# HW 5. Problem 25.1 MAE 185.

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**Problem**

Solve the initial value $\frac{dy}{dx} = yx^2 - 1.2y$ analytically over the interval from $x = 0$ to 2.where $y(0) = 1$.Plot the solution.

**Answer**

This ODE is solved by separation of variables. Move all terms in $x$ to one side, and all terms in $y$ to the other side:

$$\begin{aligned}
\frac{dy}{dx} &= y\left(x^2 - 1.2\right) \\
dy &= y\left(x^2 - 1.2\right) dx \\
\frac{1}{y} dy &= \left(x^2 - 1.2\right) dx \\
\int \frac{1}{y} dy &= \int \left(x^2 - 1.2\right) dx \\
\ln(y) + k_1 &= \frac{x^3}{3} - 1.2x + k_2
\end{aligned}$$

Where $k_1$ and $k_2$ are the constants of integration.

$$\ln(y) = \frac{x^3}{3} - 1.2x + (k_2 - k_1) \quad Let\,(k_2 - k_1) = C$$

Where C is a new constant

$$\ln(y) = \frac{x^3}{3} - 1.2x + C$$

Applying initial conditions to find $C$. Since $y(0) = 1$ then

$$\begin{aligned}
\ln(1) &= \frac{0^3}{3} - 1.2(0) + C \\
\ln(1) &= C \\
C &= 0
\end{aligned}$$

Therefore the analytical solution is

$$\begin{aligned}
\ln(y) &= \frac{x^3}{3} - 1.2x \\
y &= \exp\left(\frac{x^3}{3} - 1.2x\right) \\
y &= \exp\left(x\left(\frac{x^2}{3} - 1.2\right)\right)
\end{aligned}$$

Using matlab to plot the above function from $x = 0 \cdots 2$

```
y='exp(x*(x^2/3 - 1.2))';
ezplot(y,0,2)
title('plot of solution of dy/dx= yx^2 - 1.2 y')
ylabel('y')
```