# Lab Assignment 1

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## Task 1

Use `SymPy` to solve the differential equation $y' = -y^2 \sin(x)$, with $y(0) = 1$, and plot the solution.

In [2]:

```
import sympy as sym
sym.init_printing()
from IPython.display import display_latex
import sympy.plotting as sym_plot
from sympy import sin
```

In [15]:

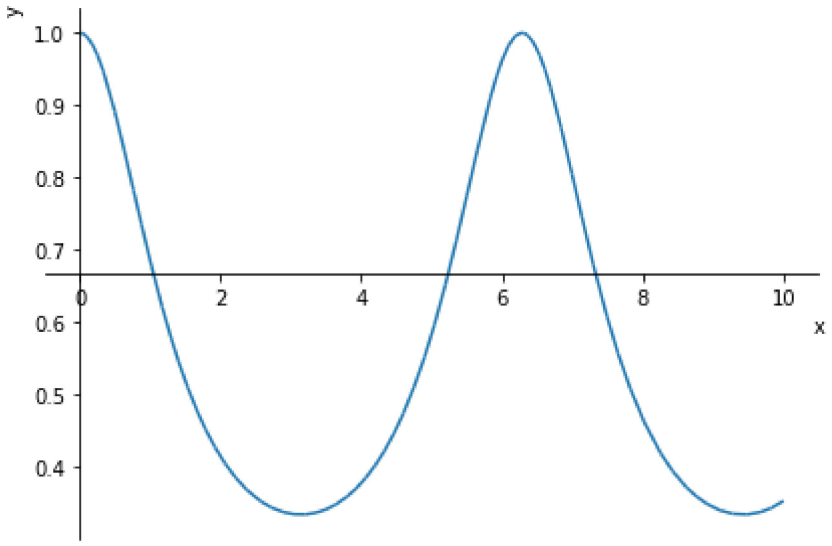
```
# Define the equation
x = sym.symbols('x')
y = sym.Function('y')
eq1 = sym.Eq(y(x).diff(x), -y(x)*y(x)*sin(x))

# Solve the equation
eq1sol0 = sym.dsolve(eq1, y(x), ics={y(0):1})
eq1sol0
```

Out[15]:

$$y(x) = -\frac{1}{\cos(x) - 2}$$

In [20]:

```
sym_plot.plot(eq1sol0.rhs, (x,0,10), xlabel = 'x', ylabel = 'y')
```




Out[20]:

```
<sympy.plotting.plot.Plot at 0x25aae27c880>
```

# Task 2

Use SciPy 's odeint function to solve the system of equations

$$\frac{dx}{dt} = y$$
$$\frac{dy}{dt} = x - x^3$$

Produce a plot of the solutions for $0 \leq t \leq 10$ with initial conditions $x(0) = 0$ and $y(0) \in \{0, 0.5, 1, \ldots, 3\}$.

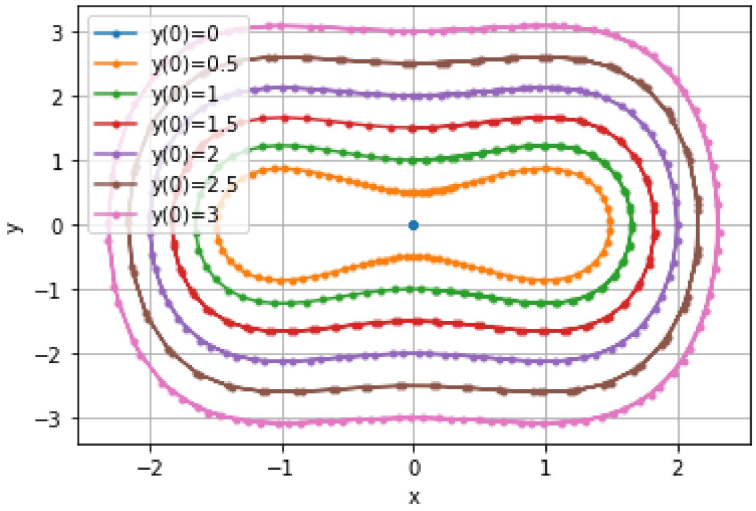
How many curves do you expect to see plotted? How many do you actually see, and why is this?

In [7]:

```
import numpy as np
import matplotlib.pyplot as plt
from scipy.integrate import odeint
```

In [18]:

```
#form the system of equations
def dX_dt(X, t):
    x, y = X
    return [y, x-x**3]

#initial values of y
y0=[0,0.5,1,1.5,2,2.5,3]

t = np.linspace(0, 10, 100)

#iterate through initial values of y, label each one
for i in range (7):
    X0=[0,y0[i]]
    Xsol = odeint(dX_dt, X0, t)
    plt.plot(Xsol[:, 0], Xsol[:, 1],label='y(0)='+str(y0[i]),marker='.')
plt.xlabel('x')
plt.ylabel('y')
plt.legend()
plt.grid()
```




As there are seven 7 values of y, I expect to see 7 curves plotted. However, only six of them are plotted, with only a dot at (0,0) for initial condition [0,0]. This is because when trying to solve the system of equations, $\frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}}$, and when $y(0) = 0 \Rightarrow \frac{dx}{dt} = 0$. Which means we will not get a solution for $\frac{dy}{dx}$ and we will not get an equation with $x$ and $y$, hence no curve for initial condition [0,0].

In [ ]: