

Problem 1 (25 pts)

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

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

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

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

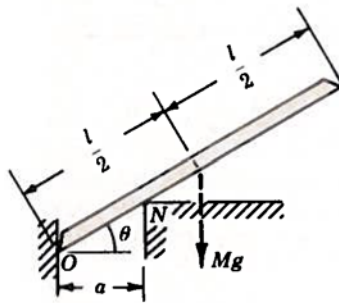
Problem 2 (25 pts)

Find analytical solutions for all eigenvalues and normalized eigenvectors of the following matrix:

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

Problem 3 (40 pts)

A uniform slender beam of mass M has its center of gravity as shown below. The corner on which it rests is a knife; hence the reaction N is perpendicular to the beam. The vertical wall on the left is smooth. What is the value of the angle θ in terms of l and a for equilibrium?

**Problem 4 (10 pts)**

Multiply the following matrices (show your work, i.e., do not just show the final result):

$$\begin{bmatrix} 2 & -1 \\ -1 & 3 \end{bmatrix} \begin{bmatrix} 1 \\ 2 \end{bmatrix}, \quad \begin{bmatrix} 1 & -1 \\ 0 & 3 \\ 1 & -2 \end{bmatrix} \begin{bmatrix} 1 & 2 & -1 & 6 \\ -1 & 2 & 3 & -1 \end{bmatrix}, \quad \begin{bmatrix} 2 \\ -3 \end{bmatrix} \begin{bmatrix} -2 & 3 & 1 \end{bmatrix}, \quad \begin{bmatrix} 1 & -2 \end{bmatrix} \begin{bmatrix} 2 \\ 3 \end{bmatrix}$$

Problem 5 Extra Credit (10 pts)

Simulate the responses from all ODEs in Problem 1 using the MATLAB ode45 command and plot both the MATLAB solutions and your analytical results to make sure that they match.

I attest that that the homework solutions I provided are my own and that I did not copy any solution for anybody in class or elsewhere. I further understand that if I am caught cheating on any homework or project solution then I am subject to ethical violations procedures as outlined by UB in <https://catalog.buffalo.edu/policies/integrity.html>.

Signature

Date