**Phys 340 – First Midterm Test**

**1 hour and 15 minutes**

**Professor: Dr. Edward J. Brash**

**Rules and Regulations:**

1. Calculators, with memory cleared, are permitted.
2. You may bring as many pencils, pens, and erasers with you as you like.
3. You may use your notes, as needed.
4. The test consists of three (3) questions where you should present full solutions. The full solution questions are worth 10 points each (30 points total).
5. You should complete your solutions to the full solution questions on the exam paper itself.
6. Your solutions to the full solution problems should, in general, contain a combination of diagrams, equations, and English word sentences explaining your strategy and thought process.
7. Many of the questions involve showing that certain results are true. If you cannot manage to solve one of the question parts directly, you can use the given result of that question part in attempting to solve another question part.

**STUDENT NAME: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**STUDENT ID NUMBER:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**SIGNATURE:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

* 1. Consider the following two vectors:

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1. Calculate the following quantity:

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1. By comparison of the results from parts (a) and (b), show that:

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* 1. Consider the following set of coupled second-order differential equations:

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1. Express these equations in matrix form, and show that the eigenvalues of the associated transformation matrix are:

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1. Show that the normalized eigenvectors of the transformation are given by:

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1. The fundamental theorem of eigenvectors states that we can express the original problem as:

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Write down the matrices S and Lambda, and determine the

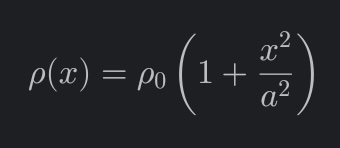
the inverse of S.

1. What will be the function form of the solutions to the following resulting problem?

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* 1. Consider a thin bar of length, a, positioned with one end at x=-a/2 and the other at x=a/2. If the density of the bar, along its length, is given by:



1. Draw a diagram of the bar, and indicate the values of the density at the center (i.e. x=0) and two ends (i.e x = +/-a/2).
2. Show that the mass of the bar is

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1. Without doing the explicit calculation, where is the center of mass of the bar? Hint: Think about symmetry!
2. Show that the moment of inertia of the bar for rotation around the y-axis is:

A math equation with numbers

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Given that the Physics 201 result for the moment of inertia of a uniform bar of length a, around the center of the bar, is:

I = 1/12 M a^2,

comment on the result for part d), given the given density profile.