01564

BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING (COMPUTER INTEGRATED MANUFACTURING)

Term-End Examination

June, 2010

BME-029 : ROBOTICS

Time : 3 hours *Maximum Marks : 70*

Note : *Answer **any seven** questions. All questions carry **equal** marks.*

1. (a) Name and describe the robot sub systems. **7**

(b) Sketch a robot arm in cylindrical coordinates. **3**

2. (a) Discuss the advantages and disadvantages of hydraulic actuators in robot. **6**

(b) Write a note on permanent magnet stepper motor. **4**

3. (a) What is an encoder ? What are the types of encoder ? **5**

(b) Describe the functions of strain gauge and piezoelectric sensor. Are these internal or external sensors ? **5**

4. Describe the non - manufacturing applications of robots. Discuss safety issues in robot application. **10**

5. (a) The reference frame can have pure translation, pure rotation or both. Show these three transformation by sketching reference frames before and after transformation and write transformation matrix in each case. **6**

   (b) Sketch three arms connected by revolute joints. **4**

6. (a) What do you understand by position analysis ? Describe how to solve a direct problem ? **6**

   (b) Sketch an articulated arm of a robot and explain its motion. **4**

7. (a) What is "Lagrangian" ? How is Lagrangian correlated with forces in the links of a kinematic chain ? **5**

   (b) The kinetic energy, T and potential energy U of robot links are expressed as : **5**

$$T = \frac{1}{2} \dot{\Theta}^T I \dot{\Theta} \text{ and}$$

$$U = -\sum_{i=1}^{n} m_i \, c_i^T \, g$$

Explain the meanings of Θ, I, m_i, c_i and g.

8. For a joint, initial angle is Θ_0 at time $t=0$ and the final angle is Θ_f at time $t=t_f$. The end effector start with a velocity $\dot{\Theta}_0$ and acceleration $\ddot{\Theta}_0$ and it stops with velocity $\dot{\Theta}_f$ and acceleration $\ddot{\Theta}_f$. Write these boundary conditions in time variable and a polynomial in time, t to express Θ (t). Derive expressions for coefficient of polynomial. **10**

9. (a) What are overdamped, underdamped and critically damped systems. Show these characteristics on graph between displacement, x(t) and time, t. **4**

   (b) In a mass, damper and spring system, mass = 1, damping coefficient = 5 and spring constant = 6. Find equation to displacement x(t). **6**

10. (a) What is control law ? Express the force to be applied by an actuator in form of an equation. Express closed loop dynamics in equations. What conclusions are drawn from these equations ? **6**

    (b) What are lead through programming and walk through programming of a robot ? **4**