Lab Assignment 8 - State Space Model

1. Obtain the State Space model of the system on paper and using Python.
   - Consider the state variable as current i and voltage across the capacitor v_c.
   - Obtain the output state equations such that it would be possible to monitor output across capacitor and output across the resistor
   - Take $R = 240\Omega$, $C = 1mF$, $L = 40H$

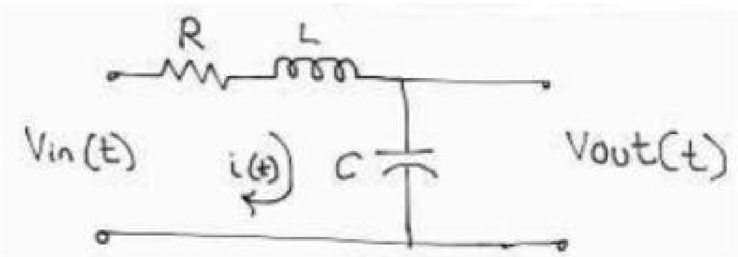

Figure 1: RLC circuit

- Python code in comments should have student's name, GR No., Roll No., Date of Lab, Lab assignment title, problem statement.
- At the end the conclusion, learning outcomes of the lab are to be written
- Hand written matter, Code, plots, Conclusion, learning outcomes should be in one single PDF file for submission

In [3]:
```
"""
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"""
```
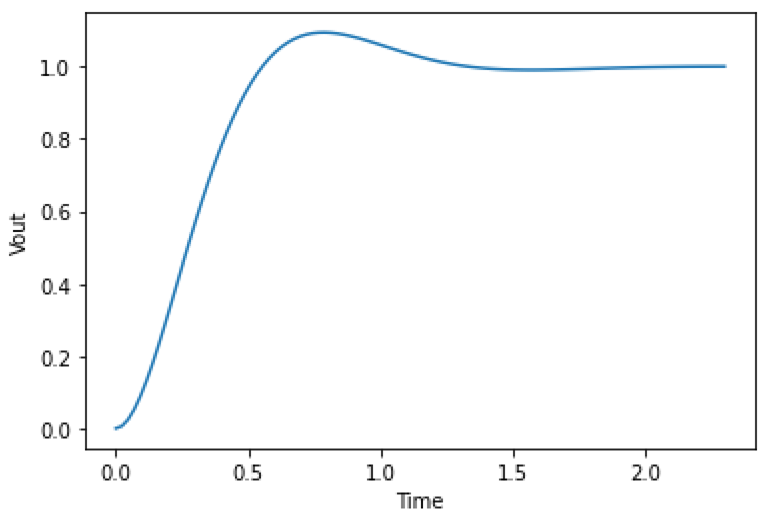

Out[3]: '\nName:- Abhijeet Shivachary\nroll no:- 48\nGr. No. 11911048\nLAB-8\nDiv :- IC-C Batch 2\n\n'

In [ ]:

In [3]:
```
import numpy as np
import control
from matplotlib import pyplot as plt

R = 240
L = 40
C1 = 0.001

A = [[0,1/C1],[-1/L,-R/L]]
B = [[0],[1/L]]
C = [[1,0],[0,R]]
D = [[0],[0]]

S = control.ss(A,B,C,D)
print(S)

tf = control.ss2tf(S)
print(tf)


T,y= control.step_response(tf[0,0])
plt.plot(T,y)
plt.xlabel("Time")
plt.ylabel("Vout")
plt.show()
```

```
A = [[ 0.0e+00  1.0e+03]
     [-2.5e-02 -6.0e+00]]

B = [[0.   ]
     [0.025]]

C = [[  1.   0.]
     [  0. 240.]]

D = [[0.]
     [0.]]


Input 1 to output 1:
      25
--------------
s^2 + 6 s + 25

Input 1 to output 2:
     6 s
--------------
s^2 + 6 s + 25
```



Conclusion:

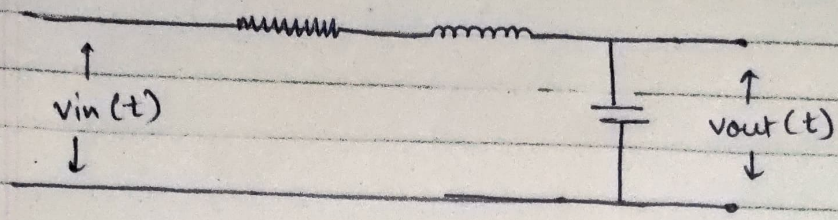
In this lab we learn how to derive transfer function of given system and also how to derive State Space Model from Differential Equation

Learning Outcomes:

1)In this lab we learnt state space model from differential equation and their transfer function. 2)And also, we plot the step response of that function.

In [ ]:

[Q]



$v_{out}(t) = v_c(t)$

by KVL,

$$v_i(t) = Ri(t) + L\frac{di}{dt}(t) + v_c(t)$$

$$\therefore \frac{di(t)}{dt} = -\frac{Ri(t)}{L} - \frac{v_c(t)}{L} + \frac{v_i(t)}{L}$$

The voltage across the capacitor,

$$v_c(t) = \frac{1}{c}\int i(t)\,dt$$

$$\therefore \frac{dv_c(t)}{dt} = \frac{i(t)}{c} \qquad [\because \text{differentiate}]$$

state vector

$$x = \begin{bmatrix} i(t) \\ v_c(t) \end{bmatrix}$$

diff state vect,

$$\dot{x} = \begin{bmatrix} di(t)/dt \\ dv_c(t)/dt \end{bmatrix}$$

$$\therefore \dot{x} = \begin{bmatrix} -R/L & -1/L \\ 1/c & 0 \end{bmatrix} \begin{bmatrix} i(t) \\ v_c(t) \end{bmatrix} + \begin{bmatrix} 1/L \\ 0 \end{bmatrix} \begin{bmatrix} v_i(t) \end{bmatrix}$$

$$Y = \begin{bmatrix} 0 & 1 \end{bmatrix} \begin{bmatrix} i(t) \\ v_c(t) \end{bmatrix}$$

where,

$$A = \begin{bmatrix} -R/L & -1/L \\ 1/c & 0 \end{bmatrix} \quad B = \begin{bmatrix} 1/L \\ 0 \end{bmatrix}, \quad C = \begin{bmatrix} 0 & 1 \end{bmatrix} \quad D = \begin{bmatrix} 0 \end{bmatrix}$$