University of Notre Dame
Aerospace and Mechanical Engineering

AME 30314: Differential Equations, Vibrations and Controls I
First Exam

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ID Number:_____

NAME:_____

- Do not start or turn the page until instructed to do so.
- You have 50 minutes to complete this exam.
- This is an open book exam. You may consult the course text and your own course notes, but nothing else. You may have supplemented your notes with your own summaries or hand-written copies of other material, but you may not consult printed homework solutions, photocopies of homework solutions, *etc.*
- You may **not** use a calculator or other electronic device.
- There are four problems. Each problem is worth 25 points.
- Your grade on this exam will constitute 25% of your total grade for the course. *Show your work* if you want to receive partial credit for any problem.
- Answer each question in the space provided on each page. If you need more space, use the back of the pages or use additional sheets of paper as necessary.
- If you do not have a stapler, do not take the pages apart.

You know, lately it seems all you hear is "Don't overdo it" and "Don't push yourself." Well, I think that's a lot of bull. If you push the human body, it will respond.
—Bob Clarke, Philadelphia Flyers general manager, NHL Hall of Fame

1. Determine the general solution to

$$\dot{x} + 2x = t.$$

2. Determine the general solution to the *third* order differential equation

$$\dddot{x}(t) + 2\ddot{x}(t) + 3\dot{x}(t) = -2\cos(2t) - 8\sin(2t).$$

Hint: use one or more methods covered in the course so far. Saying it is third order and hence you don't know how to solve it is not an acceptable answer.

3. Do Exercise 2.31 in the course text, parts 1 and 2 only.

4. Consider a mass-spring-damper system like the one illustrated in Figure 4.1 in the course text, with $m = 1$ and $k = 16$, $f(t) = \sin(4t)$.

   If the steady-state solution is

   $$x_{ss} = -\frac{5}{32}\cos(4t)$$

   determine the damping ratio by using one of the figures in the course text. Fully explain your answer by referring to the figure, what you had to compute to use the figure, what values you used and read from the figure, and so on.