|                           | Utech                              |
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| Invigilator's Signature : |                                    |

# CS/B.Tech (CSE)/SEM-8/CS-801A/2010 2010

# **ROBOTIC CONTROL**

Time Allotted: 3 Hours Full Marks: 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

#### **GROUP - A**

## (Multiple Choice Type Questions)

1. Choose the correct alternatives for any ten of the following:

 $10 \times 1 = 10$ 

 i) In the relation between OXYZ coordinate system and OUVW coordinate system

$$p_{xyz} = R_{x,\alpha} \cdot p_{uvw}$$

what is the value of  $(i_x.i_u)$  within  $R_{x,\alpha}$ ?

a) 0

b)  $\cos \alpha$ 

- c)  $\sin \alpha d$
- 1.
- ii) What is called 'roll'?
  - a) A rotation of  $\psi$  about the OX axis ( $R_{x_{-1}}$ )
  - b) A rotation of  $\theta$  about the OY axis  $(R_{y,\theta})$
  - c) A rotation of  $\phi$  about the *OZ* axis  $(R_{z, \phi})$
  - d) None of these.
- iii) In robotics application, the scale factor within the homogeneous transformation matrix is equal to

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## CS/B.Tech (CSE)/SEM-8/CS-801A/2010



a) 0

b) 1

c)  $\cos \theta$ 

- d) none of these
- iv) In Denavit-Hartenberg representation, which axis lies along the axis of motion of a joint?
  - a) Z-axis

b) X-axis

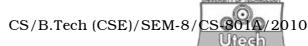
c) Y-axis

d) *U*-axis.

$$v) \quad \text{In } T = \left[ \begin{array}{cccc} n & s & a & p \\ \\ 0 & 0 & 0 & 1 \end{array} \right]$$

### p means

- a) sliding vector of the hand
- b) position vector of the hand
- c) normal vector of the hand
- d) none of these.
- vi) External state sensors deal with the detection of variable such as
  - a) range, proximity and touch
  - b) range and arm joint position
  - c) only arm joint position
  - d) none of these.
- vii) Inductive sensors detect
  - a) all solid materials
  - b) all liquid materials
  - c) all ferromagnetic materials
  - d) none of these.
- viii) Which sensor is the best among the following for sensing all tyes of materials ?
  - a) Half-effect sensors
- b) Inductive sensors
- c) Ultra-sonic sensors
- d) None of these.



- ix) The diffuse lightning approach is a type of
  - a) sensing
- b) illumination technique
- c) flow of control
- d) none of these.

- x) RMFC is
  - a) Robotic Motion Force Control
  - b) Random Motion Force Control
  - c) Resolved Motion Force Control
  - d) Relative Motion Force Control.
- xi) How many DOFs are possible in a rigid mechanical body in 3D space?
  - a) 3

b) 4

c) 5

- d) 6.
- xii) The term 'Robot' was first indroduced by
  - a) Karel Capek
- b) Alan MacWorth
- c) Robert Fu
- d) H.G. Wells.

#### **GROUP - B**

## (Short Answer Type Questions)

Answer any three of the following.

 $3 \propto 5 = 15$ 

- 2. What is the advantage of Newton-Euler formulation over Lagrange-Euler formulation?
- 3. Define degree of freedom ( DOF ). What are Roll, Pitch & Yaw ?
- 4. Explain internal state sensing and external state sensing.
- 5. Derive the translation matrix of imaging geometry.
- 6. Considering the robot arm control as a path trajectory tracking problem, classify the motion control.

#### **GROUP - C**

## (Long Answer Type Questions)

Answer any three of the following.



- 7. a) Show and describe the architecture of a computer-based intelligent robotic manipulator.
  - b) Describe an intelligent application of vision-controlled Robotic system. 8 + 7
- 8. a) Derive the basic form of Transformation matrix (R) & thus explain orthogonal transformation.
  - b) Explain Langrange-Euler formulation of Robot Arm Dynamics. 7 + 8
- 9. a) What is Trajectory Planning? How does it function?
  - b) What is Rotation matrix used in Robot Arm Kinematics? Note down the rotation matrices when
    - i) OUVW coordinate system is rotated an angle  $\alpha$  about the OX axis
    - ii) OUVW coordinate system is rotated an angle  $\boldsymbol{\varphi}$  about the OY axis
    - iii) OUVW coordinate system is rotated an angle  $\theta$  about the OZ axis. 7 + 8
- 10. a) Describe the basic algorithm for generating joint trajectory set points.

How is it modified for Cartesian path control?

- b) Classify Robotic Arms according to mechanical structures. 8 + 7
- 11. Write short notes on any *three* of the following :  $3 \times 5$ 
  - a) Degree of freedom
  - b) Binary sensors
  - c) Expert system & knowledge engineering
  - d) Robot learning
  - e) Proximity sensing.

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