

1. Solve the following differential equation:

$$y'' + 2y' - 8y = 0; y(0) = 3, y'(0) = -12$$

2. Solve the following differential equation:

$$y'' + 4y' + 4y = 0; y(0) = 1, y'(0) = 3$$

3. Solve the following differential equation:

$$y'' + 2y' + 2y = 0; y(0) = 0, y'(0) = 2$$

4. Find y_p for the differential equation

$$y'' + 3y' + 2y = 3x + 3 + 10 \sin x .$$

5. Solve the differential equation below.

$$y'' + 9y = \sec^2 3t$$

6. A $1/8$ kg mass is attached to a spring with stiffness 16 N/m. The damping constant for the system is 2 N-sec/m. If the mass is pulled 0.5 m to the left of equilibrium and given an initial leftward velocity of 4 m/sec:
- What is the equation of motion for the spring?
 - What is the equation of motion in the form $y = e^{\alpha t} \sin(\beta t + \phi)$
 - When will it first return to the equilibrium position, $y = 0$?

Bonus +5: Derive Euler's formula: $e^{ix} = \cos x + i \sin x$