ME 460/660, Mechanical Vibration — Exam 2, Spring 1999

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

Problems are 20 points each. 10 points for graduate/bonus.

1. A compressor rotor consists of a slender shaft of stiffness $k = 1.8 \times 10^5$ N/m, a disk of diameter $d = 0.5$m, and mass 81.8 kg. While rotating at 500 rpm, a steel blade of length 0.2 m, constant cross section 11×10^{-4} m^2, is broken at half its length. Determine the resulting steady state vibration. Assume a density of steel of 7,800 kg/m^3.

2. A heat exchanger of mass m is supported midway between two floors of a building by vertical supports of spring constant k, as shown below. If the upper floor is vibrating with an amplitude Y and frequency ω_b, determine the vertical vibration of the heat exchanger.

3. Use the convolution integral to find the forced response of the following system for $t > \pi/5$: $m = 1$ kg, $c = 0$ kg s, $k = 100$ N/m, $F(t) = 1$ for $0 < t < \pi/5$, $F(t) = 0$ for $\pi/5 < t < \infty$. Assume zero initial conditions.

4. Graduate students/bonus: Determine the mode shapes and natural frequencies of a bar with constant circular cross section in torsional vibration with free-free boundary conditions. The equation of motion is given by $GJ_1 \frac{\partial^2 \theta(x,t)}{\partial x^2} = \rho J \frac{\partial^2 \theta(x,t)}{\partial t^2}$.