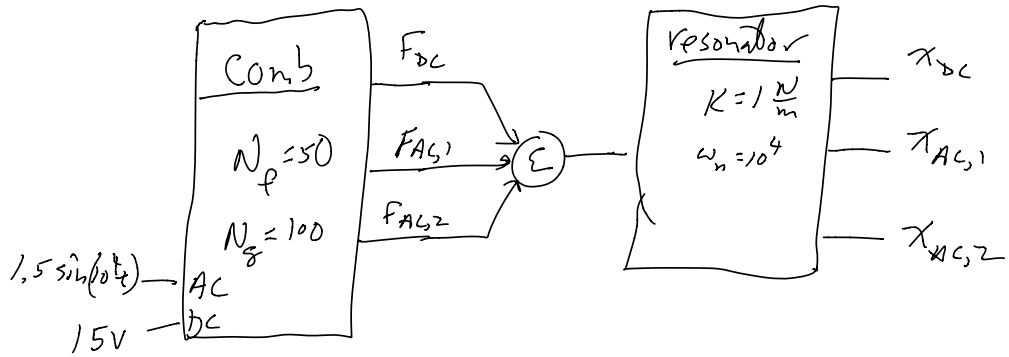

$$F_{DC} = \underbrace{\tfrac{1}{2}\epsilon_0 (15V)^2}_{1nN} \underset{100}{N_g} \underset{\text{call it 2 for now}}{\frac{t+g}{g}} = 200nN$$

$$F_{AC,1} = \underbrace{\tfrac{1}{2}\epsilon_0 (1.5V)(15V)}_{0.1nN}\underbrace{(-2) N_g \left(\frac{t+g}{g}\right)}_{400} = -40nN \sin(10^4 t)$$

$$F_{AC,2} = \underbrace{\tfrac{1}{2}\epsilon_0 (1.5V)(1.5V)}_{0.01nN}\underbrace{\left(\tfrac{1}{2}\right) N_g \left(\frac{t+g}{g}\right)}_{100}\left(-\cos(2\times10^4 t)\right)$$

$$= -1nN \cos(2\times10^4 t)$$

At DC, force drives spring

$$x_{DC} = \frac{F_{DC}}{K} = 0.2\mu m$$

At resonance, amplitude is Q times DC deflection, and phase shift -90

$$x_{AC,1} = Q\left(\frac{-40nN}{1N/m}\right)\sin(10^4 t - 90^\circ)$$

$$= (4\mu m)\sin(10^4 t - 270^\circ)$$

for high Q systems, above resonance the force drives the mass, and the phase shift is -180 degrees, canceling the -1

$$x_{AC,2} = \underbrace{\frac{1nN}{m(2\omega_n)^2}}_{\frac{1nN}{4K}} \cos(2\times10^4 t)$$

$$= 0.25nm \cos(2\times10^4 t)$$

this term is actually only 3K, as shown in another problem since the spring knocks out $\frac{1}{4}$ of the inertial term but full credit for 4K