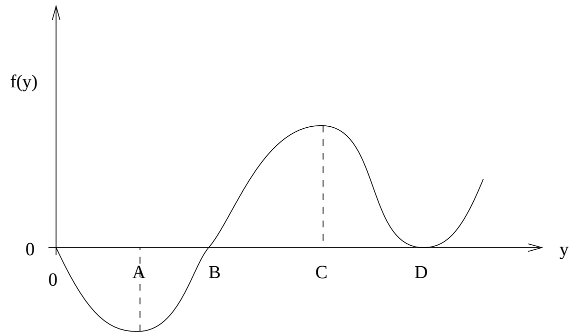
1. Suppose $N'(t) = F(N(t))$, where the graph of $F(N)$ is given below. Carefully draw the integral curves for this equation. What are the equilibrium solutions? What are their stability types? Describe the initial concavity of the solution curves. Assume $N(t)$ and t are nonnegative.



2. Solve the initial value problem, $(x^2+1)y' + 3xy = 6x$, with initial condition $y(0) = 2$.

3. Solve $y'' - 4y' + 4y = 0$. What is the limit as $t \to \infty$?

4. Find the general solution of the equation below. (You need not solve for y.)

$$(x^2y + yx - y) + x^2(y-2)\,y' = 0$$

5. The equation below is homogeneous (in the sense of section 2.9). Find its general solution. (You need not solve for y.)

$$\frac{dy}{dx} = \frac{x^2+3y^2}{2xy}$$

6. The number of algae cells in a tank of water grows according to

$$A'(t) = .2\left(1 - \frac{A(t)}{100}\right)A(t) \qquad \text{light on, and}$$
$$A'(t) = -.2A(t) \qquad \text{light off.}$$

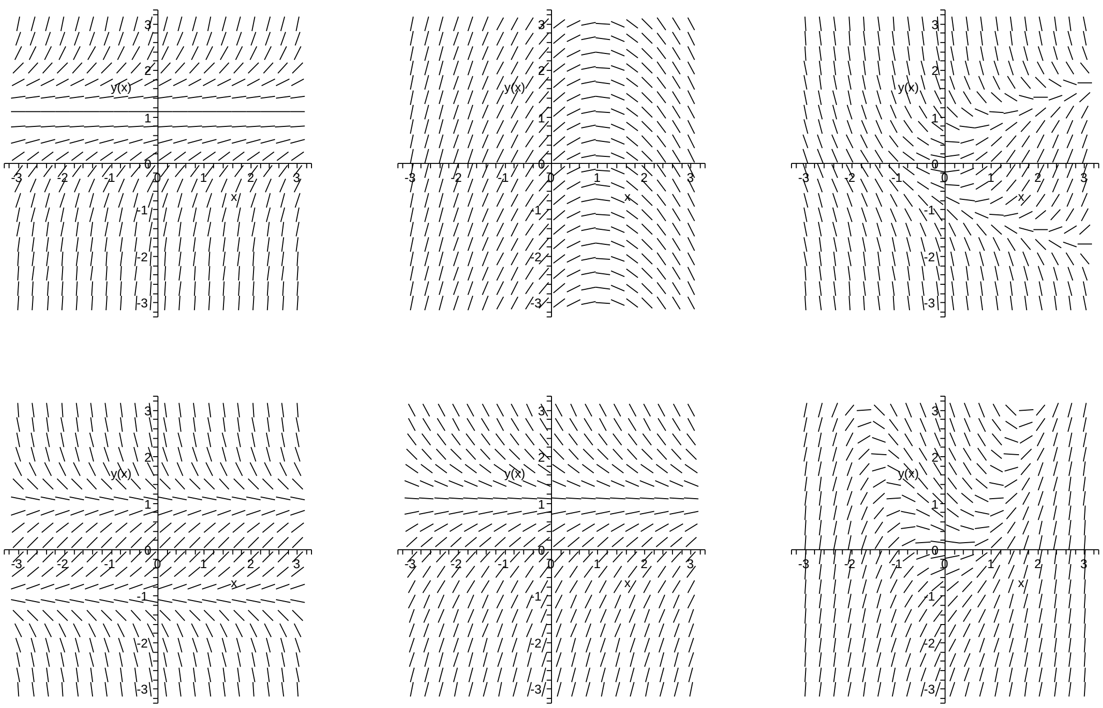
In words, the carrying capacity drops from 100 (billion cells) to zero when the light goes out. At $t = 0$ you start a ten (10) hour experimental run with $A(0) = 25$ and plan to keep the light on. When you come back at $t = 10$ you discover that the light bulb has burned out. You measure $A(10)$ to be 15. What time did the light bulb burn out?

4 decimal places. The integral below will be helpful:

$$\int \frac{dx}{x(a+bx)} = \frac{1}{a} \ln\left(\frac{x}{a+bx}\right) + C$$

7. Match the differential equation with its direction field. (You get 4 points for each correct match, -1 for each wrong match.)

   1. $y' = y - 2$
   2. $y' = 2 - y$
   3. $y' = |y - 2|$
   4. $y' = y + x$
   5. $y' = x - y$



8. Find a continuous solution to the initial value problem, $y' + p(t)y = g(t)$, $y(0) = 1$, where

$$p(t) = \begin{cases} 1 & t \leq 1 \\ 0 & t > 1 \end{cases}$$

and

$$g(t) = \begin{cases} 0 & t \leq 2 \\ 1 & t > 2 \end{cases}$$

Sketch the graph of your solution, $y(t)$, for $0 \leq t \leq 5$. Hint: $y(5) = 3 + 1/e$.

9. A tank contains 200 gallons of salt water. The initial salinity is .5 lb/gal. The water is then pumped out of the tank, run through a filter, and pumped back in. The flow rate is 5 gallons a minute. The filter removes 30% of the salt. Also, water is evaporating at a rate of 1 gallon per minute. How much salt is left in the tank when the water has all evaporated? Assume the water in the tank is well mixed.