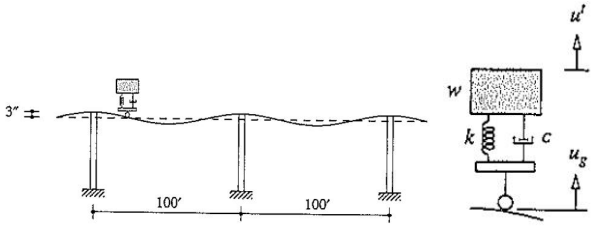
Aerospace Structural Dynamics – AE31002
Tutorial Sheet – 3

1. The mass m, stiffness k, and natural frequency ω_n of an undamped SDOF system are unknown. These properties are to determined by harmonic excitation tests. At an excitation frequency of 4 Hz, the response tends to increase without bound (i.e., a resonant condition). Next a weight Δw = 5 lb is attached to the mass and the resonance test is repeated. This time resonance occurs at f= 3 Hz. Determine the mass and the stiffness of the system.

   Ans. m = 6.43/g lbs/g, k = 10.52 lbs/in

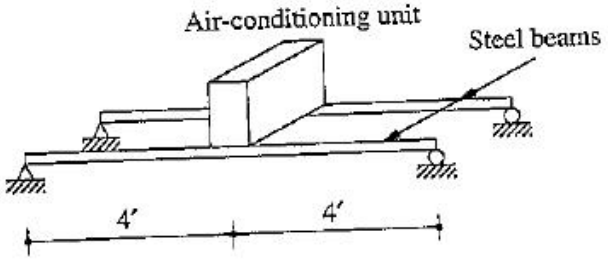
2. An automobile is traveling along a multi-span elevated roadway supported every 100 ft. Long term creep has resulted in a 6 in deflection at the middle of each span. The roadway profile can be approximated as sinusoidal with an amplitude of 3 in and period of 100 ft.



   The SDOF system shown is a simple idealization of an automobile, appropriate for a "first approximation" study of the ride quality of the vehicle. When fully loaded, the weight of the automobile is 4 kips. The stiffness of the automobile suspension system is 800 lb/in and its viscous damping coefficient is such that the damping ratio of the system is 40%. Determine a) the amplitude u_0^t of vertical motion $u^t(t)$ when the automobile is traveling at 40 mph and b) the speed of the vehicle that would produce a resonant condition for u_0^t.

   Ans. u_0^t = 3.56 in, v = 85mph

3. An air conditioning unit weighing 1200 lb is bolted at the middle of two parallel simply supported steel beams. The clear span of the beams is 8 ft. The second moment of cross sectional area of each beam is 10 in^4. The motor in the unit runs at 300 rpm and produces an unbalanced force of 60 lb at this speed. Neglecting the weight of the beams and assuming 1% damping in the system; for steel E = 30000 ksi. Determine the amplitudes of steady-state deflection and steady-state acceleration (in g's) of the beams at their midpoints which result from the unbalanced force.



   Determine the damping coefficient c of the system. k= 200 lb/in and m= 10 lb-sec^2/in.

   Ans. X = 1.104, $\ddot{X}$ = 0.0052 g

4. In a forced vibration test under harmonic excitation it was noted that the amplitude of motion at resonance was exactly four times the amplitude at an excitation frequency 20% higher than the resonant frequency. Determine the damping ratio of the system.

   Ans. ξ = 0.0576