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Reg. No. :

Question Paper Code : 90852

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

Seventh/Eighth Semester

Mechanical Engineering

ME 8099 – ROBOTICS

(Common to: Automobile Engineering/Manufacturing Engineering/Mechanical Engineering (Sandwich)/ Mechanical and Automation Engineering/Production Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

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1. Mention the four basic robot configurations that are commercially available.
2. List the characteristics that define the precision of a robot's movement.
3. List any four important factors to consider when selecting and designing grippers.
4. Explain why the stripping device is required in the magnetic grippers.
5. What are some desirable engineering characteristics of sensors?
6. Schematically illustrate the basic functions of machine vision and their relationships.
7. A frame F was rotated about the y-axis 90^0, followed by a rotation about the o-axis of 30°, followed by a translation of 5 units along the n-axis, and finally, a translation of 4 units along the x-axis. Write an equation that describes the motions.
8. Distinguish between Path and Trajectory.
9. What distinguishes RGV from AGV?
10. Define the payback period and formula.

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PART B — (5 × 13 = 65 marks)

11. (a) (i) Explain briefly the factors to be considered when determining the robot's desired speed and load-carrying capability. (10)

(ii) Draw a robot wrist with pitch, yaw, and roll indicated. (3)

Or

(b) Explain the major components of a robot and their functions with a conceptual sketch.

12. (a) Explain and compare the various drive systems used with an industrial robot, along with their selection criteria. Suggest a suitable drive system for the robot with medium speed and strength, as well as improved accuracy and repeatability. Justify your choice with an appropriate reason.

Or

(b) Examine the various grippers that can be used with an industrial robot. Suggest a suitable gripper for the component depicted in Figure 1. Justify your choice with an appropriate reason.

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Figure 1. 18-8 Stainless Steel Flange

13. (a) Explain the various technologies available for designing proximity and range sensors, as well as their applications in robots.

Or

(b) (i) Explain the significance of illumination in a vision sensor. (3)

(ii) Explain and contrast various machine vision lighting techniques. (10)

14. (a) Derive the forward and inverse kinematic equations of a 2 DOF RR configuration robot And also determine the values to which the angles of 2 DOF RR configuration manipulators must be set to achieve the point (24, 14) in space, if the length of links 1 and 2 are 20 cm and 15 cm respectively.

Or

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(b) (i) Discuss programming languages used in computer-controlled robots. (4)

(ii) Create a VAL II program to instruct a PUMA robot to unload a cylindrical part with a diameter of 10 mm from machine 1 at point P1 and load the part on machine 2 at point P2. The robot moves at a rate of 40 inches per second. However, for safety reasons, the speed is reduced to 10 inches per second when moving to a machine for unloading or loading. (9)

15. (a) Explain briefly the various steps involved in implementing the robot in industries.

Or

(b) Explain briefly the three levels of safety sensor systems in robotics as defined by the National Bureau of Standards.

PART C — (1 × 15 = 15 marks)

16. (a) A camera is attached to the hand frame T_H of a robot as given. The corresponding inverse Jacobian of the robot at this location is also shown. The robot makes a differential motion described as D= [0.05, 0 –0.1 0 0.1 0.03]^T.

$$T = \begin{bmatrix} 0 & 1 & 0 & 3 \\ 1 & 0 & 0 & 2 \\ 0 & 0 & -1 & 8 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad J^{-1} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 2 & 0 & -1 & 0 & 0 & 0 \\ 0 & -0.2 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

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(i) Find which joints must make a differential motion, and by how much, to create the indicated differential motions. (4)

(ii) Find the change in the frame. (3)

(iii) Find the new location of the frame after the differential motion. (4)

(iv) Find how much the differential motions (given above) should have been, if measured relative to Frame T, to move the robot to the same new location as in part (iii). (4)

Or

(b) An automated manufacturing system for machining crankshafts in a forging industry is planning to implement AGVs in the production line. There are five CNC workstations (A, B, C, D, F) and a load-unload station (F). The approximate time of moving the crankshaft on AGVs between stations is shown in Table.

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CNC Workstations	A	B	C	D	E	F
A	–	2.5				05
B	2.5	–	3.0			
C		3.0	–	2.0		
D			2.0	–	1.5	
E				1.5	–	1.0
F	0.5				1.0	

One hundred crankshafts are finished and packed every 8 hours shift and the crankshaft operations are performed in sequence from station A to E, which uses an asynchronous transport system for work part transfer. Every pickup and drop-off at all five stations takes approximately 0.75 min. The availability, load factor (effect of load on vehicle speed) and traffic factor are assumed to be 0.90, 0.75 and 0.95 respectively. Design a flow path layout for the given application, the layout requires the AGV pathway network to be fixed permanently and calculate the number of AGVs required. Fill the following table based on the above information and substantiate the answers with appropriate reasons.

S.No	AGV Characteristics	Type or method that best suits the application
1	Type of AGV	
2	Type of flow path	
3	Guidance system	
4	Load transfer	
5	Control System	

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