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

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, April 2018

Program: B.Tech - MSNT | **Semester – VIII**
Subject (Course): Nano Electronics and Robotics | **Max. Marks : 100**
Course Code : MTEG - 422 | **Duration : 3 Hrs**
No. of page/s : 02

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. Classify robots according to Japanese Industrial Robot Association (JIRA). (CO1)
2. Explain briefly about the characteristics of actuators. (CO2)
3. A hydraulic rotor actuator is used for a twist joint with hydraulic power source of pressure 50 bars and flow rate 8 cm^3/min. The outer and inner radii of vane are 80 mm and 20 mm respectively and the width is 10 mm. Determine the angular velocity and torque generated by the actuator. (CO2)
4. Explain briefly about two types of proximity sensors. (CO5)

Section B

5. Explain the different components of a robot. Explain the common robotic joints. **(8+2)** (CO1)
6. Frame {2} is rotated with respect to frame {1} about x-axis by an angle of 60º and then by an angle of 45º about z-axis. The position of origin of frame {2} as seen from frame {1} is $[7\ 5\ 7]^T$. Obtain the homogeneous transformation matrix which describes the frame {2} relative to frame {1}. If the location of a point P with respect to frame {2} is $[3\ -2\ 5]^T$, find the location of P with respect to frame {1}. (CO3)

   OR

   Determine the new location of point G, initially at G = $[3\ 0\ -1\ 1]^T$, if:
   i. It is rotated by π about z-axis and then translated by 3 units along y-axis, and
   ii. It is first translated by 3 units along y-axis and then rotated by π about z-axis
   Examine whether the two locations are same or not
7. Explain in detail about the different types of electrical actuators used in Robots. (CO2)
8. The homogeneous transformation matrices between frames {1} – {2} and {2} – {3} are: (CO3)

$$^1T_2 = \begin{bmatrix} 0.527 & -0.574 & 0.628 & 2 \\ 0.369 & 0.819 & 0.439 & 5 \\ -0.766 & 0 & 0.643 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix} \text{ and } {}^2T_3 = \begin{bmatrix} 0.92 & 0 & 0.39 & 5 \\ 0 & 1 & 0 & 6 \\ -0.39 & 0 & 0.92 & 2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Determine $^3T_1$

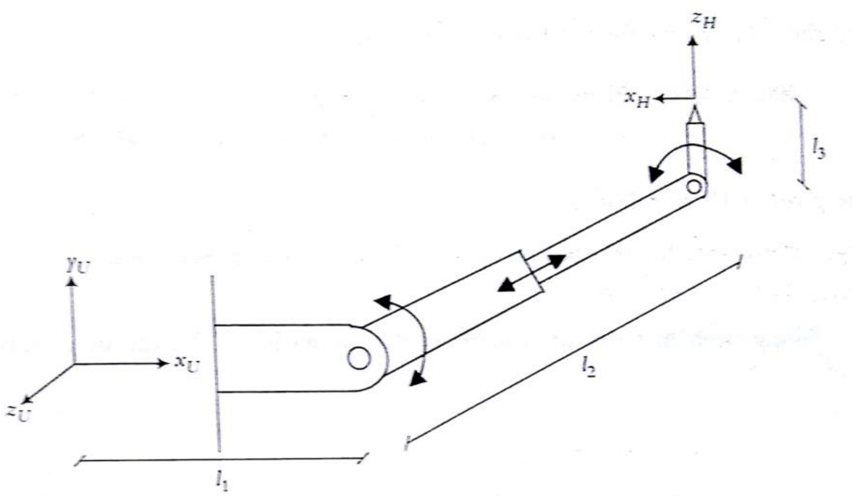
Section C

9. A piezo-electric transducer has a capacitance of 1000 pF and a charge sensitivity of 40 X 10^{-3} C/m. The connecting cable has a capacitance of 300pF while the oscilloscope used for readout has a readout input resistance of 1MΩ with a parallel capacitance of 50pF. (CO5 & CO6)

    i. Determine the sensitivity (V/m) of the transducer alone.
    ii. Compute the high frequency sensitivity (V/m) of the entire measuring system.
    iii. Compute the lowest frequency that can be measured with 5 percent amplitude error by the entire system.

10. A special 3-DOF spraying robot has been designed as shown: (CO3)

    i. Assign the coordinate frames based on the D-H representation.
    ii. Prepare the parameter table.
    iii. Compute individual transformation matrix for each pair of frames.
    iv. Compute the final transformation matrix for the end effector.



OR

In a 3-DOF robot, the DH parameters are as given below:

	θ	d	a	α
0-1	θ_1	0	0	90º
1-2	θ_2	0	0	-90º
2-H	0	d_3	0	0

The transformation matrix is given as:

$$T = \begin{bmatrix} 0.354 & 0.866 & 0.354 & 0.106 \\ -0.612 & 0.500 & -0.612 & -0.184 \\ 0.707 & 0 & 0.707 & 0.212 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Determine the joint variables if $-100^o < \theta_1 < 100^o$, $-30^o < \theta_2 < 70^o$ *and* $0.05\ m < d_3 < 0.5\ m$