

B.E DEGREE EXAMINATIONS: APRIL/MAY 2014

(Regulation 2009)

Sixth Semester

ELECTRONICS AND INSTRUMENTATION ENGINEERING

EIE119: Robotics and Automation

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. The number of degrees of freedom of a manipulator depends on number of independent
 - a) Position variable
 - b) Joint variables
 - c) Links
 - d) Joint
2. The robot configuration which covers large floor space
 - a) Cartesian
 - b) Articulated
 - c) cylindrical
 - d) Spherical
3. The dynamic model of an arm can be obtained from physical laws such as
 - a) Law of Jacobian
 - b) Laws of Newtonian and lagrangian
 - c) Laws of biot savart
 - d) Laws of Fourier
4. If scale factor w is greater than unity, the vector component are
 - a) Enlarge
 - b) Small
 - c) Unchanged
 - d) Very small
5. The jacobian matrix represents
 - a) $[D]=[J][D\theta]$
 - b) $[D\theta]=[D][J]$
 - c) $[J]=[D][D\theta]$
 - d) $[J]=2[J][D\theta]$
6. Articulated co-ordinates is also called as
 - a) Rectangular
 - b) Anthromorphic
 - c) Gantry
 - d) Circular
7. Path and trajectory planning requires the use of _____ of robot.
 - a) Dynamics
 - b) Kinematics
 - c) Both a and b
 - d) None of the above
8. MIMO manipulator is controlled by _____.
 - a) Approximating MIMO system
 - b) Treating it as a single joint
 - c) N independent SISO system
 - d) All the above
9. If the roots are real and unequal, the response is called _____.

- a) Under damped
 - b) Critically damped
 - c) Over damped
 - d) Undamped
10. The specified trajectory may require the robot to run into itself or out of reach in _____.
 - a) Trajectory with acceleration/deceleration
 - b) Joint space trajectory normalized movements
 - c) Joint space trajectory non normalized
 - d) Cartesian space trajectory

PART B (10 x 2 = 20 Marks)

11. Define robot and write about their classification.
12. What is meant by end effectors.
13. Write the format of DH parameter table.
14. Write the matrix representation of Cylindrical co ordinates.
15. Define path and trajectory.
16. How to blend different motion segments in a path?
17. Write the computer loop to convert positions and orientations of the hand to joint values through inverse kinetic equations.
18. Mention the difference between Cartesian-space trajectories and Joint- space trajectories.
19. With neat diagrams explain the responses of system based on the location of roots.
20. Draw the high – level block diagram of a robot-control system.

PART C (5 x 14 = 70 Marks)

21. a) Describe in detail about the hydraulic and pneumatic actuators and discuss the differences between them.

(OR)

- b) i) What are the advantages and disadvantages of robot. (7)
- ii) Discuss about any 2 robotic applications. (7)

22. a) Derive the forward and inverse kinematics equation for orientation.

(OR)

- b) Explain about the DH representation of forward kinematics equations of robot.

23. 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 $D=[0.05 \ 0 \ -0.1 \ 0 \ 0.1 \ 0.03]^T$

- a) Find which joints must make a differential motion, and by how much, in order to create the indicated differential motions.
- b) Find the change in the hand frame
- c) Find the new location of the camera after the differential motion

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

(OR)

- b) Find the location of the hand after the differential motion, given

$$T = \begin{bmatrix} 1 & 0 & 0 & 5 \\ 0 & 0 & -1 & 3 \\ 0 & 1 & 0 & 2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad J = \begin{bmatrix} 3 & 0 & 0 & 0 \\ -2 & 0 & 1 & 0 \\ 0 & 4 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ -1 & 0 & 0 & 1 \end{bmatrix} \quad \begin{bmatrix} d\theta_1 \\ d\theta_2 \\ d\theta_3 \\ d\theta_4 \end{bmatrix} = \begin{bmatrix} 0.1 \\ -0.1 \\ 0.05 \\ 0.1 \\ 0 \end{bmatrix}$$

24. a) Discuss in detail about the Cartesian-space Trajectories and Joint space trajectories.

(OR)

- b) (i) Explain the basics of Trajectory planning. (7)
- (ii) Explain in detail about the joint – space Trajectory planning. Mention its applications. (7)

25. a) Describe the architecture of an industrial robot controller. List few applications of robots.

(OR)

- b) Explain control law partitioning and trajectory following control with neat diagrams.
