This works if $\boxed{\omega_1 = \omega_2 = \sqrt{\frac{k}{m}}}$ A_1, A_2 are adjustable

c) $x(t) = x_{eq} + A_1 e^{\omega_1 t} + A_2 e^{-\omega_2 t}$ $\boxed{\text{Yes}}$

Check EOM: $\ddot{x}(t) = A_1\omega_1^2 e^{\omega_1 t} + A_2\omega_2^2 e^{\omega_2 t}$

$\Rightarrow A_1\omega_1^2 e^{\omega_1 t} + A_2\omega_2^2 e^{\omega_2 t} = -\frac{k}{m}A_1 e^{\omega_1 t} - \frac{k}{m}A_2 e^{\omega_2 t}$

This works if $\omega_1 = \omega_2 = \sqrt{-\frac{k}{m}} = i\sqrt{\frac{k}{m}}$ $A_1 A_2$ are adjustable

Note: ω_1 and ω_2 are imaginary but the real part of the solution will be the physical one!

d) $x(t) = x_{eq} + A\sin[\omega_0(t-t_0)]$ $\boxed{\text{Yes}}$

Satisfies EOM as long as $\omega_0 = \sqrt{\frac{k}{m}}$ A, t_0 are adjustable

e) $x(t) = A_1\sin(\omega_1 t) + A_2\sin(\omega_2 t)$ (have to add x_{eq} to satisfy EOM)

Check EOM: $\ddot{x}(t) = -A_1\omega_1^2\sin(\omega_1 t) - A_2\omega_2^2\sin(\omega_2 t)$

$= -\frac{k}{m}A_1\sin(\omega_1 t) - \frac{k}{m}A_2\sin(\omega_2 t) + \frac{k}{m}x_{eq}$

$\Rightarrow \omega_1^2 = \frac{k}{m},\ \omega_2^2 = \frac{k}{m}$

but this means $A_1 = A_2 = A \rightarrow$ only 1 adjustable parameter

$\boxed{\text{Not a general solution}}$

(f) $x(t) = x_{eq} + A_1\sin(\omega_1 t) + A_2\cos(\omega_2 t)$ $\boxed{\text{Yes}}$

Check EOM: $\ddot{x}(t) = -A_1\omega_1^2\sin(\omega_1 t) - A_2\omega_2^2\cos(\omega_2 t) = -\frac{k}{m}A_1\sin(\omega_1 t) - \frac{k}{m}\cos(\omega_1 t$

$\Rightarrow \omega_1 = \omega_2 = \sqrt{\frac{k}{m}}$, A_1, A_2 are adjustable

(g) $x(t) = x_{eq} - A\sin(\phi - \omega_0 t)$ $\boxed{\text{Yes}}$

Check EOM: $\ddot{x}(t) = A\omega_0^2\sin(\phi - \omega_0 t) = \frac{k}{m}A\sin(\phi - \omega_0 t)$

$\Rightarrow \omega_0 = \sqrt{\frac{k}{m}}$, A, ϕ are adjustabe