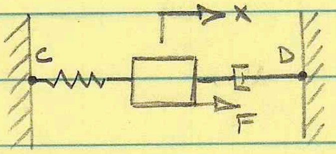
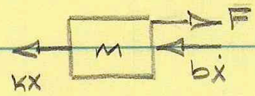
21a.



(15min) i. For the case that C and D are fixed (as shown) and a force $F = F_0 \sin\omega_0 t$ acts on mass, determine A, B.



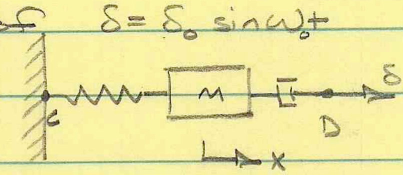
Linear Momentum Balance

$$\sum F = m\dot{v}$$

$$-kx - b\dot{x} + F = m\ddot{x}$$

$$m\ddot{x} + b\dot{x} + kx = F = F_0 \sin\omega_0 t \longrightarrow \boxed{A = 0, \ B = F_0}$$

(15min) ii. For case where C is fixed and D oscillates with magnitude of $\delta = \delta_0 \sin\omega_0 t$



Linear Momentum Balance

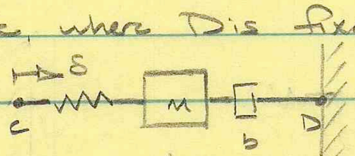
$$\sum F = m\dot{v}$$

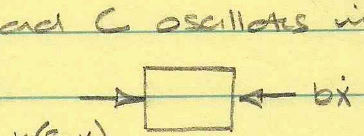
$$-kx + b(\dot{\delta} - \dot{x}) = m\ddot{x} \qquad \text{where} \quad \frac{d}{dt}(\delta) = \omega_0 \delta_0 \cos\omega_0 t$$

$$m\ddot{x} - b(\omega_0 \delta_0 \cos\omega_0 t - \dot{x}) + kx = 0$$

$$m\ddot{x} + b\dot{x} + kx = b\omega_0 \delta_0 \cos\omega_0 t \longrightarrow \boxed{A = b\omega_0\delta_0, \ B = 0}$$

(15min) iii. Case where D is fixed and C oscillates with $\delta = \delta_0 \sin\omega_0 t$





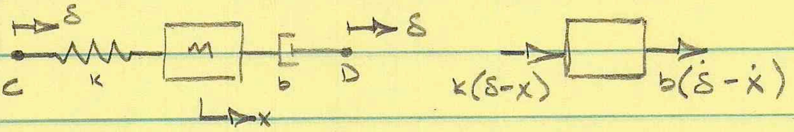
$$\sum F = m\dot{v}$$

$$k(\delta - x) - b\dot{x} = m\ddot{x} \qquad \text{where} \quad \delta = \delta_0 \sin\omega_0 t$$

$$k(\delta_0 \sin\omega_0 t - x) - b\dot{x} = m\ddot{x}$$

$$m\ddot{x} + b\dot{x} + kx = k\delta_0 \sin\omega_0 t \longrightarrow \boxed{A = 0, \ B = k\delta_0}$$

(15 min) 1V. Case when C and D oscillate together with $\delta = \delta_o \sin \omega t$



$\sum F = m\dot{v}$

$k(\delta - x) + b(\dot{\delta} - \dot{x}) = m\ddot{x}$ where $\delta = \delta_o \sin \omega_o t$, $\frac{d}{dt}(\delta) = \delta_o \omega_o \cos \omega_o t$

$k(\delta_o \sin \omega_o t - x) + b(\delta_o \omega_o \cos \omega_o t - \dot{x}) = m\ddot{x}$

$m\ddot{x} + b\dot{x} + kx = b\delta_o \omega_o \cos \omega_o t + k\delta_o \sin \omega_o t \rightarrow \boxed{A = b\delta_o \omega_o,\ B = k\delta_o}$

b. Trivial cooling, did not attempt.