Mechanical Control Systems (ME 4473)

Recitation - 3

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- **Agenda:**
  - Revision (Definitions & Terms)
  - Problems(State Space)

- **Answer the following questions:**
  - **What is a state?**

  - **What is the meaning of state space description of the system?**

  - **What is the matrix equation for the state space representation of a system?**

  - **How many state equations can a 5th order ODE be represented in terms of?**

  - **Which of the following techniques are used to linearize a system?**
    i. Taylor Series Representation
    ii. Small Angle Approximation
    iii. Jacobian Linearization
    iv. All of the Above
    v. None of the Above

- **Problems:**

- **For the simple pendulum, the nonlinear equations of motion are given by:**

$$\Theta''(t) + \frac{g}{L} sin(\Theta) + \frac{k}{m}\Theta'(t) = 0$$

(Written against actual convention: dot notation for time derivative and prime notation for length derivative)

where g is gravity, L is the length of the pendulum, m is the mass attached at the end of the pendulum (we assume the rod is massless), and k is the coefficient of friction at the pivot point.

a. Linearize the equations of motion about the equilibrium condition Θ= 0°.

b. Obtain a state variable representation of the system.

c. Come up with parameters for the model of a pendulum

Now, let's change our system by providing an input such that our original ODE becomes:

$$\Theta''(t) + \frac{g}{L} sin(\Theta) + \frac{k}{m}\Theta'(t) = u(t)$$

(Written against actual convention: dot notation for time derivative and prime notation for length derivative)

d. Linearize the equations of motion about the equilibrium condition Θ= 0°.

e. Obtain a state variable representation of the system.

f. Evaluate a step response of this system using simulink.

@Simulink

Bibliography:

- **Modern Control Systems, 13th edition, Chapter 3**