NPTEL Course

Robotics and Control: Theory and Practice

Assignment 3

1. If K denotes the kinetic energy, P denotes the potential energy, L denotes the Lagrangian and $\theta_i : i = 1,2, \dots \dots n$ denotes the joint variables of manipulator, then dynamic equation is given by:
    a. $\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}_i}\right) - \frac{\partial L}{\partial \theta_i} = \tau \text{ and } L = K + P$
    b. $\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}_i}\right) - \frac{\partial L}{\partial \theta_i} = \tau \text{ and } L = K - P$
    c. $\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}_i}\right) + \frac{\partial L}{\partial \theta_i} = \tau \text{ and } L = K + P$
    d. $\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}_i}\right) + \frac{\partial L}{\partial \theta_i} = \tau \text{ and } L = K - P$
2. If V(x) denotes the Lyapunov function for the system $\dot{x} = f(x) : f(0) = 0$ then:
    a. x=0 is stable if V is positive semi definite and $\dot{V}$ is negative definite.
    b. x=0 is asymptotically stable if V positive definite and $\dot{V}$ is negative semi-definite.
    c. x=0 is unstable if V is positive definite and $\dot{V}$ is negative definite.
    d. x=0 is stable if V is negative definite and $\dot{V}$ is positive semi-definite.

3. If $M(q, \dot{q})\ddot{q} + V(q, \dot{q}) + G(q) = \tau$ is the dynamic equation of n arm manipulator, then:
    a. M denotes the centripetal and centrifugal terms.
    b. V denotes the centripetal and centrifugal terms.
    c. V denotes Inertia term.
    d. M denotes friction term.
4. The degree d of the unique polynomial trajectory obtained using n conditions is given by:
    a. d=n-1
    b. d>n-1
    c. d=n
    d. d=n+1
5. A point $x_e \in R^n$ is said to be an equilibrium point of the system

$$\dot{x} = f(t, x)$$

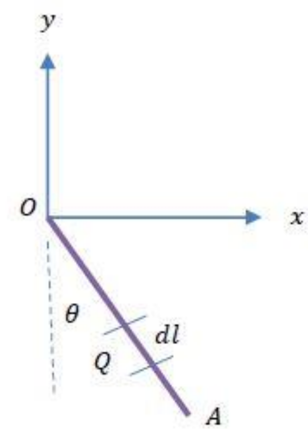
    a. If $f(t, x_e) = 0$ for some t.
    b. If $f(t, x_e) = 1$ for some t.
    c. If $f(t, x_e) = 0$ for all t.
    d. If $f(t, x_e) = 1$ for all t.

6. Finding joint torques given joint angles, velocities and acceleration as input is known as:
    a. Dynamics
    b. Kinematics

c. Inverse Kinematics

d. Inverse Dynamics

7. Dynamic equation for single arm robot manipulator as shown in figure with length l_1, torque τ and uniformly distributed mass M is given by:



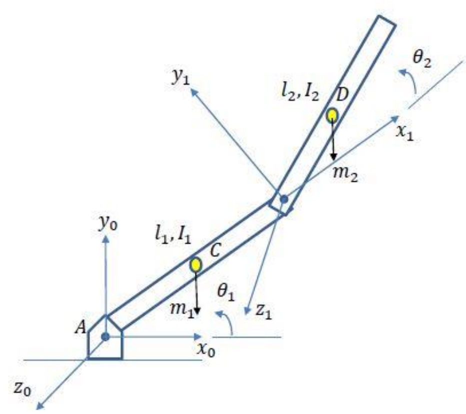
a. $\frac{1}{3}ML_1^2\ddot{\theta} + \frac{Mg}{2}L_1 \sin\theta = \tau$

b. $\frac{1}{3}ML_1^2\ddot{\theta} + \frac{Mg}{2}L_1 \cos\theta = \tau$

c. $\frac{1}{3}ML_1^2\ddot{\theta} - \frac{Mg}{2}L_1 \sin\theta = \tau$

d. $\frac{1}{3}ML_1^2\ddot{\theta} - \frac{Mg}{2}L_1 \cos\theta = \tau$

8. Consider following example of a two-arm manipulator with uniformly distributed mass with lengthl_1 and l_2, moment of inertia I_1 and I_2 and mass m_1 and m_2 for respective links.



Then moment of Inertia of link 1 about A is:

a. $\frac{1}{3}m_1 l_1^2$

b. $\frac{1}{12}m_1 l_1^2$

c. $m_1 l_1^2$

d. $\frac{1}{2}m_1 l_1^2$

9. Consider same example as in (8), moment of inertia of link 2 about D is given by:
    a. $\frac{1}{3}m_2 l_2^2$
    b. $\frac{1}{12}ml_2^2$
    c. $\frac{1}{2}m_2 l_2^2$
    d. ml_2^2
10. Potential energy P_2 in (8) for link 2 is given by:
    a. $mg(l_1 \sin\theta_1 + l_2 \sin(\theta_1 + \theta_2))$
    b. $mg(l_1 \sin\theta_1 + l_2 \sin\theta_2)$
    c. $mg(l_1 \sin\theta_1 + l_2 \cos(\theta_1 + \theta_2))$
    d. $m_2 g(l_1 \sin\theta_1 + \frac{1}{2}l_2 \sin(\theta_1 + \theta_2))$