

## 2. Review

### Initial value problem

1/1 point (graded)

Find a solution to the following homogeneous, second order initial value problem:

$$\frac{d^2}{dt^2}x + 4x = 0, \quad x(0) = 0, \quad \frac{dx}{dt}(0) = 1.$$

(This system models a simple harmonic oscillator which starts at position  $x = 0$  (m), with a velocity 1 (m/s) to the right.)

$x(t) =$

sin(2\*t)/2

✓ Answer: sin(2\*t)/2

$\frac{\sin(2 \cdot t)}{2}$

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#### Solution:

The characteristic equation  $r^2 + 4 = 0$  of this differential equation has complex roots  $\pm 2i$ . The general solution to this second order, homogeneous differential equation with complex roots is



$$x(t) = A \cos(2t) + B \sin(2t).$$

We solve for the constants  $A$  and  $B$  using the initial conditions.

$$\begin{aligned} x(0) &= A \cos(0) + B \sin(0) = 0 && \longrightarrow A = 0 \\ x'(0) &= -2A \sin(0) + 2B \cos(0) = 1 && \longrightarrow B = 1/2 \end{aligned}$$

Therefore the solution to this initial value problem is

$$x(t) = \frac{1}{2} \sin(2t).$$

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**i** Answers are displayed within the problem

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