



**B.E DEGREE EXAMINATIONS: MAY 2018**

(Regulation 2015)

Sixth Semester

**ELECTRONICS AND INSTRUMENTATION ENGINEERING**

U15EITE16 : Robotics and Automation

**COURSE OUTCOMES**

**CO1:** Understand the basic concepts of various types of robot configurations.

**CO2:** Understand the different types of sensors, actuators, drive systems for robot and their applications in robots

**CO3:** Apply spatial transformation to obtain forward kinematics equation of robot manipulators

**CO4:** Analyze and design the motion for articulated systems.

**CO5:** Do the path planning for a robotic system.

**CO6:** 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. Matching type item with multiple choice code

CO1 [K<sub>2</sub>]

List I	List II
A. Three linear (3P) joints position followed by	i. Spherical
B. one prismatic and two revolute (2RP) joints position followed by	ii. Articulated
C. Two prismatic and one revolute (R2P) joints position followed by	iii. Cartesian
D. Three revolute (3R) joints position followed by	iv. Cylindrical

	A	B	C	D
a)	ii	i	iii	iv
b)	iii	iv	ii	i
c)	ii	iv	iii	i
d)	iii	i	iv	ii

2. \_\_\_\_\_ is responsible for the physical action of the robot CO1 [K<sub>1</sub>]
- a) Arm b) Actuator  
 c) Sensor d) End Effectors
3. Which of the following statements are concerning Fixed reference frame? CO3 [K<sub>2</sub>]
- 1) Fixed reference frame are vectors mutually perpendicular to each other axis  
 2) Fixed reference frame are vectors are expressed the only object location  
 3) Fixed reference frame are vectors are expressed the object location and orientation relative  
 4) ) Fixed reference frame are vectors are expressed the only components relative
- a) 1,3 b) 1,4  
 c) 1,2 d) 2,3
4. Setting components of the location of the hand frame of the cylindrical matrix  $r\cos\alpha = 3$ ,  $r\sin\alpha = 4$ . Find  $\alpha$  CO3 [K<sub>1</sub>]
- a) -49.1 b) -53.1  
 c) 53.1 d) 49.1
5. Assertion (A): Directional vector can be represented by  $w=0$  CO4 [K<sub>1</sub>]  
 Reason (R): length is not importance, but direction is represent by components of vector
- a) Both A and R are Individually true and R is the correct explanation of A b) Both A and R are Individually true but R is not the correct explanation of A  
 c) A is true but R is true d) A is false but R is true
6. The jacobian matrix represents CO4 [K<sub>1</sub>]
- a)  $[D_{\square}] = [J][D_{\square}]$  b)  $[D] = [J_{\square}][D]$   
 c)  $[D] = [J_{\square}][D_{\square}]$  d)  $[D] = [J][D_{\square}]$
7. Third-order polynomial Trajectory boundary conditions are CO5 [K<sub>1</sub>]
- 1)  $\square(t_f) = C_0 + C_1 t_f + C_2 t_f^2 + C_3 t_f^3$   
 2)  $\square(t_i) = \square_i$   
 3)  $\square(t_f) = \square_f$   
 4)  $\square(t_i) = C_1 + 2C_2 t_f + 3C_3 t_f^2$
- a) 2-3-4-1 b) 1-3-2-4  
 c) 3-4-2-1 d) 4-1-3-2

8. The sequence of the movements that robots makes is described in CO5 [K<sub>1</sub>]  
 a) Joint space b) Cartesian Path  
 c) Cartesian space d) Joint path
9. Assertion (A): MIMO manipulator articulate robot control strategy CO6 [K<sub>1</sub>]  
 Reason (R): It controlled independently.  
 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 the correct explanation of A  
 c) A is true but R is false d) A is false but R is true
10. Which of the following statements concerning implementation of robotic systems is correct? CO6 [K<sub>1</sub>]  
 a) implementation of robots CAN save existing jobs b) implementation of robots CAN create new jobs  
 c) robotics could prevent a business from closing d) all of the mentioned

**PART B (10 x 2 = 20 Marks)**  
**(Answer not more than 40 words)**

11. What is meant by End Effectors? CO1 [K<sub>2</sub>]
12. Classify of robot programming language. CO1 [K<sub>2</sub>]
13. Write the matrix representation of spherical co ordinates of robot. CO2 [K<sub>2</sub>]
14. It is desired to position the origin of the hand frame of a Cartesian robot at point P = [3, 4, 7]<sup>T</sup>. CO3 [K<sub>3</sub>]  
 Calculate the necessary Cartesian coordinate motion that need to be made.
15. State Lagrangian mechanics. CO4 [K<sub>2</sub>]
16. Calculate the linear and angular differential motion of the Jacobian robot's hand frame for CO4 [K<sub>3</sub>]  
 given joint differential motions

$$J = \begin{bmatrix} 2 & 0 & 0 & 0 & 1 & 0 \\ -1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 2 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad D\theta = \begin{bmatrix} 0 \\ 0.1 \\ -0.1 \\ 0 \\ 0 \\ 0.2 \end{bmatrix}$$

17. Differentiate Cartesian space trajectories and joint space trajectories. CO5 [K<sub>2</sub>]
18. Differentiate path vs trajectory. CO5 [K<sub>2</sub>]
19. List out the general considerations in robot material handling. CO6 [K<sub>2</sub>]
20. Mention any four applications of Robots in manufacturing industries. CO6 [K<sub>2</sub>]

**Answer any FIVE Questions:-**  
**PART C (5 x 14 = 70 Marks)**  
**(Answer not more than 300 words)**

**Q.No. 21 is Compulsory**

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|---|-----|-------------------|
| 21. What is a robot? What are the classifications of robots? Also explain the advantage and disadvantage of Robot.  | CO1 | [K <sub>2</sub> ] |
| 22. What is Homogeneous transformation matrix? Write the transformation matrix for translational and rotational transformation.                               | CO2 | [K <sub>3</sub> ] |
| 23. Explain in detail about the DH representation of forward kinematics equations of robot.   | CO2 | [K <sub>2</sub> ] |
| 24. Drive the Dynamic equations for multiple degrees of the robots.   | CO3 | [K <sub>3</sub> ] |
| 25. Discuss the schemes used in joint-space trajectory planning.<br>i) Third order polynomial trajectory planning<br>ii) Linear segment with parabolic blends | CO4 | [K <sub>2</sub> ] |
| 26. What are the advantages and disadvantages of robot? Write a note on the below stated robot application.<br>i) Spray painting<br>ii) Palletizing           | CO5 | [K <sub>2</sub> ] |
| 27. Describe the architecture of an industrial robot controller. List few applications of robots.   | CO6 | [K <sub>2</sub> ] |

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