1. Solve the following ODEs, by writing $y(t) = y_h(t) + y_p(t)$. That is, solve the homogeneous equation, then guess a particular solution, and add those together to get the general solution.

   (a) $y' - 2y = 0$

   (b) $y' - 2y = 10$

   (c) $y' - 2y = t$

   (d) $y' - 2y = t^2 + 1$

   (e) $y' - 2y = 4e^{3t}$

   (f) $y' - 2y = 5 \sin 3t$

2. A tank contains 100 gal of pure water. A salt solution with concentration 3 lb/gal enters the tank at a rate of 2 gal/min. Solution drains from the tank at a rate of 2 gal/min. Sketch a picture of this situation, then *without doing any math*, determine the eventual concentration of the salt solution in the tank (i.e., the steady-state solution).

3. A tank contains 100 gal of pure water. At time zero, a sugar-water solution containing 0.2 lb of sugar per gal enters the tank at a rate of 3 gal per minute. Simultaneously, a drain is opened at the bottom of the tank allowing the sugar solution to leave the tank at 3 gal per minute. Assume that the solution in the tank is kept perfectly mixed at all time.

   (a) What will be the sugar content in the tank after 20 minutes?

   (b) How long will it take the sugar content in the tank to reach 15 lb?

   (c) What will be the eventual sugar content in the tank?

4. A tank initially contains 50 gal of sugar water having a concentration of 2 lb of sugar for each gal of water. At time zero, pure water begins pouring into the tank at a rate of 2 gal per minute. Simultaneously, a drain is opened at the bottom of the tank so that the volume of sugar-water solution in the tank remains constant.

   (a) How much sugar is in the tank after 10 minutes?

   (b) How long will it take the sugar content in the tank to dip below 20 lbs?

   (c) What will be the eventual sugar content in the tank?

5. A tank contains 500 gal of a salt-water solution containing 0.05 lb of salt per gallon of water. Pure water is poured into the tank and a drain at the bottom of the tank is adjusted so as to keep the volume of solution in the tank constant. At what rate (gal/min) should the water be poured into the tank to lower the salt concentration to 0.01 lb/gal of water in under one hour (i.e., $t = 60$ minutes)?

6. A tank initially contains 100 gal of a salt-water solution containing 0.05 lb of salt for each gallon of water. At time zero, pure water is poured into the tank at a rate of 2 gal per minute. Simultaneously, a drain is opened at the bottom of the tank that allows the salt-water solution to leave at a rate of 3 gal per minute. What will be the salt content in the tank when precisely 50 gal of salt solution remain.

7. A tank initially contains 100 gal of pure water. Water begins entering a tank via two pipes: through pipe A at 6 gal per minute, and pipe B at 4 gal per minute. Simultaneously, a drain is opened at the bottom of the tank through which solution leaves the tank at a rate of 8 gal per minute.

   (a) To their dismay, supervisors discover that the water coming into the tank through pipe A is contaminated, containing 0.5 lb of pollutant per gallon of water. If the process had been running undected for 10 minutes, how much pollutant is in the tank at the end of this 10-minute period?

   (b) The supervisors correct their error and shut down pipe A, allowing pipe B and the drain to function in precisely the same matter as they did before the contaminant was discovered in pipe A. How long will it take the pollutant in the tank to reach one half of the level achieved in part (a)?