a) $x = -2e^{-2t} + 3e^{-3t}$
$y = 4e^{-2t} - 3e^{-3t}$
$[-0.5, 2]$

b) $x = -4e^{2t} + 3e^{3t}$
$y = -2e^{2t} + 3e^{3t}$
$[-2, 0.5]$

c) $x = -2e^{-2t} - e^{3t}$
$y = e^{-2t} + e^{3t}$
$[-1.5, 1.0]$

d) $x = \cos 2t - 3\sin 2t$
$y = 2\sin 2t + \cos 2t$
$[-2\pi, 4\pi]$

e) $x = e^{t}(\cos t + 5\sin t)$
$y = e^{t}(-8\sin t + \cos t)$
$[-\pi, \pi/2]$

f) $x = e^{-t}(\cos t + \sin t)$
$y = e^{-t}(\cos t - \sin t)$
$[-\pi, \pi]$

2. Select **Gallery→linear system** in the PPLANE5 Setup window. Adjust the parameters to match the linear system in each of the following exercises. Accept all other default settings in the PPLANE5 Setup window. Select **Solutions→Keyboard input** in the PPLANE5 Display window to start a solution trajectory with the given initial condition. Finally, select **Graph→Both** and click your solution trajectory to obtain plots of x and y versus t. Compare your output to the corresponding problem in Exercise 1.

a) $x' = -4x - y$
$y' = 2x - y$
$x(0) = 1, y(0) = 1$

b) $x' = x + 2y$
$y' = -x + 4y$
$x(0) = -1, y(0) = 1$

c) $x' = -7x - 10y$
$y' = 5x + 8y$
$x(0) = -3, y(0) = 2$

d) $x' = -2x - 4y$
$y' = 2x + 2y$
$x(0) = 1, y(0) = 1$

e) $x' = 4x + 2y$
$y' = -5x - 2y$
$x(0) = 1, y(0) = 1$

f) $x' = -x + y$
$y' = -x - y$
$x(0) = 1, y(0) = 1$

3. In the predator-prey system

$$L' = -L + LP,$$
$$P' = P - LP,$$

L represents a ladybug population and P represents a pest that ladybugs like to eat. Enter the system in the PPLANE5 Setup window, set the display window so that $0 \le L \le 2$ and $0 \le P \le 3$, then select **Arrows** for the direction field.

a) Use the Keyboard input window to start a solution trajectory with initial condition (0.5, 1.0). Note that the ladybug-pest population is periodic. As the ladybug population grows, their food supply dwindles and the ladybug population begins to decay. Of course, this gives the pest population time to flourish, and the resulting increase in the food supply means that the ladybug population begins to grow. Pretty soon, the populations come full cycle to their initial starting position.

b) Suppose that the pest population is harmful to a farmer's crop and he decides to use a poison spray to reduce the pest population. Of course, this will also kill the ladybugs. Question: Is this a wise idea? Adjust the system as follows:

$$L' = -L + LP - HL,$$
$$P' = P - LP - HP.$$

Note that this model assumes that the growth rate of each population is reduced by a fixed percentage of the population. Enter this system in the PPLANE5 Setup window, but keep the original display window settings. Create and set a parameter `H=0.25`. Start a solution trajectory with initial condition (0.5, 1.0).

c) Repeat part (b) with $H = 0.50$, 0.75, and 1.00. Is this an effective way to control the pests? Why? Describe what happens to each population for each value of the parameter H.

4. Enter the system

$$x' = \sin y - 2\sin x^2 \sin 2y,$$
$$y' = -\cos x - 2x\cos x^2 \cos 2y,$$