18. (*expires 10/16*) Find an analytic expression for all the solutions to the differential equation

$$\frac{d}{dt}x(t) = -2x(t), \quad t \in \mathbb{R}.$$

Among those, write the formula for the one satisfying $x(0) = 3$.

Hint: This is simple enough that you can do this in your head. But I suggest at least trying to get Maple to do this for you. See the help page `HowDoI,SolveAnOrdinaryDifferentialEquation` for more information.

19. (*expires 10/16*) Have Maple find analytic solutions to the following system of differential equations,

$$\begin{cases} y''(t) - z(t) &= e^t, \\ z'(t) - y(t) &= 0, \end{cases}$$

with initial conditions: $y(0) = 1$, $y'(0) = 0$, $z(0) = k$. Let us denote the solutions by $y_k(t)$, $z_k(t)$ (since they depend on the parameter k).

For k taking all integer values from -10 to 10, and $t \in [-4, 2]$, plot the functions y_k in blue, and the functions z_k in red, all on the same graph. (Yes, you will then have 42 functions plotted on the same graph.)
This is certainly a case when you don't want to retype the functions that Maple finds. You will almost certainly need to read the help page mentioned above and/or the help on `dsolve`. I also found `subs`, `unapply`, and `seq` useful.

20. (*expires 10/16*) For the functions $y_k(t)$ and $z_k(t)$ found in the previous problem, plot the parametric curves $\varphi_k(t) = [y_k(t), z_k(t)]$ for integer values of k between -7 and 7 and $-10 < t < 4$ on the same graph. Use the `view` option to plot in order to only show what lies in the region $-15 < y < 15$, $-15 < z < 15$ (with y and z having the same scale). Use a sequence of colors so that each solution is a different color, and the coloring follows a predictable pattern. It would be nice to include a legend at the right of the plot.
Hint: you might find something like `seq(COLOR(HUE,i/16),k=-7..7)` useful for the coloring, and `seq(sprintf("k=%d",k), k=-7..7)` helpful in making the legend.

21. (*expires 10/16*) Find all the fixed points of the system

$$\begin{cases} \dot{x} &= x^2 + y, \\ \dot{y} &= x(y^2 - 1), \end{cases}$$

where a "fixed point" is a solution for which **both** $x(t)$ **and** $y(t)$ are constant. For each of these solutions you find, describe the behavior of the solutions that have initial conditions nearby. You can use Maple to figure out what happens for nearby points, or you can use more mathematical methods.

NOTE: The fact that there are various notations for differential equations is purely intentional.