1) Find $v(t)$ & $x(t)$

Know: m, $F_f = -\alpha v$

$$m\ddot{x} = F_f = -\alpha v$$

$$\frac{dv}{dt} = \underbrace{\frac{-\alpha}{m}}_{\text{const.} \equiv \frac{1}{\tau}} v$$

$$\int \frac{dv}{v} = \int -\frac{1}{\tau} dt$$

$$\int \frac{1}{v} dv = \frac{-1}{\tau} \int dt$$

$$e^{(\ln v)} = e^{\left(-\frac{1}{\tau} t + c\right)}$$

$e^c = v_0$ @ $t=0$

$$v = e^c e^{-t/\tau}$$

$$\boxed{v(t) = v_0 e^{-t/\tau}}$$

$$X = \int V(t) = \int_0^t V_0 e^{-t'/\tau} \, dt'$$

$$X(t) = V_0 \tau \left(1 - e^{-t/\tau}\right) + c$$

$$c = X_0 \text{ @ } t = 0$$

$$\therefore X(t) = X_0 + V_0 \tau \left(1 - e^{-t/\tau}\right)$$

2) Find $v(t)$ & $x(t)$

$$F = F_0 \cos(\omega t + \phi)$$

$$m \frac{dv}{dt} = F_0 \cos(\omega t + \phi)$$

$$\int \frac{dv}{dt} = \int \frac{F_0}{m} \cos(\omega t + \phi)$$

$$= \frac{F_0}{m} \int \cos(\omega t + \phi) =$$

$$= \underbrace{\frac{F_0}{m} \frac{1}{\omega}}_{V_c} \left[\sin(\omega t + \phi) - \sin\phi \right] + c$$

$$c = V_0$$

$$\boxed{\therefore V(t) = V_0 + V_c \left[\sin(\omega t + \phi) - \sin\phi \right]}$$

$$X(t) = \int V(t)$$

$$= \int V_c\, dt + \int V_c \left[\sin(\omega t + \phi) - \sin\phi\right]$$

$$= X_0 + V_0 t - V_c \sin\phi\, t + \frac{V_c}{\omega}\left[\cos\phi - \cos(\omega t + \phi)\right]$$

$$\therefore\ X(t) = X_0 + \frac{V_c}{\omega}\left[\left\{\frac{V_0}{V_c} - \sin\phi\right\}\omega t + \cos\phi - \cos(\omega t + \phi)\right]$$