LESSON OBJECTIVES
1. Derive the equation of motion for an undamped spring-mass dynamic system.
2. Define the single-degree-of-freedom system, the limitations of this idealization, and identify when this idealization will tend to be a good approximation of the real structural behavior.
3. Plot the displacement and acceleration response of a freely vibrating undamped SDOF system.
4. Determine K-values of various beams, based on formulae from AISC and other references.
5. Determine dynamic forces, based on either the maximum displacement (using ku) or the maximum acceleration (using ma).

DIFFERENTIAL EQUATION NOTES:
If a differential equation is linear and two trial solutions can both be shown to satisfy this linear differential equation, then the superposition of these two solutions is also a solution to the linear differential equation.

Reading: Today’s class covers sections 1.1, 1.2, 1.5, 1.6 in the textbook (Chopra)

Equations to Find the Spring Stiffness of Beams (see AISC Table 3-23)

Homework (Due Monday)
Refer to AISC Table 3-23, as necessary. For problems 2 and 3, assume that the point mass is large, so that the steel structure weight may be neglected (i.e., treat it as a SDOF system). For all, ignore damping.

1. Write the effective stiffness of the combined springs (i.e., think carefully about this question: Do springs in series add? Do springs in parallel add? Hint: investigate the problems in Chopra’s book at the end of chapter 1).

2. A single-legged water tower supports a weight of 75,000 lbs, at a height of 50 feet. If the moment of inertia of the steel tower is 10,000 in^4, determine the natural frequency of the tower in units of rad/s and the natural period of vibration in units of seconds. Then, if Godzilla were to impart a 10 inch initial horizontal displacement to the water tank with an

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"Gentlemen, it is better to have died as a small boy than to fumble this football." – John Heisman

John Heisman took a fairly hard-line position on the issue of ball security.
initial velocity of 50 in/s, plot the displacement (units: inches) and acceleration (in g’s) responses of the tower (plot to a scale so that approximately 5 cycles are shown), over time, assuming no damping. Then, determine the maximum base moment on the steel tower.

3. If the beam shown is a W16x26 in strong axis bending (refer to the AISC manual) and the weight is 10kips, the beam will (of course) deflect some static distance. Determine this distance. Then, beam is pulled one inch down by some external effect (probably Godzilla) and released, resulting in free vibration. Plot the displacement (which will include both static and dynamic effect) as function of time for 5 cycles, identifying the period (seconds). From this, determine the maximum moment on the beam.