Fall 2022 **AuE 4600-6600** **Sample Questions/Problems**

Name: _____

Problem 1: Describe the following. Give examples where necessary:

1. Degrees of Freedom
2. Kinematics
3. Kinetics
4. Newton's Laws
    a. First Law
    b. 2nd Law
    c. 3rd Law
5. Linear Momentum
6. Angular Momentum
7. Impulse
8. Kinetic Energy
9. Potential Energy
10. Conservation of energy
11. Non-Linear System
12. Linear System
13. Operating Point
14. Resonance
15. Stability
16. Transfer Function
17. Frequency Response Function
18. Eigenvalues
19. Eigenvectors
20. Newton Euler Equations
21. Lagrange's Equations

Problem 2. Given the Differential Equation:

$$\ddot{y} + 2\,\dot{y} + 5y = 3\,Sin\,5t$$

a. Write the equation in State-Space Form

b. Find it's complete solution

Problem 3. Given the equation

$$\ddot{y} + 2\,\dot{y} + 5y^2 = 2 + 3\,Sin\,5t$$

a. Find the operating points
b. Linearize the equation about one of the operating points.

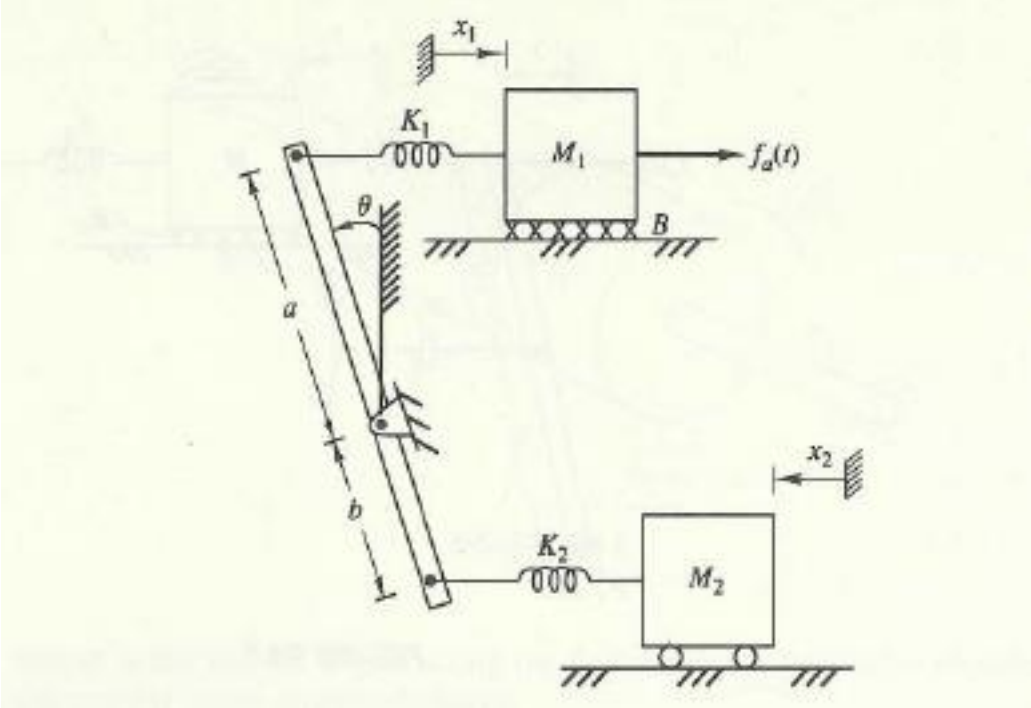
Problem 4: Find the analytical solutions to the following differential equations and analytically prove that your answers are correct (don't forget about initial conditions):

a) $\ddot{x} + 3\dot{x} + 2x = 0, \quad x(0) = 0, \quad \dot{x}(0) = 1$

b) $\ddot{x} + 3\dot{x} + 2x = 1, \quad x(0) = 0, \quad \dot{x}(0) = 0$

c) $\ddot{x} + 3\dot{x} + 2x = 1, \quad x(0) = 0, \quad \dot{x}(0) = 1$

Problem 5: Write the equations of motion of the system shown below:



Please note that the center of mass of the lever is located at (a+b)/2. It has a moment of inertia of I_L and mass M_L

Cast the equations in State-Space form