Exam.Code:0941
Sub. Code: 33864

2125
B. E. (Mechanical Engineering)
Fifth Semester
MEC-503: Robotics

Time allowed: 3 Hours **Max. Marks: 50**

NOTE: ***Attempt five questions in all, including Question No. I which is compulsory and selecting two questions from each Part.***

x-x-x

1 a) What is SCARA? How many DOF of PUMA 560 robot?
b) What do you mean by dextrous workspace?
c) What is work volume?
d) What is the working principal of Proximity sensor?
e) Define pitch, yaw and roll in terms of robotics. 5x2

Part A

2 a) A frame {B} is initially coinciding with frame {A}; then frame {B} is rotated by 60 degrees about the vector ${}^{A}\hat{K} = [\ 0.5\ 0.866\ 0\ ]^{T}$ (passing through the origin). Describe frame {B} with respect to frame {A}. 5

b) Drive relationship for left arm configuration by geometric approach to inverse kinematics with diagram. 5

3 a) The tip of a two-link robot traces the path A to B with a uniform velocity of 1.0 m/s as shown in fig.1. Show that both the joint velocity is excessively high when the tip is near point A. Take $l_1 = l_2 = 0.3$ m 5

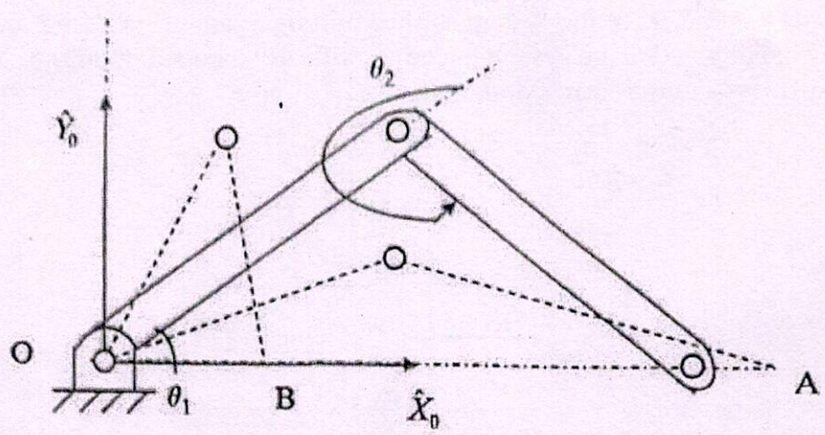

Fig.1 Two-link manipulator moving its tip along the path AB.

b) Given 5

$$ {}^{A}_{B}\mathrm{T} = \begin{bmatrix} 0.866 & -0.500 & 0.000 & 10.0 \\ 0.500 & 0.866 & 0.000 & 0.0 \\ 0.000 & 0.000 & 1.000 & 5.0 \\ 0 & 0 & 0 & 1 \end{bmatrix}; $$

If the velocity vector at the origin of {A} is

$$ \mathrm{A_v} = \begin{bmatrix} 0.0 \\ 2.0 \\ -3.0 \\ 1.414 \\ 1.414 \\ 0.0 \end{bmatrix} $$

Find the 6x1 velocity vector with reference point the origin of {B}.

Contd.....P/2

4 a) A 6-DOF manipulator has three consecutive intersecting wrist axes. Show how Pieper's solution can be applied to find joint variables. 5

b) Define law of robotics. What is SCARA? 5

Part B

5 a) Find inertia tensor for the rectangular body of uniform density ρ w.r.t the coordinate system shown in fig. 2 5

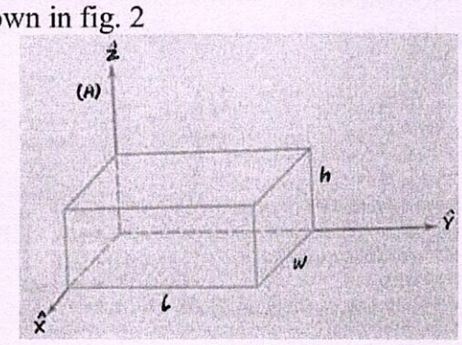

Fig. 2

b) It is desired to have the third joint of a 6-axis robot go from an initial angle of 20° to a final angle of 80° in 4 seconds. Calculate the coefficients for a third-order polynomial joint-space trajectory and plot the joint angles, velocities, and accelerations. The robot starts from rest, but should have a final velocity of 5°/Sec. 5

6 a) The parameters of the system as shown in fig.3, are m = 2, b = 2 and k = 2. For a value of $k_p = 16$, the system becomes critically damped. Find the closed-loop stiffness and the corresponding k_v 5

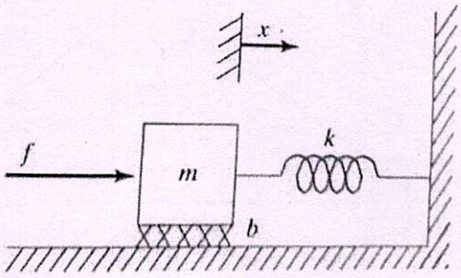

Fig. 3

b) Why actuator location is important? Explain w.r.t transmission system in robots. 5

7 Explain working principle of the following with neat sketch

a) Proximity sensor; b)Tactile sensor 5, 5

x-x-x