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V SEMESTER B.TECH. (MECHATRONICS ENGINEERING) END SEMESTER EXAMINATIONS, DEC 2018

SUBJECT: MECHANICS OF ROBOTIC SYSTEMS [MTE 3102] REVISED CREDIT SYSTEM

Time: 3 Hours

MAX. MARKS: 50

Instructions to Candidates:

- ✤ Answer ALL the questions.
- Data not provided may be suitably assumed
- 1A. Explain the different configuration of robotic systems with a neat labelled 04 sketches.
- 1B. A cylindrical robot with a prismatic joint has a stroke length of 800mm. The control memory is of 10 bit capacity. The associated mechanical inaccuracies have a standard deviation of 0.1mm which is equal in all the directions. Determine the given below:
 - a. Control Resolution
 - b. Spatial Resolution
 - c. Accuracy
 - d. Repeatability

1C. Explain different types of joint in a robotics system. 02

- 2A. A point P is given by [7,4,5] attached to a frame subjected to the following 04 sequence of operations
 - Rotation of 45° OX axis.(T1)
 - Rotation of 30° about OB axis.(T2)
 - Translation of 5 units in OY direction(T3)

Find final position of P.

2B. Explain any two properties of rotational matrix.	02
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2C. A frame was rotated about Z axis by 90°, then translates about the current 'a' ('noa') axis 3 units before being rotated about Y axis by 45°. Write an equation describing the motions in terms of homogeneous transformation matrix.

3A. Determine the DH parameters and obtain the direct kinematics for RRP robotic 05 manipulator arm as shown in Fig.3A.





- 3B. Calculate the Jacobian matrix for RRP manipulator as shown in Fig.3A.
 05 Evaluate end-effector velocities if joint velocities are given as [3, 5, 4]^T.
- **4A.** Formulate the dynamics of the system as shown in Fig Q.4A using Lagrangian method.





4B. Obtain the solutions for inverse kinematics of RR manipulator and calculate the joint the parameters if the final transformation matrix is

$$A = \begin{bmatrix} 0 & -1 & 0 & 141.4 \\ 1 & 0 & 0 & 341.33 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Assume $\theta_1 = \theta_2$

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- **5A.** A joint of an articulative robot traverse from an initial angle of 30° to final angle of 70° in 5 s with a cruising velocity of ω =10 degrees/s. Calculate the time for blending and plot the joint positions, velocities and accelerations.
- 5B. A joint of a robot manipulator transverse from an initial position of 25° to 75° in 5 s. Assuming a fifth order polynomial and a starting acceleration of 4 deg/sec², determine the acceleration at the end of 5 s and plot the results.