In Problems 1-3, find the general solution of the equation.

**Problem 1.** $y'' - y = e^{2t}$.

**Problem 2.** $y'' - y = te^{2t} + 2e^{t} + t$.

**Problem 3.** $y'' + 2y' + 8y = -e^{t}$.

In Problems 4-9, write the general solution of the equation with undetermined coefficients (but do not find the coefficients). Indicate which coefficients are undetermined but fixed (such as $A, B$), and which are general constants which are to be determined for the initial value problem ($C_1, C_2$).

*Example:* $y'' - y = 2te^{t} \Rightarrow y = C_1e^{t} + C_2e^{-t} + (At^2 + Bt)e^{t}$.

**Problem 4.** $y'' - y' - 6y = t^2e^{-t}$.

**Problem 5.** $y'' - 4y = -0.5t^3e^{3t} + 1$.

**Problem 6.** $y'' - 4y' + 3y = -4t^2e^{t} + e^{3t}$.

**Problem 7.** $y'' + 4y = -3(t^5 - 4t)e^{-t}$.

**Problem 8.** $y'' - 6y' + 9y = -(t^2 + t)e^{3t} - 4t^3 + t^2e^{t}$.

**Problem 9.** $y'' + 3y' + 2y = -2t^2 + 3 + (t^3 - 4t)e^{-t}$.

**Problem 10*. According to one model of air resistance, the resistance force is proportional to the square of the speed: $F = kv^2$. Suppose we drop a ball with mass $m$ with zero initial speed from initial height 0. The gravitational force is $F = mg$.

(i) Find $v(t)$, the speed at time $t$.

(ii) Draw a diagram of stable/unstable/semistable solutions. Find the limiting speed as $t \to \infty$.

The problems marked with an asterisk are optional, non-mandatory, for extra credit. Also, if you are going to apply to a graduate or professional school, and if you solve them, then I will mention this in your recommendation letter, which will make this recommendation stronger.