

Consider the following circuit:

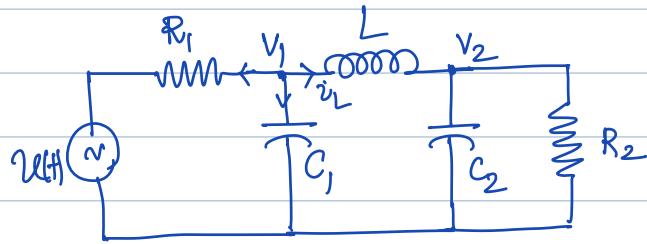
Let  $R_1 = 1 \text{ k}\Omega$

$C_1 = 1 \text{ mF}$

$R_2 = 2 \text{ k}\Omega$

$C_2 = 4 \text{ mF}$

$L = 0.5 \text{ H}$



- ① Assuming  $u(t)$  to be the input, express the dynamic evolution of different voltage and current values in state-space form.

Determine if the system is controllable.

- ② For each of the following choice of outputs/measurements, determine if the system is observable.

- i) voltage across  $C_1$ ,
- ii) voltage across  $C_2$
- iii) voltage across  $L$

- ③ Implement the above circuit in Simulink using circuit elements using a variable resistor for  $R_1$  and controlled voltage source for  $u(t)$ .

- ④ Design a state feedback controller to regulate voltage  $V_2$  at 10 volt, when the measurement is the voltage across  $C_1$  available after being sampled at  $1 \text{ kHz}$ .

- ⑤ Design an estimator that estimates the value of  $R_1$  using the control input and measurement for each of the three output configurations stated in ②.