3) a) equation of motion: $-k(x - x_{eq}) - bm\frac{dx}{dt} = m\frac{d^2x}{dt^2}$

try solution $x(t) = x_{eq} + e^{\alpha t}$

$$-k(x_{eq} + e^{\alpha t} - x_{eq}) - bm(\alpha e^{\alpha t}) = m(\alpha)^2 e^{\alpha t}$$

$$-\frac{k}{m}(e^{\alpha t}) - b(\alpha e^{\alpha t}) - (\alpha)^2 e^{\alpha t} = 0$$

$$(\alpha)^2 + b\alpha + \frac{k}{m} = 0$$

$$\alpha = \frac{-b \pm \sqrt{b^2 - 4(\frac{k}{m})}}{2}$$

$\therefore$ this is a solution if $\alpha = \frac{-b \pm \sqrt{b^2 - 4\frac{k}{m}}}{2}$

A general solution is a linear combination of these 2 solutions

$$x(t) = x_{eq} + \underline{A}e^{\alpha_1 t} + \underline{B}e^{\alpha_2 t}$$

where $\alpha_1 = \frac{-b + \sqrt{b^2 - \frac{4k}{m}}}{2}$ and $\alpha_2 = \frac{-b - \sqrt{b^2 - \frac{4k}{m}}}{2}$

b) $\alpha_1 = \frac{-20 + \sqrt{(20)^2 - \frac{4(300)}{.40}}}{2} = -10 + 25.5\,i$

$\alpha_2 = -10 - 25.5\,i \quad \Rightarrow x(t) = \underline{A}e^{(-10+25.5i)t} + \underline{B}e^{(-10-25.5i)t}$

$x_0 = x(t=0) = \underline{A}e^{(-10+25.5i)0} + \underline{B}e^{(-10-25.5i)0} = \underline{A} + \underline{B} = -6 \times 10^{-3}$

$\underline{B} = -6 \times 10^{-3} - \underline{A}$

$v_0 = v(t=0) = (-10+25.5i)\underline{A}e^{(-10+25.5i)0} + (-10-25.5i)\underline{B}e^{(-10-25.5i)0} =$

$= (-10+25.5i)\underline{A} + (-10-25.5i)\underline{B} = -.16$

$= (-10+25.5i)\underline{A} + (-10-25.5i)(-6\times 10^{-3} - \underline{A}) = -.16$