



1.) KVL:  $-v_g + L \frac{di}{dt} + v = 0$

$\Rightarrow \frac{di}{dt} = -\frac{v}{L} + \frac{v_g}{L}$

KCL:  $i = C \frac{dv}{dt} + \frac{v}{R}$

$\Rightarrow \frac{dv}{dt} = \frac{i}{C} - \frac{v}{RC}$

$y = v$

IN MATRIX FORM:

$$\frac{d}{dt} \begin{bmatrix} v \\ i \end{bmatrix} = \underbrace{\begin{bmatrix} -\frac{1}{RC} & \frac{1}{C} \\ -\frac{1}{L} & 0 \end{bmatrix}}_A \begin{bmatrix} v \\ i \end{bmatrix} + \underbrace{\begin{bmatrix} 0 \\ \frac{1}{L} \end{bmatrix}}_B v_g$$

$$y = \underbrace{\begin{bmatrix} 1 & 0 \end{bmatrix}}_C \begin{bmatrix} v \\ i \end{bmatrix} + \underbrace{\begin{bmatrix} 0 \end{bmatrix}}_D v_g$$

2) a)  $\frac{v}{v_g}(s) = \frac{R \parallel \frac{1}{sC}}{sL + R \parallel \frac{1}{sC}}$

$R \parallel \frac{1}{sC} = \frac{R \frac{1}{sC}}{R + \frac{1}{sC}} = \frac{R}{1 + sRC}$

$\Rightarrow \frac{v}{v_g} = \frac{\frac{R}{1 + sRC}}{sL + \frac{R}{1 + sRC}} = \frac{1}{s^2 LC + \frac{sL}{R} + 1}$

$= \frac{\frac{1}{LC}}{s^2 + s \frac{1}{RC} + \frac{1}{LC}}$

2. b) Phase variable form.

$A = \begin{bmatrix} 0 & 1 \\ -\frac{1}{LC} & -\frac{1}{RC} \end{bmatrix}, B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}, C = \begin{bmatrix} \frac{1}{LC} & 0 \end{bmatrix}, D = 0$

2c Dual phase variable form

$A = \begin{bmatrix} -\frac{1}{RC} & 1 \\ -\frac{1}{LC} & 0 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}, C = \begin{bmatrix} 1 & 0 \end{bmatrix}, D = 0$

**ECE451/551**  
**HW #1**

L = 560e-6  
C = 100e-6  
R = 5

A1 = [-1/(R\*C), 1/C; -1/L, 0]  
B1 = [0; 1/L]  
C1 = [1, 0]  
D1 = 0

A2 = [0, 1; -1/(L\*C), -1/(R\*C)]  
B2 = [0; 1]  
C2 = [1/(L\*C), 0]  
D2 = 0

A3 = [-1/(R\*C), 1; -1/(L\*C) 0]  
B3 = [0; 1/(L\*C)]  
C3 = [1, 0]  
D3 = 0

my\_tf = tf(1/(L\*C), [1, 1/(R\*C), 1/(L\*C)])

```
bode(ss(A1,B1,C1,D1))  
hold on  
bode(ss(A2,B2,C2,D2))  
bode(ss(A3,B3,C3,D3))  
bode(ss(my_tf))  
hold off
```

