2012

ROBOTICS & CONTROL ENGINEERING

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 the following : $10 \times 1 = 10$

i) A PUMA is a

a) Programmable Universal Manipulation Arm Robot

b) Programmable Universal Manipulation Articulated

Robot Arm

c) Programmable Universal Manipulation Assembly

Robot.

d) none of these.

ii) What type of joint are normally used in manipulator ?

a) Hinge joint b) Ball joint

c) Sliding joint d) All of these.

iii) A transducer converts

a) electrical energy to any other form of energy

b) electrical energy to light energy

c) mechanical displacement into electrical signal

d) electrical energy to mechanical energy.

iv) Joint angles are converted into position & orientation of

end effector

a) this is forward kinematics

b) this is inverse kinematics

c) this is reverse kinematics

d) none of these.

v) A reprogrammable, multifuctional manipulator designed

to move material, parts, tools or specialized devices

through various programmed motions for the

performance of a variety of tasks is

a) robot b) rigid body

c) end-effector d) none of these.

vi) For the case of spherical joint, degrees of freedom is

a) 1 b) 2

c) 3 d) 4.

vii) How accurately the same position can be reached if the

motion is to be repeated many time ?

a) Accuracy b) Repeatability

c) Resolution d) All of these.

viii) CZECH word 'Robota' means

a) forced labour b) worker

c) both (a) and (b) d) none of these.

ix) In an Closed-loop control system

a) the input has control over output

b) input has no control over output

c) both are true

d) none is true.

x) All the points from origin to the perimeter is called

a) reachable workspace b) dextraus workspace

c) envelope workspace d) none of these.

GROUP – B

(Short Answer Type Questions)

2. Answer any *three* of the following. $3 \times 5 = 15$

a) Compare between Reachable & Dextraus Workspace. 5

b) Write down the principal operation of *dc* servo motor. 5

c) Explain the principle of SENSOR. 5

d) What is embedded system ? Write the characteristic of embedded system. 1 + 4

e) What is Proximity sensor ? Write its application on robots. 5

f) What should be the criteria presents in a machine to call it a ROBOT ? 5

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

3. Find out the 3 * 3 rotational matrices on the reference coordinate system OXYZ. Given two points $a_{uvw} = (4,3,2)^T$ and $b_{uvw} = (6,2,4)^T$ with respect to the rotated OUVW coordinate system, determine the corresponding points a_{uvw} b_{uvw} with respect to the reference coordinate system if it has been rotated 60° about the OZ axis. 10 + 5

4. A *T* matrix is to be determined that represents a rotation of α -angle about the OX axis, followed by a translation of *b* units along the rotated OV axis.

Find a homogeneous transformation matrix *T* that represents a rotation of α -angle about the OX axis, followed by a translation of *a* units along the OX axis, followed by a translation of *d* units along the OZ axis, followed by a rotation of θ angle about the OZ axis.

What is the rotation matrix for a rotation of 30° about the OZ axis, followed by a rotation of 60° about the OX axis, followed by a rotation of 90° about the OY axis ? 5 + 5 + 5

5. Find out translation matrix along *Z*-axis with *h* and also draw the frame.
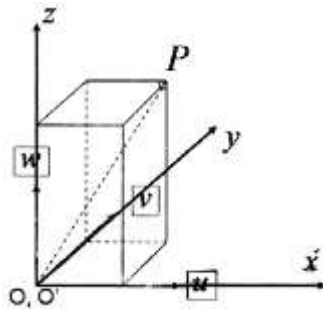
Find the homogeneous transformation matrix (*T*) for the following operations :

Rotation α about OX axis, translation of *a* along OX axis, translation of *d* along OZ axis, rotation of θ about OZ axis

$T = T_{Z,,\theta}\, T_{Z}\,,_{d}\, T_{X,a}\, T_{X}, \alpha\ I_{4x4}$ 7+ 8

6. What is Robot ? Discuss the working principle of Manipulator ? Write the three laws of Robot. Write down the characteristics of Robot. What are the basic elements of Robot ? What types of joint are normally used in manipulator ? 1 + 2 + 3 + 3 + 3 + 3

7. Write short note on any *three* of the following : 3 × 5

a) Trajectory Planning

b) Robot Workspace

c) Robot Vision

d) Robot Intelligence

e) Lagrangian formulation for Robot arm dynamics.

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