Register Number:……..

KUMARAGURU
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B.E DEGREE EXAMINATIONS: APRIL 2018

(Regulation 2014)

Eighth Semester

ELECTRONICS AND INSTRUMENTATION ENGINEERING

U14EITE07: Robotics and Automation

COURSE OUTCOMES

CO1: Understand the basic concepts of various drive systems for robot, sensors and their applications in robots and programming of robots.

CO2: Apply spatial transformation to obtain forward kinematics equation of robot manipulators.

CO3: Analyze and design the motion for articulated systems.

CO4: Do the path planning for a robotic system.

CO5: Identify control methods for a robotic system.

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Match list I (Parts of a Robot) with list II (Function of their Robot part) and select the correct answer the codes given below. CO1 [K_2]

List I (Robot part)	List II (Function)
A. Manipulator arm	1. For holding a piece or tool
B. Controllers	2. Move the manipulator arm and end effector
C. Drives	3. Number of degrees of freedom of movement
D. Gripper	4. Delivers commands to the actuators

a) A-1, B-4, C-2, D-3 b) A-3, B-4, C-2, D-1

c) A-3, B-2, C-4, D-1 d) A-4, B-3, C-2, D-1

2. Assertion (A): Hydraulic actuators have high efficiency and high power-to-size ratio. CO1 [K_2]

Reason (R): In hydraulic actuators, leakages can occur to cause loss in performance.

a) Both A and R are true and R is the correct explanation of A

b) Both A and R are true but R is not correct explanation of A

c) A is true but R is false

d) A is false but R is true

3. The inverse kinematics problem is much more complex because CO2 [K_1]

a) The equation to be solved are in general non-linear in joint variables
b) Multiple solutions may exist
c) There might be no admissible solutions
d) All the above

4. The rotation about z axis by an angle α. Then the rotation matrix Q is _____ CO2 [K_3]

a) $Q = \begin{bmatrix} C\alpha & -S\alpha & 0 \\ S\alpha & C\alpha & 0 \\ 0 & 0 & 1 \end{bmatrix}$
b) $Q = \begin{bmatrix} C\alpha & S\alpha & 0 \\ S\alpha & C\alpha & 0 \\ 0 & 0 & 1 \end{bmatrix}$
c) $Q = \begin{bmatrix} C\alpha & -S\alpha & 0 \\ S\alpha & -C\alpha & 0 \\ 0 & 0 & 1 \end{bmatrix}$
d) $Q = \begin{bmatrix} C\alpha & -S\alpha & 0 \\ -S\alpha & C\alpha & 0 \\ 0 & 0 & 1 \end{bmatrix}$

5. Consider the following statements for a formulation of robot dynamic of motion. CO3 [K_3]

1. Euler – Lagrange approach eliminates the forces of constraints from the dynamic equation of motion.
2. The eliminated constraints in the Euler – Lagrange approach cannot be recovered by Lagrange multipliers.
3. Newton and Euler equations of motion for each link of the robot results in a system of equations that contain both the applied forces and the forces of constraints.
4. Newton and Euler laws for linear and non-linear rotational motion respectively.

Which of the statements given above are correct?

a) 1, 2, 3 and 4
b) 1, 2 and 3 only
c) 1, 3 and 4 only
d) 1 and 4 only

6. Newton – Euler equations and Euler – Lagrange equations are based on _____ and _____ respectively. CO3 [K_4]

a) Scalar approach & Energy approach
b) Vector approach & Energy approach
c) Energy approach & Vector approach
d) Energy approach & Scalar approach

7. The rate at which the trajectory points are computed at run time is called _____ CO4 [K_1]

a) Path update rate
b) Trajectory generation
c) Spline
d) Path

8. Consider the following for the trajectory planning problem. CO4 [K_2]

1. Task description
2. Computing the trajectory
3. Selecting and employing a trajectory planning technique

Choose the correct sequence for solving the trajectory problem.

a) 1-2-3
b) 2-1-3
c) 3-2-1
d) 1-3-2

9. The system has sluggish and non oscillatory time response, then the damping ratio is _____ CO5 [K_2]

a) 0 b) < 1

c) 0 d) > 1

10. A single link robot has link parameter: I_m=0.02 and I_l=1.5 and gear ratio η=100. Where I_m and I_l are the motor and link inertia in kg.m^2 respectively. The effective inertia's at the output side is _____ CO5 [K_4]

a) 201.5 kg.m^2 b) 200.5 kg.m^2

c) 21.5 kg.m^2 d) 222.5 kg.m^2

PART B (10 x 2 = 20 Marks)

(Answer not more than 40 words)

11. Classify the robots based on actuation systems. CO1 [K_2]
12. Recall degrees of freedom of a robot manipulator. CO1 [K_1]
13. Compare forward kinematics and inverse kinematics. CO2 [K_4]
14. Identify the four parts of Homogenous transformation matrix. CO2 [K_2]
15. Reproduce the Jacobian matrix for prismatic and revolute joint. CO3 [K_1]
16. List the characteristics of Lagrange-Euler formulation in robot dynamics. CO3 [K_1]
17. Indicate the features of joint space trajectory planning algorithm. CO4 [K_2]
18. Differentiate path and trajectory. CO4 [K_4]
19. Identify the simple linear control schemes for the control of robotic manipulator. CO5 [K_2]
20. List the any four non industrial applications of robots. CO5 [K_1]

Answer any FIVE Questions:-

PART C (5 x 14 = 70 Marks)

(Answer not more than 300 words)

Q.No. 21 is Compulsory

21. Determine the direct kinematics equation of the 4 – DOF Selective Compliance Assembly Robot Arm (SCARA) robot and model of SCARA robot shown in Figure:C.1 CO2 [K_5]

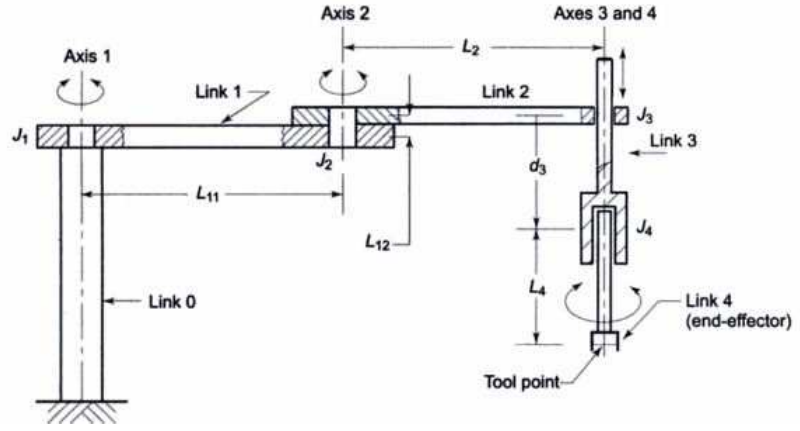

Figure:C.1

22. Illustrate the following four robot configurations: CO1 [K_2]
(i) Polar configuration,
(ii) Cylindrical configuration,
(iii) Cartesian co-ordinate configuration and
(iv) Jointed arm configuration.

23. Examine the Denavit and Hartenberg (DH) algorithm for revolute and prismatic joint. CO2 [K_4]

24. Summarize the Lagrange-Euler algorithm to derive the closed form of dynamic model of a manipulator. CO3 [K_2]

25. Examine the third order polynomial trajectory planning. CO4 [K_3]

26. Explain the any two applications of robots in manufacturing. CO5 [K_2]

27. (i) Illustrate the robot language structure. (7) CO1 [K_2]
(ii) Differentiate between Joint space and Cartesian space descriptions. (7) CO4 [K_4]

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