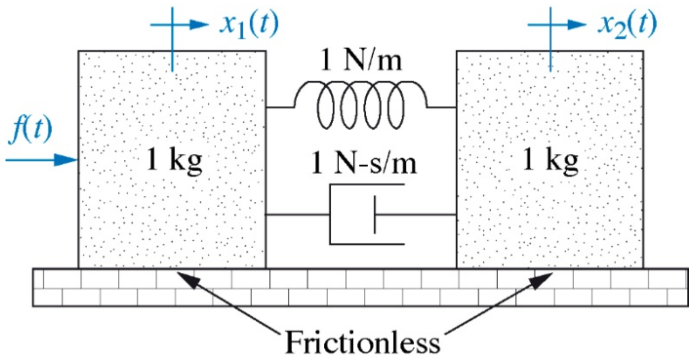
기계 항공 시스템 해석
2009. 1학기

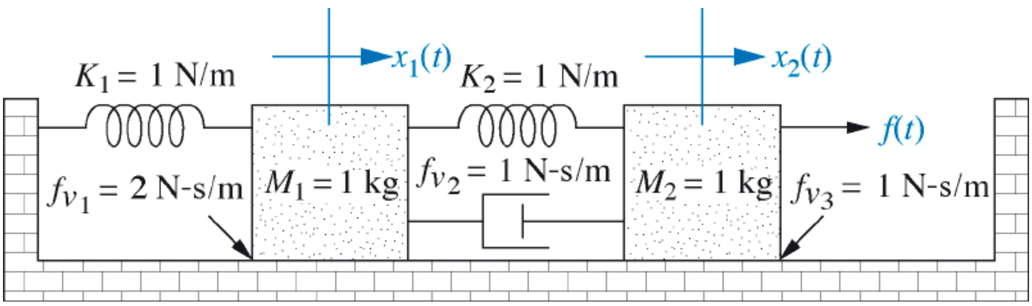
HW#3. Due 4/2 AM 9:00

1. Find the transfer function, $G_1(s) = \frac{X_1(s)}{F(s)}, G_2(s) = \frac{X_2(s)}{F(s)}$, for the translational mechanical network shown in Figure P1. Use MATLAB step & impulse function input f(t) to solve each transfer function $G_1(s), G_2(s)$, then **draw two graph in one plot**(Hint: use hold on) and compare step response with impulse response.



<Figure P1>

2. For the system of Figure P2, find the transfer function, $G_1(s) = \frac{X_1(s)}{F(s)}, G_2(s) = \frac{X_2(s)}{F(s)}$. Use MATLAB step & impulse function input f(t) to solve each transfer function $G_1(s), G_2(s)$, then **draw two graph in one plot**(Hint: use hold on) and compare step response with impulse response.



<Figure P2>

3. A table with four identical legs supports a vertical force. The solid cylindrical legs are made of metal with $E = 2 \times 10^{11}\ N/m^2$. The legs are 1 m in length and 0.03 m in diameter. Compute the equivalent spring constant due to the legs, assuming the table top is rigid.

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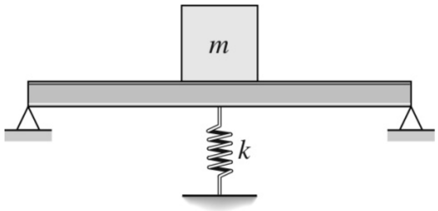
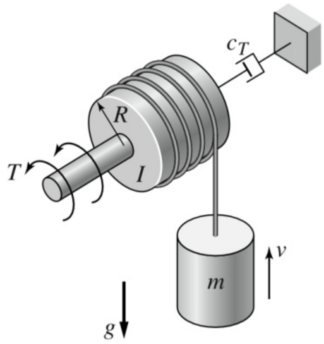
4. The beam shown in Figure P4 has been stiffened by the addition of a spring support. The steel beam is 3 ft long, 1 in thick, and 1 ft wide, and its mass is 3.8 slugs. The mass m is 40 slugs. Neglecting the mass of beam,
    a. Compute the spring constant k necessary to reduce the static deflection to one-half its original value before the spring k was added.
    b. Compute the natural frequency ω_n of the combined system.



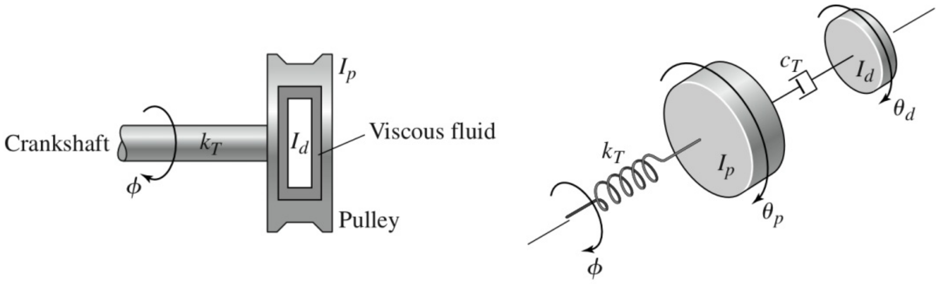
<Figure P4>

5. In Figure P5 a motor supplies a torque T to turn a drum of radius R and inertia I about its axis of rotation. The rotating drum lifts a mass m by means of a cable that wraps around the drum,. The drum's speed is ω. Viscous torsional damping C_T exists in the drum shaft. Neglect the mass of the cable.
    a. Obtain the equation of motion with the torque T as the input and the vertical speed v of the mass as the output.
    b. Suppose that $m = 40\ \mathrm{kg}, R = 0.2\ \mathrm{m}, I = 0.8\ \mathrm{kg \cdot m^2}$, and $C_T = 0.1 \cdot \mathrm{N \cdot m \cdot s}$. Find the speed v(t) if the system is initially at rest and the torque T is a step function of magnitude $200\ \mathrm{N \cdot m}$.



<Figure P5>

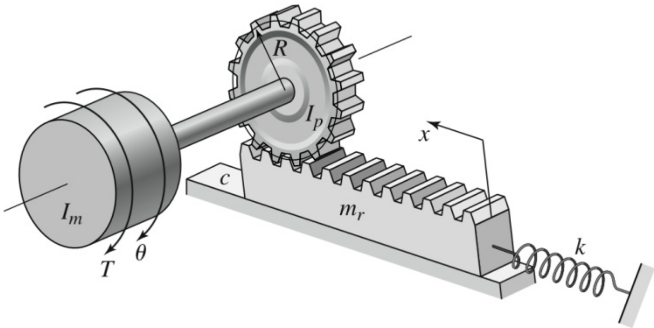
6. Figure P6 shows a Houdaille damper, which is a device attached to an engine crankshaft to reduce vibrations. The damper has an inertia I_d that is free to rotate within an enclosure filled with viscous fluid. The inertia I_d is the inertia of the fan-belt pulley. Modeling the crankshaft as a torsional spring K_T, the damper system can be modeled as shown in part (b) of the figure. Derive the equation of motion with the angular displacements θ_p and θ_d as the outputs and the crankshaft angular displacement φ as the input.



(a) (b)

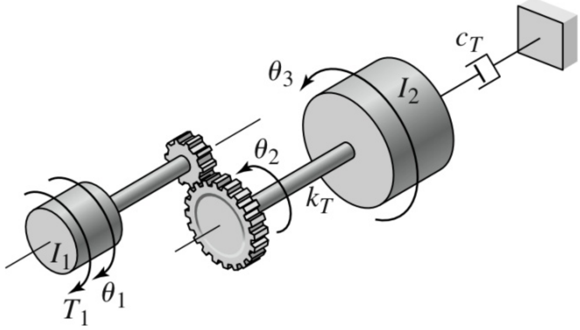
<Figure P6>

7. Figure P7 shows a rack-and-pinion gear in which a damping force and a spring force act against the rack. Develop the equivalent rotational model of the system with the applied torque T as the input variable and the angular displacement θ is the output variable. Neglect any twist in the shaft.



<Figure P7>

8. Figure P8 shows a drive train with a spur-gear pair. The first shaft turns N times faster than the second shaft. Develop a model of the system including the elasticity of the second shaft. Assume the first shaft is rigid, and neglect the gear and shaft masses. The input is the applied torque T_1. The outputs are the angles θ_1 and θ_3.



<Figure P8>