Roll No: ----------

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, April, 2017

Program/course: B.Tech – MSENT | **Semester – VIII**
Subject: Nano Electronics & Robotics | **Max. Marks : 100**
Code :MTEG – 422 | **Duration : 3 Hrs**
No. of page/s: 03

Note:
All questions are compulsory.
Section A: 5 X 4= 20 Marks
Section B: 10 X 4 = 40 Marks
Section C: 20 X 2 = 40 Marks

Section A

1. State the laws of robotics as given by Asimov.
2. Find out the holding force and velocity of movement of piston of a single acting hydraulic actuator if fluid pressure is 100 bar, diameter of piston is 50 mm and flow rate is 0.3 m^3/min.
3. Explain briefly about the characteristics of actuators.
4. Discuss about stroke and reach of a robotic arm with suitable example.

Section B

5. The homogeneous transformation matrices between frames {i}-{j} and {i}-{k} are:

$$ {}^{j}T_{i} = \begin{bmatrix} 0.500 & -0.866 & 0 & 11 \\ 0.866 & 0.500 & 0 & -1 \\ 0 & 0 & 1 & 8 \\ 0 & 0 & 0 & 1 \end{bmatrix} ; \quad {}^{k}T_{i} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0.866 & -0.500 & 20 \\ 0 & 0.500 & 0.866 & -10 \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

Determine ${}^{j}T_{k}$

6. A vector $P = 3i - 2j + 5k$ is first rotated by 90º about x-axis, then by 90º about z-axis and finally translated by $-3i + 2j - 5k$. Determine the new position of the vector.

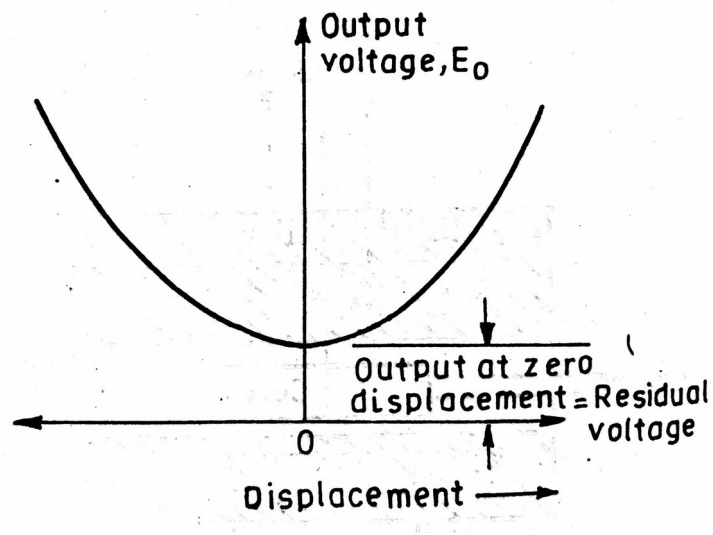
OR

Determine the rotation matrix for a rotation of frame {2} with respect to frame {1} by 45º about y-axis, followed by a rotation of 120º about z-axis and a final rotation of 90º about x-axis.

7. Explain in detail about the different types of electrical actuators used in Robots.

8. In reference to LVDT:

   As per the differential output $E_o = E_{s_1} - E_{s_2} = 0$ at NULL position, where E_{s_1} is output voltage of secondary coil S_1 and E_{s_2} is output voltage of secondary coil S_2. Although as per the characteristic graph for variation output voltage with linear displacement for an LVDT (shown below) as per actual practice there exists a small voltage at the null position. What are the probable reasons for the same?



Section C

9. For the 3-DOF manipulator arm as shown in Fig.1, assign frames and obtain the joint-link parametes (dH parameters). Also, determine the position of the tool tip with respect to the base frame {0}. Take the values of $\theta_1 = 30°$, $\theta_3 = 45°$, and $d_2 = 0.8\,m$.

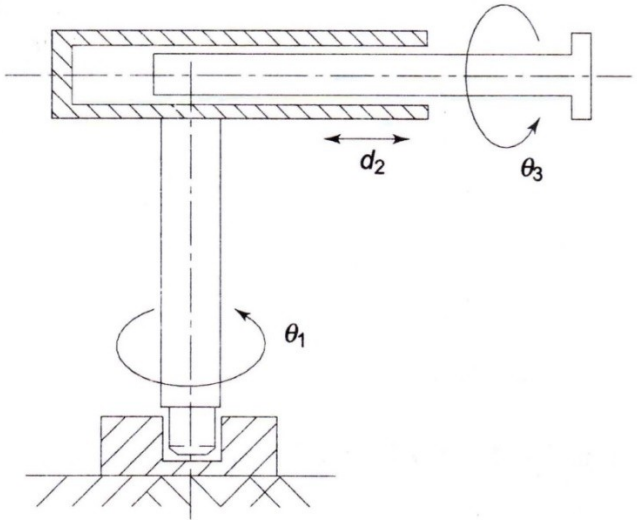


Fig. 1: A 3-DOF manipulator

OR

In a 2-DOF robot, the DH parameters are as given below:

	θ	d	a	α
0-1	θ_1	0	l_1	0
1-H	θ_2	0	l_2	0

The transformation matrix is given as:

$$ {}^{0}T_{H} = \begin{bmatrix} -0.2924 & -0.9563 & 0 & 0.6978 \\ 0.9563 & -0.2924 & 0 & 0.8172 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

If the length of each link l_1 and l_2 is 1m, calculate the values of θ_1 and θ_2 for the given location.

10. Explain why discrete histogram equalization technique does not, in general yield a flat histogram? Suppose that a digital image is subjected to histogram equalization. Show that a second pass of histogram equalization (on the histogram equalized image) will produce exactly the same result as the first pass.

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Section A

1. Explain briefly about the different components of a robot.
2. Explain about hydraulic and pneumatic actuators as used in Robots.
3. A hydraulic rotary actuator is to be used for a twist joint. The outer and inner radii of vane are 80 mm and 20 mm and width of vane is 10 mm. Determine angular velocity and torque generated if pressure is 50 bar and flow rate is 8 cm^3/min.
4. Explain about different types of grippers used in robots.

Section B

5. Name and explain the basic four types of arm configuration in robots.
6. A point *P* in space is defined as ${}^{B}P = (5, 3, 4)^{T}$ relative to frame *B* which is attached to the origin of the reference frame *A* and is parallel to it. Apply the following transformations to frame *B* and find ${}^{A}P$.
   - Rotate 90º about x-axis, then
   - Translate 3 units about y-axis, 6 units about z-axis, and 5 units about x-axis, then
   - Rotate 90º about z-axis

OR

Frame {2} is rotated with respect to frame {1} about x-axis by an angle of 60º. The position of the origin of frame {2} as seen from frame {1} is ${}^{1}D_2 = [7 \quad 5 \quad 7]^T$. Obtain the transformation matrix ${}^{1}T_2$ which describes the frame {2} relative to frame {1}. Using the matrix, also determine the description of frame {1} relative to frame {2}.

7. A vector $P = 3i - 2j + 5k$ is first rotated by 90º about x-axis, then by 90º about z-axis and finally translated by $-3i + 2j - 5k$. Determine the new position of the vector.
8. The output voltage of a LVDT is 1.5 V at maximum displacement. At a load of 0.5 MΩ, the deviation from linearity is maximum and it is ±0.003 V from a straight line through origin. Find the linearity at the given load.

Section C

9. For the 3-DOF robotic manipulator arm shown in Fig.1, assign frames to each of the links and determine the joint-link parameters and, obtain the direct kinematic model.

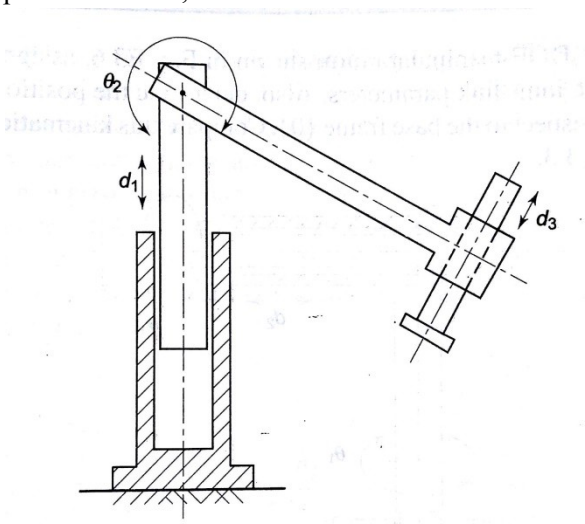

Fig.1: 3-DOF PRP manipulator arm

10. In a 2-DOF articulated robot arm as shown in Fig.2, find the link-joint parameters and formulate the transformation matrix in symbolic form. If the transformation matrix is given in numerical form as shown below and length of each link a_1 and a_2 is 1m, calculate the values of θ_1 and θ_2 for given location.

$$ {}^{0}T_H = \begin{bmatrix} -0.2924 & -0.9563 & 0 & 0.6978 \\ 0.9563 & -0.2924 & 0 & 0.8172 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

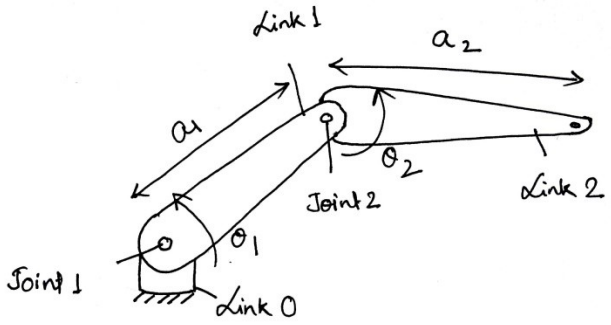

Fig.2: 2-DOF articulated robot arm