. | Identify the sensor used for measurement of thickness of the material, the material being a nonconductive material. | CO1 | An | 8 |
|  | b. | Give the criteria needed to be checked while buying a sensor/instrument. | CO1 | An | 4 |
|  |  |  |  |  |  |
| 23. | a. | Derive the expression of gain for Inverting and Non- Inverting Amplifiers. | CO3 | A | 8 |
|  | b. | Design an amplifier to add signals from three different sensors with a gain of 3. | CO3 | E | 4 |
|  |  | **COMPULSORY QUESTION** |  |  |  |
| 24. |  | Justify the necessity of IoT in agriculture with proper outcomes. | CO6 | E | 12 |

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

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 13 | 4 | - | 12 |  |  | 29 |
| CO2 |  | 2 | 9 |  |  | 6 | 17 |
| CO3 | 1 |  | 11 | 1 | 4 | 12 | 29 |
| CO4 | 2 | 15 |  |  |  | - | 17 |
| CO5 |  | 5 | - |  |  | 12 | 17 |
| CO6 |  | 3 |  |  | 12 |  | 15 |
|  | | | | | | | **124** |



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| **Course Code** | **20RO3001** | **Duration** | **3hrs** |
| **Course Name** | **ROBOTICS: SYSTEM AND ANALYSIS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(5 X 16= 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Compare the robot configurations based on their physical configuration and work volume with relevant sketches and applications. | CO1 | An | 12 |
|  | b. | A cartesian coordinate robot has an orthogonal slide with a total range of 30 inches. One of the specifications of the robot is that it has a control resolution of 0.010 inches. On this particular axis, determine the number of bits of storage capacity which the robot’s control memory must possess toprovide this level of precision. | CO1 | A | 4 |
|  |  |  |  |  |  |
| 2. | a. | A frame B was rotated about the x-axis by 900, then, it was translated about the current w-axis by 3 inches before it was rotated about z-axis 600. Finally, it was translated aboutcurrent v-axis by 5 inches.  a) Write an equation that describes the motion.  b) Find the final location of a point P (1, 5, 4)T attached to the frame relative to thereference frame. | CO2 | A | 12 |
|  | b. | Comment on the significance of the DH parameters and hence deduce the arm equation of a robot. | CO2 | An | 4 |
|  |  |  |  |  |  |
| 3. |  | Determine the Lagrange function of the 2 DoF manipulator shown in Fig. and hence derive the equations of motion. | CO3 | U | 16 |
|  |  |  |  |  |  |
| 4. | a. | Compare joint space and cartesian space description of robot trajectory. | CO4 | 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 and plotthe joint angles, velocities, and accelerations. The robot starts from rest but should have a final velocityof 50/sec. | CO4 | A | 10 |
|  |  |  |  |  |  |
| 5. | a. | Draw the block diagram of a robot controller with the feedback loop and mention the function of each block. | CO5 | U | 6 |
|  | b. | The electromechanical actuating system in a robot controller has a tachogenerator for velocity feedback. Draw the block diagram of the system and hence derive the transfer function. | CO5 | A | 10 |
|  |  |  |  |  |  |
| 6. | a. | Give the classification of robots based on the control mechanisms involved. | CO1 | U | 6 |
|  | b. | Mention the parameters that determine the performance characteristics of a robot. | CO1 | U | 10 |
|  |  |  |  |  |  |
| 7. | a. | For the 2 link RR manipulator shown in Fig. below, given that the link length L1­ = 12 inches and L2 = 10 inches, joint angles θ1 =300 and θ2=450. Compute the coordinate positions x and y for the end of the arm Pw. | CO2 | A | 10 |
|  | b. | Illustrate the use of Jacobians in differential kinematic analysis and hence comment on the concept of joint space singularities. | CO2 | An | 6 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Elaborate on the image processing techniques used in machine vision with relevant diagrams and explanations. | CO6 | A | 10 |
|  | b. | It is required to design an integrated robotic system that inspects the quality of the finished product in an assembly line based on the required shape and size using vision feedback. Sketch a schematic of the entire system and specify the component selection process, integration of the system and the algorithm for inspection. | CO6 | C | 10 |

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the fundamentals of robotics. |
| CO2 | Acquire knowledge in kinematics of robotics. |
| CO3 | Comprehend Dynamic Analysis and Forces. |
| CO4 | Explore Trajectory Planning. |
| CO5 | Understand Motion Control Systems. |
| CO6 | Explain Image processing and analysis with vision systems. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 |  | 16 | 4 | 12 |  |  | 32 |
| CO2 |  |  | 22 | 10 |  |  | 32 |
| CO3 |  | 16 |  |  |  |  | 16 |
| CO4 |  |  | 10 | 6 |  |  | 16 |
| CO5 |  | 6 | 10 |  |  |  | 16 |
| CO6 |  |  | 10 |  |  | 10 | 20 |
|  | | | | | | | **132** |



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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** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(5 X 16= 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | With neat diagrams explain the architecture of 8051. | CO1 | U | 10 |
|  | b. | Discuss the necessity of Direct memory access. | CO1 | A | 6 |
|  |  |  |  |  |  |
| 2. | a. | Discuss in detail with the operation of interrupts and the different sources of interrupt generation in embedded system. | CO2 | An | 10 |
|  | b. | With neat diagram give the working of RS 485. | CO2 | A | 6 |
|  |  |  |  |  |  |
| 3. | a. | Examine the pre-emptive and non-pre-emptive scheduling operations in embedded system. | CO3 | A | 10 |
|  | b. | Define the following with respect to RTOS  i) Task  ii) Process  iii) Interrupt Routine | CO3 | R | 6 |
|  |  |  |  |  |  |
| 4. |  | Discuss the concept and merits of an open source software. | CO4 | An | 16 |
|  |  |  |  |  |  |
| 5. | a. | Tabulate the elements in Java Program. | CO5 | A | 8 |
|  | b. | Summarize the development embedded software using J2ME. | CO5 | E | 8 |
|  |  |  |  |  |  |
| 6. | a. | Explain the serial bus communication protocol used for short distances. | CO2 | An | 8 |
|  | b. | Illustrate the methods used for generation of interrupts and the priority assigned to each sources. | CO2 | A | 8 |
|  |  |  |  |  |  |
| 7. |  | Explain in detail the features and operation of various RTOS concepts used in COS -II. | CO4 | U | 16 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. |  | With relevant block diagrams give a case study on adaptive cruise control. | CO6 | C | 20 |

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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 | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 |  | 10 | 6 |  |  |  | 16 |
| CO2 | 6 |  | 8 | 18 |  |  | 32 |
| CO3 | 6 |  | 10 |  |  |  | 16 |
| CO4 |  | 16 |  | 16 |  |  | 32 |
| CO5 |  |  | 8 |  | 8 |  | 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** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Explain in detail about IoT enablers and connectivity layers. | CO1 | A | 15 |
|  | b. | Differentiate Industrial IoT and Consumer IoT. | CO1 | U | 5 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | With a neat block diagram, elaborate the functional blocks of IoT service oriented architecture. | CO2 | A | 15 |
|  | b. | Highlight the desirable characteristics of sensors used in IoT applications. | CO2 | R | 5 |
|  |  |  |  |  |  |
| 3. | a. | Explain the various types of sensors with their applications in IoT. | CO3 | A | 15 |
|  | b. | Compare the types of actuators used in IoT applications. | CO3 | U | 5 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Explain in detail about connectivity technology in MQTT. | CO4 | U | 15 |
|  | b. | Mention the need of different Types of Protocols. | CO4 | R | 5 |
|  |  |  |  |  |  |
| 5. | a. | Describe about the network security techniques. | CO5 | A | 15 |
|  | b. | Explain the conventional web technology and relationship with IIOT. | CO5 | R | 5 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Explain in detail about various layers in HART Protocol. | CO3 | A | 15 |
|  | b. | Distinguish between failed node and selfish node in MQTT protocol. | CO3 | U | 5 |
|  |  |  |  |  |  |
| 7. | a. | Elaborate the functional blocks of CoAP architecture. | CO4 | A | 15 |
|  | b. | Explain in detail about cots cloud platforms. | CO4 | U | 5 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Write short note on Zigbee Protocol and its significant characteristics. | CO4 | U | 15 |
|  | b. | Highlight the role of IoT in Automotive Industry | CO5 | U | 5 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Quote the applications of IoT in the manufacturing sector and describe the process of implementation with a relevant case study. | CO6 | A | 15 |
|  | b. | Explain about the role of analytics in IoT. | CO6 | U | 5 |

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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 | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 |  | 5 | 15 |  |  |  | 20 |
| CO2 | 5 |  | 15 |  |  |  | 20 |
| CO3 |  | 10 | 30 |  |  |  | 40 |
| CO4 | 5 | 35 | 15 |  |  |  | 55 |
| CO5 | 5 | 5 | 15 |  |  |  | 25 |
| CO6 |  | 5 | 15 |  |  |  | 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** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(5 X 16= 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Explain the components of digital image processing with a neat sketch. | CO1 | U | 12 |
|  | b. | Interpret an image as a matrix and classify the types of images based on color format. | CO1 | U | 4 |
|  |  |  |  |  |  |
| 2. | a. | Discuss in detail the function of the anatomical parts and label the structure of human eye with a suitable diagram. | CO2 | U | 12 |
|  | b. | Distinguish between photopic and scotopic vision. | CO2 | An | 4 |
|  |  |  |  |  |  |
| 3. |  | Discuss briefly the process of image enhancement in the spatial domain and compare the smoothing and sharpening filters. | CO3 | U | 16 |
|  |  |  |  |  |  |
| 4. | a. | Explain in detail the image compression and coding models with a block diagram. | CO4 | U | 12 |
|  | b. | Summarize the process of visual data compression and classify various types of data. | CO4 | U | 4 |
|  |  |  |  |  |  |
| 5. |  | Discuss the application of machine vision in inspection and identification of parts in industries. | CO5 | U | 16 |
|  |  |  |  |  |  |
| 6. | a. | Explain with sketches the fundamental steps involved in digital image processing. | CO1 | U | 12 |
|  | b. | Recall the digital representation of an image as a 2D signal over the spatial coordinates x and y. | CO1 | R | 4 |
|  |  |  |  |  |  |
| 7. |  | Apply histogram equalization for the gray levels of an 8 X 8 image and plot the histogram of the original and the processed image.   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Gray levels | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | No. of pixels | 9 | 8 | 11 | 4 | 10 | 15 | 4 | 3 | | CO3 | A | 12 |
|  | b. | Outline the importance of histogram equalization. | CO3 | U | 4 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. |  | Explain the structure of industrial machine vision and extend the illumination techniques for vision systems in detail. | CO6 | U | 20 |

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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 | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 4 | 28 | - | - | - | - | 32 |
| CO2 | - | 12 | - | 4 | - | - | 16 |
| CO3 | - | 20 | 12 |  | - | - | 32 |
| CO4 | - | 16 | - | - | - | - | 16 |
| CO5 | - | 16 | - | - | - | - | 16 |
| CO6 | - | 20 | - | - | - | - | 20 |
|  | | | | | | | **132** |



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

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(5 X 16= 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Brief the following: (i) Joint probability (ii) Conditional probability and (iii) Bayesian rule.  A patient takes a lab test and the result comes back positive. It is known that the test returns a correct positive result in only 98% of the cases and a correct negative result in only 97% of the cases. Furthermore, only 0.008 of the entire population has this disease. 1. What is the probability that this patient has cancer? 2. What is the probability that he does not have cancer? 3. What is the diagnosis? | CO1 | U | 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 component using PCA Algorithm. | CO1 | A | 10 |
|  |  |  |  |  |  |
| 2. | a. | 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 |
|  | b. | Compare and contrast the Linear and Logistic regression equations. | CO2 | U | 6 |
|  |  |  |  |  |  |
| 3. |  | 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 1 epoch only. At the end of this epoch show: a) The new clusters (i.e. the examples belonging to each cluster). b) The centers of the new clusters  c) Draw a 10 by 10 space with all the 8 points and show the clusters after the first epoch and the new centroids. d) How many more iterations are needed to converge? Draw the result for each epoch. | CO3 | An | 16 |
|  |  |  |  |  |  |
| 4. | 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 | An | 10 |
|  | b. | Calculate the Pearson correlation coefficient and Spearman correlation coefficient for the following data?   |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | X | 5 | 10 | 5 | 11 | 12 | 4 | 3 | 2 | 7 | 1 | | Y | 1 | 6 | 2 | 9 | 5 | 1 | 4 | 8 | 5 | 7 | | CO4 | A | 6 |
|  |  |  |  |  |  |
| 5. | a. | Explain the support vector machine from the perspective of the nonlinear Kernel by means of an algorithm. Derive the margin of the support vectors with an example and depict it with necessary diagrams. | CO5 | U | 10 |
|  | b. | Discuss about the random forest algorithm using bagging and boosting models. | CO5 | U | 6 |
|  |  |  |  |  |  |
| 6. |  | Construct the dendrogram using Single Linkage method for Hierarchical Agglomerative Clustering.   |  |  |  | | --- | --- | --- | |  | 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 | | CO3 | An | 16 |
|  |  |  |  |  |  |
| 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. | Describe the concept on density based clustering and write the steps involved in DBSCAN algorithm. | CO3 | U | 6 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. |  | Discuss the benefits of applying the Apriori principle in the context of the Apriori algorithm for the association rules mining. | CO6 | A | 20 |

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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 | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 |  | 6 | 10 |  |  |  | 16 |
| CO2 |  | 6 |  | 10 |  |  | 16 |
| CO3 |  | 6 |  | 16+16 |  |  | 38 |
| CO4 |  |  | 6+10 | 10 |  |  | 26 |
| CO5 |  | 16 |  |  |  |  | 16 |
| 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** | | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | | |
| 1. | a. | | With a neat diagram explain in detail about feed forward networks. | CO1 | A | 15 |
|  | b. | | Write a short note on back propagation algorithm. | CO1 | U | 5 |
|  |  | | **(OR)** |  |  |  |
| 2. | a. | | With a neat block diagram, elaborate the architecture of any two  Convolutional networks. | CO2 | A | 15 |
|  | b. | | Write a short note on pooling. | CO2 | U | 5 |
|  |  | |  |  |  |  |
| 3. | a. | | Explain in detail about sparse coding unsupervised deep learning. | CO3 | An | 15 |
|  | b. | | Briefly describe about Adversarial Generative Networks. | CO3 | U | 5 |
|  |  | | **(OR)** |  |  |  |
| 4. | a. | | Mention the applications of deep learning of computer vision. | CO4 | U | 15 |
|  | b. | | Discuss about the attention model for computer vision. | CO4 | R | 5 |
|  |  | |  |  |  |  |
| 5. | a. | | Explain in detail about the Vector Space Model of Semantics. | CO5 | A | 15 |
|  | b. | | Write a short note on Opinion Mining using Recurrent Neural Networks. | CO5 | U | 5 |
|  |  | | **(OR)** |  |  |  |
| 6. | a. | | With neat diagram explain Image generation with Generative adversarial networks. | CO4 | A | 15 |
|  | b. | | Briefly describe about object detection. | CO4 | U | 5 |
|  |  | |  |  |  |  |
| 7. | 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 |
|  |  | | **(OR)** |  |  |  |
| 8. | a. | | Explain in detail about Heuristics algorithms for faster training. | CO1 | A | 15 |
|  | b. | | Write short note regularization and drop out. | CO1 | U | 5 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | | |
| 9. | a. | Discuss about the Sentence Classification using Convolutional Neural Networks in detail. | | CO6 | A | 15 |
|  | b. | Write a short note on Dialogue topic tracking. | | CO6 | U | 5 |

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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 | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 |  | 10 | 30 |  |  |  | 40 |
| CO2 |  | 5 | 15 |  |  |  | 20 |
| CO3 |  | 5 |  | 15 |  |  | 20 |
| CO4 | 5 | 20 | 15 |  |  |  | 40 |
| CO5 |  | 10 | 30 |  |  |  | 40 |
| CO6 |  | 5 | 15 |  |  |  | 20 |
|  | | | | | | | **180** |

Graphical user interface, application

Description automatically generated with medium confidence

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| **Course Code** | **20RO3025** | **Duration** | **3hrs** |
| **Course Name** | **ENTREPRENEURSHIP DEVELOPMENT FOR ROBOTICS AND AUTOMATION** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(5 X 16= 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Interpret the term entrepreneur. Describe the characteristics of entrepreneur. | CO1 | R | 8 |
|  | b. | Demonstrate the 3rd and 4th stage in business life cycle in detail. | CO1 | R | 8 |
| 2. |  | Describe the recruitment procedure followed by entrepreneurs for selecting the suitable candidates. Also mention the major challenges faced by the entrepreneurs. | CO2 | R | 16 |
| 3. |  | Illustrate the step-by-step procedure for making feasibility report for starting a small industry. | CO3 | U | 16 |
| 4. |  | Explain the history of your favorite entrepreneur and discuss the entrepreneurial ethics of their company. | CO4 | R | 16 |
| 5. |  | Explain the working of different business incubators with necessary examples. | CO5 | U | 16 |
| 6. | a. | State the importance and necessity of financial management. | CO2 | U | 8 |
|  | b. | Illustrate the entrepreneurial challenge in the context of time management. | CO2 | U | 8 |
| 7. | a. | Demonstrate the mechanism for handling customer complaints. | CO4 | AN | 8 |
|  | b. | Describe the various sickness in small business. | CO5 | R | 8 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | State the concept of sales tax and discuss its types in detail. | CO6 | U | 10 |
|  | b. | Explain the concepts of Taxation and its need in detail. | CO6 | U | 10 |

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|  | **COURSE OUTCOMES** |
| CO1 | Recall the basics for entrepreneurship. |
| CO2 | Analyze the challenges in entrepreneurship. |
| CO3 | Examine the responsibilities for entrepreneurship. |
| CO4 | Understand the ethics in entrepreneurship. |
| CO5 | Analyze the support for entrepreneur. |
| CO6 | Analyze the financial and accounting needs. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 16 |  |  |  |  |  | 16 |
| CO2 | 16 | 16 |  |  |  |  | 32 |
| CO3 |  | 16 |  |  |  |  | 16 |
| CO4 | 16 |  |  | 8 |  |  | 24 |
| CO5 | 8 | 16 |  |  |  |  | 24 |
| CO6 |  | 20 |  |  |  |  | 20 |
|  | | | | | | | **132** |

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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** | | | **Course Outcome** | | **Bloom’s Level** | | | **Marks** | |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | | | | | |
| 1. | State the Principle of transmissibility of force. | | | CO1 | | R | | | 1 | |
| 2. | Define Varignon’s theorem. | | | CO1 | | R | | | 1 | |
| 3. | Define center of gravity. | | | CO2 | | R | | | 1 | |
| 4. | What is the statement of Parallel Axis theorem? | | | CO2 | | R | | | 1 | |
| 5. | State D’Alembert‘s principle. | | | CO3 | | R | | | 1 | |
| 6. | What are the three main types of motion? | | | CO3 | | R | | | 1 | |
| 7. | What do you mean by work-energy principle? | | | CO4 | | R | | | 1 | |
| 8. | Define the principle of Impulse momentum. | | | CO4 | | R | | | 1 | |
| 9. | State Grashoff’s law. | | | CO5 | | R | | | 1 | |
| 10. | What is a kinematic pair chain? | | | CO5 | | R | | | 1 | |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | | | | | |
| 11. | Describe the different types of supports and their reactions. | | | CO1 | | | U | | | 3 |
| 12. | Discuss about radius of gyration with examples. | | | CO2 | | | U | | | 3 |
| 13. | How do you explain projectile motion? | | | CO3 | | | U | | | 3 |
| 14. | A flywheel starts from rest and after a minute rotates at 3000 rpm. Calculate:   * Angular acceleration * Number of revolutions made by wheel in this period | | | CO4 | | | A | | | 3 |
| 15. | What is the difference between Kutzbach criterion and Grubler criterion? | | | CO5 | | | U | | | 3 |
| 16. | Discuss the basic steps involved in Machine design process. | | | 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. |  | Two spheres A and B of weight 1000 N and 750 N, respectively are kept asshown in the Fig. Determine the reactions at all contact points 1, 2, 3 and 4.Radius of A = 400 mm and Radius of B = 300 mm. | CO1 | | | | | A | | 12 |
|  |  |  |  | | | | |  | |  |
| 18. |  | Determine the moment of inertia of the plane area shown in Figure, about thecentroidal x-axis and centroidal y-axis. | CO2 | | | | | A | | 12 |
|  |  |  |  | | | | |  | |  |
| 19. |  | On turning a corner, a motorist rushing at 20 m/s, finds a child on the road 50m ahead. He instantly stops the engine and applies brakes, so as to stop the car within 10 m of the child. Calculate:   * Retardation   Time required to stop the car | CO3 | | | | | A | | 12 |
|  |  |  |  | | | | |  | |  |
| 20. |  | Two bodies A and B of mass 80 kg and 20 kg are connected by a thread and move along a rough horizontal plane under the action of a force 400 N applied to the first body of mass 80 kg as shown in Fig.    The coefficient of friction between the sliding surfaces of the bodies and the plane is 0.3. Determine the acceleration of the two bodies and the tension in the thread, using D' Alembert’s principle. | CO4 | | | | | A | | 12 |
|  |  |  |  | | | | |  | |  |
| 21. |  | What is a kinematic chain? Describe the construction of four bar chain. What are the applications of four bar chain. | CO5 | | | | | An | | 12 |
|  |  |  |  | | | | |  | |  |
| 22. | a. | Discuss the following terms:   * Statics * Dynamics * Kinematics * Kinetics | CO1 | | | | | U | | 6 |
|  | b. | Find the tension in each rope as shown in Figure. | CO1 | | | | | A | | 6 |
|  |  |  |  | | | | |  | |  |
| 23. | a. | Describe D’Alembert’s principle of dynamic equilibrium. | CO4 | | | | | U | | 6 |
|  | b. | Describe the following:   * Completely constrained motion * Incompletely constrained motion   Successfully constrained motion | CO5 | | | | | U | | 6 |
| **COMPULSORY QUESTION** | | | | | | | | | | |
| 24. |  | With the help of a block diagram, discuss the steps involved in the process of machine design. | | | CO6 | | | An | | 12 |

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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 Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 2 | 9 | 18 | - | - | - | 29 |
| CO2 | 2 | 3 | 12 | - | - | - | 17 |
| CO3 | 2 | 3 | 12 | - | - | - | 17 |
| CO4 | 2 | 6 | 15 | - | - | - | 23 |
| CO5 | 2 | 9 | - | 12 | - | - | 23 |
| CO6 | - | 3 | - | 12 | - | - | 15 |
|  | | | | | | | **124** |

**Graphical user interface, application

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

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | Name the performance characteristic that indicates the minimum weight that can be handled by a robot. | | CO1 | R | | 1 |
| 2. | Identify the Gripper suitable for light weight 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. | List the various coordinate systems used to represent the position and orientation of robot. | | CO3 | U | | 1 |
| 6. | Give an example of velocity sensors used in robotic systems. | | CO3 | R | | 1 |
| 7. | Give an example of serial robots. | | CO4 | U | | 1 |
| 8. | How many degrees of freedom would the functional industrial robot have? | | CO4 | R | | 1 |
| 9. | Identify the type of automation that is used in robotic applications. | | CO5 | U | | 1 |
| 10. | Outline the technological aspects incorporated in smart cities. | | CO6 | U | | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | Specify the significant features of industrial robots. | | CO1 | | U | 3 |
| 12. | Bring out the difference between serial and parallel robots. | | CO2 | | U | 3 |
| 13. | Mention the advantages of using robots in a manufacturing process. | | CO3 | | U | 3 |
| 14. | Specify the significant features of collaborative robots. | | CO4 | | U | 3 |
| 15. | Mention the purpose of Robot’s motion planning. | | CO5 | | R | 3 |
| 16. | Compare forward and reverse kinematics in robotics. | | 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. |  | Classify robots based on the shape of its work volume and describe the characteristics of each type with relevant diagrams and explanations. | CO1 | | A | 12 |
|  |  |  |  | |  |  |
| 18. |  | Briefly explain the automation system with an example. | CO2 | | A | 12 |
|  |  |  |  | |  |  |
| 19. |  | With neat diagram briefly explain the working principle of acceleration sensor. | CO3 | | A | 12 |
|  |  |  |  | |  |  |
| 20. |  | Explain force measurement in robotic applications with neat diagrams. | CO3 | | An | 12 |
|  |  |  |  | |  |  |
| 21. |  | Explain house hold robotic systems and describe the technical aspects involved in these features. | CO5 | | An | 12 |
|  |  |  |  | |  |  |
| 22. | a. | Explain the types of mobile robots and elaborate upon their design aspects. | CO4 | | A | 6 |
|  | b. | Explain underwater robotic applications with neat diagrams. | CO5 | | A | 6 |
|  |  |  |  | |  |  |
| 23. |  | Explain the application of robots in the health care sector. | CO6 | | An | 12 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. |  | Explain the application of robot in spot welding and state the technical considerations in spot 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 | 1 | 4 | 12 | - | - | - | 17 |
| CO2 | - | 5 | 12 | - | - | - | 17 |
| CO3 | 1 | 4 | 12 | 12 | - | - | 29 |
| CO4 | 1 | 4 | 6 | - | - | - | 11 |
| CO5 | 3 | 1 | 6 | 12 | - | - | 22 |
| 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** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(5 X 16= 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | List out various control functions that are utilized to control the operation of an automatic transfer system. | CO1 | A | 6 |
|  | b. | A 30 station Transfer line is being proposed to machine a certain component currently produced by conventional methods. The proposal received from the machine tool builder states that the line will operate at a production rate of 100 pc / hr at 100% efficiency. From a similar transfer line it is estimated that breakdowns of all types will occur at a frequency of F = 0.20 breakdowns per cycle & that the average downtime per line stop will be 8.0 minutes. The starting blank that is machined on the line costs Rs. 5.00 per part. The line operates at a cost for 100 parts each & the average cost per tool = Rs. 20 per cutting edge. Compute the following:  1. Production rate  2. Line efficiency  3. Cost per unit piece produced on the line | CO1 | An | 10 |
|  |  |  |  |  |  |
| 2. | a. | List out various types of automated assembly systems. Explain in detail. | CO2 | U | 8 |
|  | b. | Describe the computerized line balancing method with suitable example. | CO2 | U | 8 |
|  |  |  |  |  |  |
| 3. |  | 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 Kilbridge and Wester method. (e) How many stations are required? (f) Compute the balance delay | CO2 | An | 16 |
|  |  |  |  |  |  |
| 4. |  | List out various unit load formation equipment. Explain each in detail. | CO3 | A | 16 |
|  |  |  |  |  |  |
| 5. | a. | Explain the functions and components of Automated Guided Vehicles. Explain its types. | CO3 | U | 10 |
|  | b. | Write down the principles of Material Handling. | CO3 | U | 6 |
|  |  |  |  |  |  |
| 6. | a. | Describe the Carousel Storage Systems in detail. | CO4 | A | 8 |
|  | b. | Explain the components and Terminology used in Automatic Storage/Retrieval system. | CO4 | A | 8 |
|  |  |  |  |  |  |
| 7. |  | Describe Automated Inspection Principles and Methods in detail. | CO5 | U | 16 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Explain the steps involved for Production of Tzatziki Salad in detail. | CO6 | A | 10 |
|  | b. | Describe the procedure of Barrel Filling System for Dry Bulk Material 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 |  |  | 6 | 10 |  |  | 16 |
| CO2 |  | 16 |  | 16 |  |  | 32 |
| CO3 |  | 16 | 16 |  |  |  | 32 |
| CO4 |  |  | 16 |  |  |  | 16 |
| CO5 |  | 16 |  |  |  |  | 16 |
| CO6 |  |  | 20 |  |  |  | 20 |
|  | | | | | | | **132** |



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| **Course Code** | **21RO3005** | **Duration** | **3hrs** |
| **Course Name** | **ADVANCED ROBOT OPERATING SYSTEMS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | With block diagram, explain ROS architecture. | CO1 | U | 14 |
|  | b. | Elaborate on navigation through file system. | CO1 | A | 6 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Draw the flow diagram of turtlesim and write the ROS programming for moving a turtlebot. | CO2 | A | 20 |
|  |  |  |  |  |  |
| 3. | a. | Justify why we need to transform between two frames in ROS. | CO3 | E | 10 |
|  | b. | Summarize the tricks  to reduce the amount of code in a URDF file using Xacro. | CO3 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Illustrate with example the configuration of 3D sensors on robot with MoveIt. | CO4 | A | 20 |
|  |  |  |  |  |  |
| 5. |  | Interpret YOLO object detection with ROS. | CO5 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Describe how to use MOVEIt Transfer REST API to complete the task of sending a package. | CO5 | An | 20 |
|  |  |  |  |  |  |
| 7. |  | Apply ros\_control framework used to implement and manage robot controllers for real robots and in simulation within gazebo. | CO3 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Summarize the steps involved in migrating from ROS 1 to ROS 2. | CO6 | U | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Develop the procedure for ROS 2 simulation in gazebo. | CO6 | An | 20 |

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the need for ROS and its significance. |
| CO2 | Summarize the Linux commands used in robotics. |
| CO3 | Discuss about the concepts behind navigation through file system. |
| CO4 | Explain the concepts of Node debugging. |
| CO5 | Analyse the issues in hardware interfacing. |
| CO6 | Able to program mobile robot and Industrial Robot. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 |  | 14 | 6 |  |  |  | 20 |
| CO2 |  |  | 20 |  |  |  | 20 |
| CO3 |  | 10 | 20 |  | 10 |  | 40 |
| CO4 |  |  | 20 |  |  |  | 20 |
| CO5 |  |  | 20 | 20 |  |  | 40 |
| CO6 |  | 20 |  | 20 |  |  | 40 |
|  | | | | | | | **180** |



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| **Course Code** | **21RO3006** | **Duration** | **3hrs** |
| **Course Name** | **AUTONOMOUS MOBILE ROBOTS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Write a short note on the leg configuration and stability of robots. | CO1 | U | 15 |
|  | b. | Mention some examples of legged robot locomotion. | CO1 | U | 5 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | With neat diagrams explain about the wheel kinematic constraints  of mobile robots. | CO2 | A | 15 |
|  | b. | Write a short note on mobile robot maneuverability. | CO2 | U | 5 |
|  |  |  |  |  |  |
| 3. | a. | Explain in detail about the characteristics of sensor performance. | CO3 | An | 15 |
|  | b. | Write a short note on active ranging. | CO3 | U | 5 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Draw the schematic representation for mobile robot localization and explain in detail about the challenges of localization. | CO4 | A | 15 |
|  | b. | Write some examples of localization systems. | CO4 | R | 5 |
|  |  |  |  |  |  |
| 5. | a. | Explain in detail about the Kalman filter localization. | CO4 | A | 15 |
|  | b. | Explain the schematic representation of Kalman filter. | CO4 | U | 5 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Explain about mobile robot workspace. | CO2 | U | 15 |
|  | b. | Discuss about feedback control of autonomous mobile robots. | CO3 | R | 5 |
|  |  |  |  |  |  |
| 7. | a. | Explain in detail about the wheeled mobile robots. | CO1 | U | 15 |
|  | b. | Discuss about the omnidirectional drive. | CO1 | R | 5 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Explain in detail about Markov localization. | CO5 | A | 15 |
|  | b. | Explain briefly URDF in Robotics. | CO5 | U | 5 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Highlight the role application of autonomous mobile robots in real life. | CO6 | A | 15 |
|  | b. | Explain about integrated planning and execution of mobile robots. | CO6 | U | 5 |

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|  | **COURSE OUTCOMES** |
| CO1 | Recall the overview of mobile robots. |
| CO2 | Discuss Describe the kinematic models and manoeuvrability of Robots. |
| CO3 | Identify the sensing elements and actuators used in mobile robots. |
| CO4 | Create solutions to localize the mobile robots using various techniques. |
| CO5 | Create solutions to plan and navigate the mobile robots using various techniques. |
| CO6 | Apply the concept of ROS for mobile robots in various applications. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 5 | 35 |  |  |  |  | 40 |
| CO2 |  | 20 | 15 |  |  |  | 35 |
| CO3 | 5 | 5 |  | 15 |  |  | 25 |
| CO4 | 5 | 5 | 30 |  |  |  | 40 |
| CO5 |  | 5 | 15 |  |  |  | 20 |
| CO6 |  | 5 | 15 |  |  |  | 20 |
|  | | | | | | | **180** |