

Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
SIXTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), MAY 2019

**Course Code: EC368**

**Course Name: Robotics**

Max. Marks: 100

Duration: 3 Hours

**PART A**

*Answer any two full questions, each carries 15 marks*

Marks

- |   |   |      |
|---|---|------|
| 1 | a) Draw and explain the components and structure of robotic arm.  | (5)  |
|   | b) Explain the working of linear and rotary types of hydraulic actuators with the help of neat diagrams.                  | (10) |
| 2 | a) Describe the characteristics of sensors. Explain various sensors with the help of neat diagrams.                       | (7)  |
|   | b) Briefly explain the speed control and direction control of electric motors.  | (8)  |
| 3 | a) Explain the principle of operation of stepper motors and brushless DC motors. List their advantages and disadvantages. | (8)  |
|   | b) Explain the common kinematic arrangements of robots based on various coordinate systems.                               | (7)  |

**PART B**

*Answer any two full questions, each carries 15 marks*

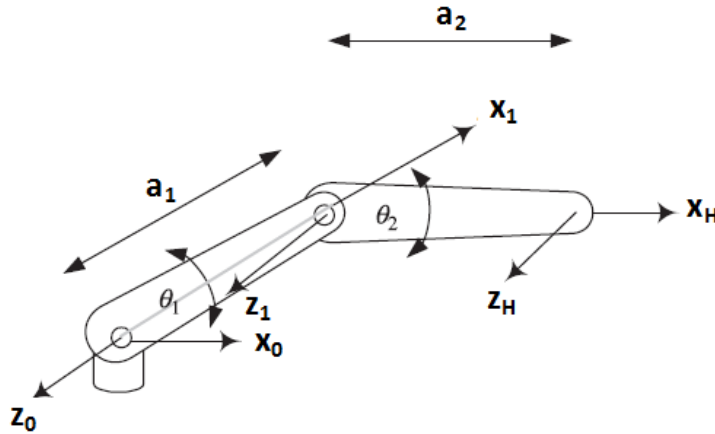
- |   |  |      |
|---|--|------|
| 4 | a) Discuss various image processing techniques used in robotics. | (10) |
|   | b) Calculate the inverse of the following transformation matrix. | (5)  |

$$T = \begin{bmatrix} 0.5 & 0 & 0.866 & 3 \\ 0.866 & 0 & -0.5 & 2 \\ 0 & 1 & 0 & 5 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

- |   |  |     |
|---|--|-----|
| 5 | a) A frame B was rotated about the x-axis 90°, then, it was translated about the current a-axis 3 inches before it was rotated about z-axis 90°. Finally, it was translated about current o-axis 5 inches. | (8) |
|   | a) Write an equation that describes the motion.  |     |
|   | b) Find the final location of a point P (1, 5, 4) <sup>T</sup> attached to the frame relative to the reference frame.  |     |
|   | b) Derive the matrix representing the orientation change with Euler angles. Which are  | (7) |

the fundamental rotations involved in this?

- 6 a) For a simple 2-axis robot shown in figure, (8)
- i) Assign appropriate frames for DH representation.
  - ii) Fill out parameters table.
  - iii) Derive the forward kinematic equations for the robot.

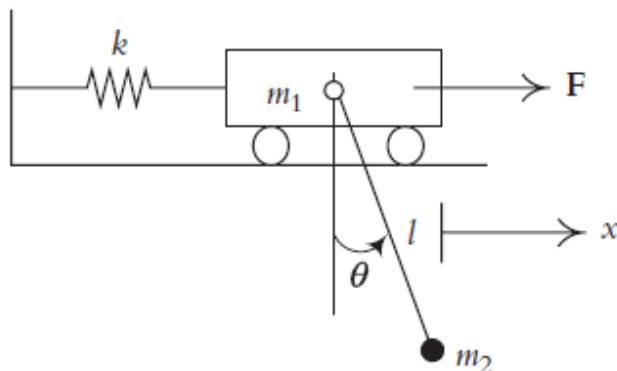


- b) Write homogeneous transformation matrix for translation in cylindrical coordinate system. Which are the three transformations involved? (7)

**PART C**

*Answer any two full questions, each carries 20 marks*

- 7 a) Derive the equations of motion for 2 DOF system shown in figure. (10)



- b) Explain the structure of robot programming language. (10)
- 8 a) Derive the Jacobian operator for linear and angular velocity of end-effector. (10)
- b) Distinguish between textual programming and lead through programming. (5)
  - c) Write VAL commands for controlling end-effector motion of a robot. (5)
- 9 a) What is the role of inverse Jacobian operator in velocity kinematics? Also, explain the significance of singularities in the same. (10)
- b) Describe the state-of-art of robotics. What are mobile robots? (10)

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