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SEAT No. _____

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SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR 388 120

M. Sc. (INSTRUMENTATION & CONTROL) Examination

IV Sem

PS04CINC23: ROBOTICS & FUZZY LOGIC

Saturday, 23rd March, 2019, Time: 2:00 P.M. – 5:00 P.M.

Total Marks: 70

Note:- Figures to the right indicate maximum marks.

- Assume suitable data wherever required and clearly mention the same.
- Neat sketches can replace a good amount of words

Q-1 Multiple Choice Questions.

- (1) What is a Robot? (01)
(a) A machine that does work on it's own
(b) A device that gathers information from the environment
(c) A machine capable of performing or extending human tasks
(d) All the above
- (2) The Robot designed with Polar coordinate systems has (01)
(a) Three linear movements (b) Three rotational movements (c) Two linear and one rotational movement (d) Two rotational and one linear movement
- (3) Which is not the part of robot anatomy (01)
(a) arm (b) End effector (c) wrist (d) all of the above
- (4) SCARA robot is very suitable in which kind of operations (01)
(a) Single Operations (b) Assembly Operations
(c) Rotary Operations (d) Translatory Operations
- (5) Which gripper is used to handle the internal (hollow) shape of part? (01)
(a) Magnetic (b) vacuum (c) expanding gripper (d) all given
- (6) Jacobian is related to (01)
(a) velocity (b) distance (c) time (d) all of the above
- (7) A form of knowledge representation suitable for notions that cannot be defined precisely, but which depend upon their context is (01)
(a) Boolean logic (b) AND logic (c) OR logic (d) Fuzzy logic
- (8) If x is A THEN y is B and is equivalent to $R = (A \times B) \dots\dots\dots$ (01)
(a) $\cup (A' \times Y)$ (b) $\pm (A \times Y)$ (c) $\cap (A' \times Y)$ (d) none

(1)

(P.T.O.)

Q-2

Short answer type questions- attempt any 7

- (1) Define robot and robotics. (02)
- (2) Define link twisted angle (α) in D-H transformation (02)
- (3) Write down the homogenous transformation matrices. (02)
- (4) Difference between forward and inverse kinematics in robot. (02)
- (5) Write down Jacobian matrix. (02)
- (6) Write down rotational matrix for z- axis. (02)
- (7) List different types of uncertainty associated with Fuzzy control. (02)
- (8) Define the term Reflexivity and Transitivity. (02)
- (9) Let A and B be the fuzzy sets for $x_1, x_2, x_3, x_4, x_5, x_6$, If
 $A = \{(x_1, 0.8), (x_2, 0.9), (x_3, 0.4), (x_4, 0.5), (x_5, 0.7), (x_6, 0.9)\}$ and
 $B = \{(x_1, 0.6), (x_2, 0.3), (x_3, 0.8), (x_4, 0.2), (x_5, 0.4), (x_6, 0.7)\}$
Find (i) $A \cup B$ & (ii) $A \cap B$ (02)

Q-3

- (a) Discuss briefly about the grippers and give its classification. (06)
- (b) Consider the forward transformation of a two joint manipulator shown in fig.1. (06)
Given the Length of the joint 1, $L_1 = 30\text{cm}$, the length of joint2, $L_2 = 25\text{cm}$, the angle $\theta_1 = 30^\circ$ and angle $\theta_2 = 45^\circ$, compute the coordinate position for the end of the arm.

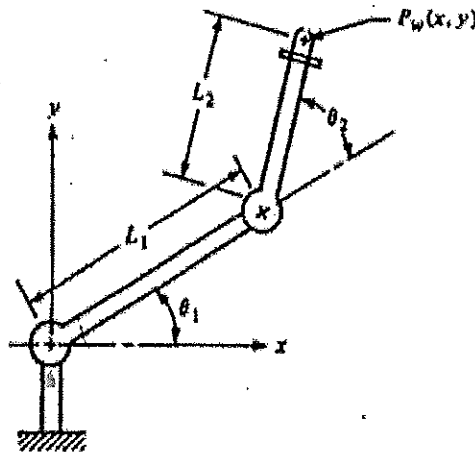


Fig.1
OR

- (b) Discuss briefly about the grippers and give its classification. (06)

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- Q-4 (a) Consider Anthropomorphic robot shown in fig. 1. Using D-H notation Construct (06)
1. Set of robotic coordinate frame
 2. A table for joint parameter
 3. Each joint individual matrix

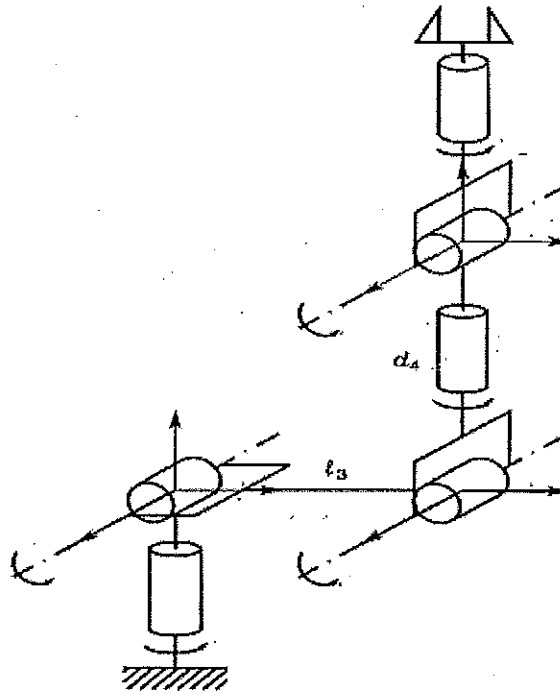


Figure 1. Anthropomorphic Robot with frame assignment.

- (b) A point $P(7,4,5)^T$ is attached to a frame (n, o, a) and is subjected to the transformations described. Find the coordinates of the point relative to the reference frame at the conclusion of transformations. (06)
- (1) Rotation of 90° about the n-axis,
 - (2) Followed by a rotation of 90° about the o-axis,
 - (3) Followed by a translation of $[6, -2, 4]$

OR

- (b) What are the advantages and disadvantages of the jointed arm robot over the other configurations? (06)

- Q-5 (a) Derive the differential relationships of simple 2-DOF mechanism for robot. (06)

(3)

(P.T.O.)

- (b) Suppose the following frame was subjected to the differential translation of $d = [1 \ 1 \ 0.8]$ units and differential rotation of $\delta = [0 \ 0.2 \ 0]$ (06)

- (a) What is differential operator relative to the reference frame?
(b) What is differential operator relative to the frame A?

$$A = \begin{pmatrix} 1 & 0 & 0 & 10 \\ 0 & 0 & 1 & 8 \\ 0 & -1 & 0 & 15 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

OR

- (b) As a result of applying a set of differential motions to frame T shown, it has changed amount dT as shown. Find the magnitude of differential changes made ($dx, dy, dz, \delta x, \delta y, \delta z$) and the differential operator with respect to frame T. (06)

$$dT = \begin{pmatrix} 0 & -0.06 & 0.04 & 0.05 \\ 0.06 & 0 & -0.02 & 0.03 \\ -0.04 & 0.02 & 0 & 0.01 \\ 0 & 0 & 0 & 1 \end{pmatrix} \quad T = \begin{pmatrix} 1 & 0 & 0 & 10 \\ 0 & 0 & 1 & 6 \\ 0 & -1 & 0 & 16 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

- Q-6 (a) List types of membership functions. (06)

Let Y and Z be the fuzzy sets for $x_1, x_2, x_3, x_4, x_5, x_6$, If

$Y = \{(x_1, 0.4), (x_2, 0.3), (x_3, 0.5), (x_4, 0.1), (x_5, 0.8), (x_6, 0.2)\}$ and

$Z = \{(x_1, 0.7), (x_2, 0.6), (x_3, 0.1), (x_4, 0.2), (x_5, 0.6), (x_6, 0.5)\}$

Find the following: (i) $Y \cap Z$ (ii) $Y - Z$ and (iii) Prove that $(Y \cup Z)^c = Y^c \cap Z^c$

- (b) Explain structure of Fuzzy controller in length. (06)

OR

- (b) Apply the fuzzy Modus Ponens rule to deduce Rotation is quite slow given that (06)
- (i) If the temperature is high then the rotation is slow.
(ii) The temperature is very high.

Let H (high), VH (very high), S (slow) and QS (quite slow) indicate the associated fuzzy sets as follows:

For $X = \{30, 40, 50, 60, 70, 80, 90, 100\}$ the set of temperatures and

$Y = \{10, 20, 30, 40, 50, 60\}$ the set of rotations per minute

$H = \{(70, 1) (80, 1) (90, 0.3)\}$

$VH = \{(90, 0.9) (100, 1)\}$

$QS = \{(10, 1) (20, 0.8)\}$

$S = \{(30, 0.8) (40, 1) (50, 0.6)\}$

Derive R (x, y) representing the implication relation.

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(4)