1. Which of the following is not a linear equation?

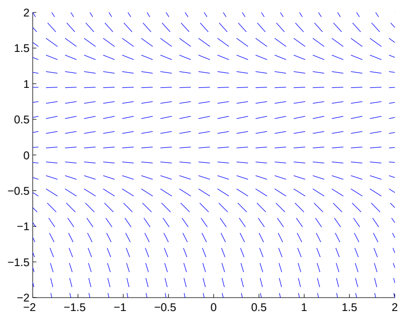
   (a) $y'''/y = 5 + \cos t$.

   (b) $y'' + (\sin t)y' = 5ye^t$.

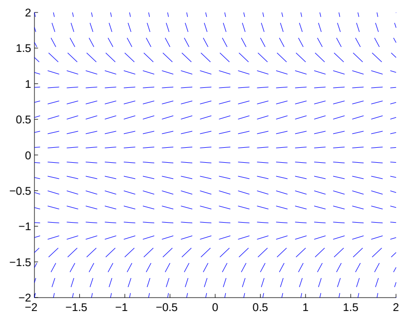
   (c) $y'' + \sin y = 0$.

   (d) $y' + y = 1$.

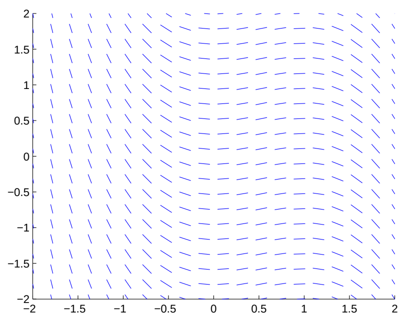
2. Which of the following is a direction field for the equation $y' = y - y^2$?



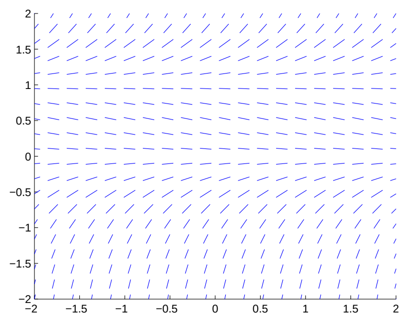
(a)



(b)



(c)



(d)

3. If $x' = tx$, and $x(0) = 2$, then $x(1)$ is

   (a) e.

   (b) 1.

   (c) $2e$.

(d) $2\sqrt{e}$.

4. A sea water aquarium initially contains 50 gallons of fresh water. Salt water containing 5 ounces of salt per gallon is pumped into the aquarium at a rate of 2 gallons per minute, while the well mixed solution is drained at the same rate. If $Q(t)$ is the amount of salt in the tank, measured in ounces, and t is measured in minutes, then Q obeys the following initial value problem:

   (a) $Q' = 2 - Q/50$, $Q(0) = 5$.

   (b) $Q' = 10$, $Q(0) = 0$.

   (c) $Q' = 10 - Q/25$, $Q(0) = 0$.

   (d) $Q' = 2t - Q/50$, $Q(0) = 5$.

5. If $y' = y^2 + 1$, $y(0) = 1$, then $y(1)$ is

   (a) $e^{1/2}$.

   (b) $2e - 1$.

   (c) $\tan(1 + \frac{\pi}{4})$.

   (d) 1.

6. You solve the initial value problem $y' = 2t + y^2$, $y(1) = 0$, using the Euler method with $h = 0.05$. Then the approximation you find for $y(1.1)$ is

   (a) 0.1.

   (b) 0.223.

   (c) 0.005.

   (d) 0.2055.

7. A particular solution of the equation $y'' - 4y = t\cos(2t)$ should have the form

   (a) $At\cos(2t) + Bt\sin(2t) + C\cos(2t) + D\sin(2t)$.

   (b) $At^2\cos(2t) + Bt^2\sin(2t)$.

   (c) $At^2\cos(2t) + Bt^2\sin(2t) + Ct\cos(2t) + Dt\sin(2t)$.

(d) $At\cos(2t) + B\cos(2t)$.

8. You are looking for a particular solution of the equation

$$y'' - y = \frac{e^t}{t}.$$

You should look for this solution in the form

(a) Ae^t/t^2.

(b) $ue^t + vte^t$.

(c) $ue^t + ve^{-t}$.

(d) Ae^t/t.

9. A mass of 5 kg stretches a spring by 9.8 cm in equilibrium. The spring is then stretched another 2 cm and the mass is released from rest. If the displacement of the mass from equilibrium is measured in cm and time in seconds, the initial value problem governing the motion of the mass is

(a) $5u'' + 49u = 0$, $u(0) = 11.8$, $u'(0) = 0$.

(b) $5u'' + 100u = 0$, $u(0) = 2$, $u'(0) = 0.098$.

(c) $u'' + 100u = 0$, $u(0) = 2$, $u'(0) = 0$.

(d) $u'' + 20u = 0$, $u(0) = 9.8$, $u'(0) = 2$.

10. The general solution of the equation $y'''' - y'' = 0$ is

(a) $y = A + Be^t$.

(b) $y = At + B + Ce^t + Dte^t$.

(c) $y = At^3e^t + Bt^2e^t + Cte^t + De^t$.

(d) $y = At + B + Ce^t + De^{-t}$.

11. The general solution of the system $y' = Ay$, where

$$A = \begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix},$$

is

(a) $c_1 e^{t}\begin{pmatrix}1\\1\end{pmatrix} + c_2 e^{-t}\begin{pmatrix}1\\-1\end{pmatrix}$.

(b) $c_1\begin{pmatrix}1\\1\end{pmatrix} + c_2\begin{pmatrix}1\\-1\end{pmatrix}$.

(c) $c_1 e^{2t}\begin{pmatrix}1\\1\end{pmatrix} + c_2\begin{pmatrix}1\\-1\end{pmatrix}$.

(d) $c_1\begin{pmatrix}1\\1\end{pmatrix} + c_2 e^{2t}\begin{pmatrix}1\\-1\end{pmatrix}$.

12. A matrix has the eigenvalue $2+i$ and the complex eigenvector $\begin{pmatrix}1+i\\2+3i\end{pmatrix}$. Then two real-valued solutions of the differential system $y' = Ay$ are

(a) $\begin{pmatrix}e^{2t}(\cos t + \sin t)\\ e^{2t}(2\cos t + 3\sin t)\end{pmatrix}$ and $\begin{pmatrix}e^{2t}(\sin t + \cos t)\\ e^{2t}(2\sin t + 3\cos t)\end{pmatrix}$.

(b) $\begin{pmatrix}e^{2t}(-\cos t + \sin t)\\ e^{2t}(3\cos t - 2\sin t)\end{pmatrix}$ and $\begin{pmatrix}e^{2t}(\sin t + \cos t)\\ e^{2t}(3\sin t + 2\cos t)\end{pmatrix}$.

(c) $\begin{pmatrix}e^{2t}(\cos t - \sin t)\\ e^{2t}(2\cos t - 3\sin t)\end{pmatrix}$ and $\begin{pmatrix}e^{2t}(\sin t + \cos t)\\ e^{2t}(2\sin t + 3\cos t)\end{pmatrix}$.

(d) $\begin{pmatrix}e^{2t}\cos t\\ 2e^{2t}\cos t\end{pmatrix}$ and $\begin{pmatrix}e^{2t}\sin t\\ 3e^{2t}\sin t\end{pmatrix}$.

13. A nonlinear system is given by

$$x_1' = x_1^2 - x_2^3 x_1.$$

$$x_2' = \sin(\pi x_1).$$

You linearize this system at the equilibrium point $(1, 1)$. The matrix of the linearization is

(a) $\begin{pmatrix}2 & -2\\ -\pi & \pi\end{pmatrix}$.

(b) $\begin{pmatrix}3 & -3\\ 0 & 0\end{pmatrix}$.

(c) $\begin{pmatrix}2 & -3\\ \pi & 0\end{pmatrix}$.

(d) $\begin{pmatrix}1 & -3\\ -\pi & 0\end{pmatrix}$.