ME 460/660, Mechanical Vibration — Exam 1, Fall 1997

Closed book, closed notes. Use one $8\frac{1}{2} \times 11$ formula sheet, front and back. Test books will be provided.

1. Define the following variables and state which ones are parameters of a system and which ones define the state of a system. (3 points each)

   (a) ω

   (b) ω_d

   (c) $x(0)$

   (d) $x(t)$

   (e) $v(t)$

   (f) c

   (g) m

   (h) ζ

   (i) δ

   (j) T

2. The mass of a SDOF system is measure to be 5 kg, while the natural frequency, ω, is found to be 10 rad/s. It is observed that during free vibration the amplitude decays to 0.25 of its initial value after five cycles. Calculate the viscous damping coefficient c. (25 points)

3. A linear system is freely oscillating. The displacement amplitude is measured to be 1 in, the velocity amplitude is measured to be 10 in/sec, and the acceleration amplitude is measured to be 125 in/sec^2. What can be concluded about the experiment? (15 points)

4. A rack and pinion system (shown below) consists of two identical gears of pitch radius r and mass moment of inertia $\bar{I}$, a rack of mass m, and a linear spring of stiffness k. For the system:

   (a) determine the equation of motion in terms of the displacement x. *Hint: Use the energy method.* (15 points)

   (b) determine the natural frequency. (5 points)