$$\vec{F} = -k\vec{s}$$

$$m\vec{a} = -k\vec{s}$$

$$ms'' = -ks$$

$$s'' = -\frac{k}{m}s$$

$$s'' + \frac{k}{m}s = 0$$

$$s'' + s = 0$$

$$s'' = -s$$

$s = \cos t$

$s' = -\sin t$

$s'' = -\cos t$

$s = \sin t$

$s' = \cos t$

$s'' = -\sin t$

$$s'' + s = 0$$

$$s(t) = A\cos t + B\sin t$$

$$s'' + \omega^2 s = 0$$

$s = \sin(\omega t)$ $\quad s'' = -\omega^2 s$

$s' = \omega\cos(\omega t)$

$s'' = -\omega^2 \sin(\omega t)$

$s = \cos(\omega t)$

$s' = -\omega \sin(\omega t)$

$s'' = -\omega\cos(\omega t)$

$$s'' + \omega^2 s = 0$$

$$s(t) = A\sin(\omega t) + B\cos(\omega t)$$

$$\sum \vec{F} = m\vec{a}$$

$$-as' - ks = ms''$$

$$ms'' + as' + ks = 0$$

$$s'' + \frac{a}{m}s' + \frac{k}{m}s = 0$$

$s = e^{rt}$

$s' = re^{rt}$

$s'' = r^2 e^{rt}$

$s'' + as' + bs = 0$

$r^2 e^{rt} + are^{rt} + be^{rt} = 0$

$e^{rt}(r^2 + ar + b) = 0$

$r^2 + ar + b = 0$

$r = \frac{-a \pm \sqrt{a^2 - 4(1)(b)}}{2(1)} = \frac{-a \pm \sqrt{a^2 - 4b}}{2}$

$s(t) = \begin{cases} e^{\frac{-a + \sqrt{a^2-4b}}{2}t} \\ e^{\frac{-a - \sqrt{a^2-4b}}{2}t} \end{cases}$

$y = e^{rt}$

$y' = re^{rt}$

$y'' = r^2 e^{rt}$

$$y'' + 3y' + 2y = 0$$

$$r^2 e^{rt} + 3re^{rt} + 2e^{rt} = 0$$

$$e^{rt}(r^2 + 3r + 2) = 0$$

$$(r+1)(r+2) = 0$$

$r = -1$ OR $r = -2$

$s = 2e^{-t} - \frac{1}{2}e^{-2t}$

$s'' + 3s' + 2s = 0$

$s = Ae^{-t} + Be^{-2t}$

$s(0) = -\frac{1}{2}$

$s'(0) = 3$

$s' = -Ae^{-t} - 2Be^{-2t}$

$-\frac{1}{2} = A + B$

$3 = -A - 2B$

$-\frac{1}{2} = A - \frac{3}{2}$

$2 = A$

$\frac{5}{2} = -B$

$-\frac{5}{2} = B$

$s = e^{rt}$

$s' = re^{rt}$

$s'' = r^2 e^{rt}$

$s'' + 2s' + 2s = 0$

$r^2 e^{rt} + 2re^{rt} + 2e^{rt} = 0$

$e^{rt}(r^2 + 2r + 2) = 0$

$r = \frac{-2 \pm \sqrt{4 - 4(1)(2)}}{2(1)} = \frac{-2 \pm \sqrt{-4}}{2}$

$= \frac{-2 \pm 2i}{2}$

$= -1 \pm i$

$$s'' + 2s' + 2 = 0$$

$$s(t) = Ae^{(-1+i)t} + Be^{(-1-i)t}$$

$$s'(t) = A(-1+i)e^{(-1+i)t} + B(-1-i)e^{(-1-i)t}$$

$$\begin{cases} s(0) = 2 \\ s'(0) = 0 \end{cases}$$

$$2 = A + B$$

$$0 = A(-1+i) + B(-1-i)$$