MATHEMATICAL QUESTIONS

Question 1

For the circuit of Fig. 1,

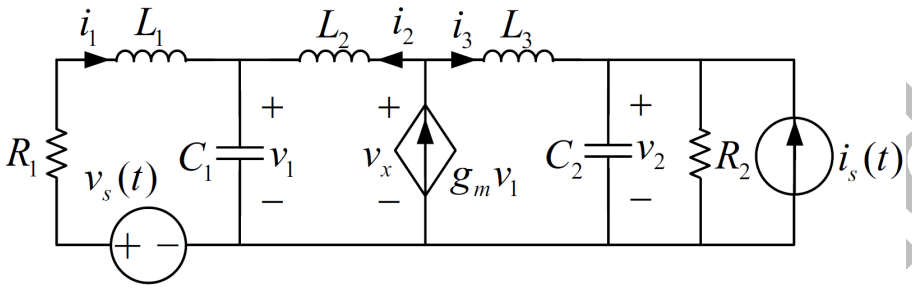

Figure 1: A circuit for which the state equations are required.

(a) Write the matrix form of the state equations.

(b) Express $v_x(t)$ in terms of the state and input vectors.

Question 2

For the circuit of Fig. 2,

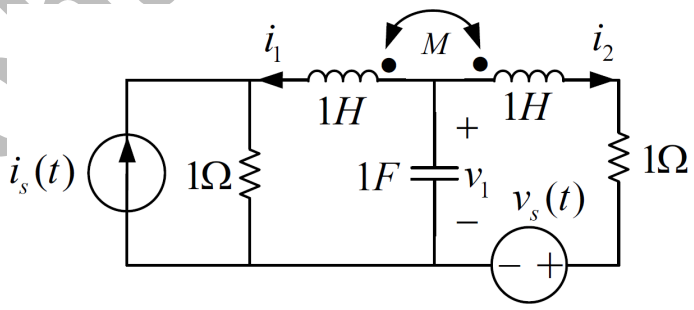

Figure 2: A coupled circuit for which the state equations are required.

Question 2 continued on next page...

(a) Write the state equations if $M = 0.5$.

(b) Write the state equations if $M = 1$.

(c) Find the transfer functions $H_V(s) = \frac{V_1(s)}{V_s(s)}\big|_{I_s(s)=0}$ *and* $H_I(s) = \frac{V_1(s)}{I_s(s)}\big|_{V_s(s)=0}$ *if* $M = 1$.

(d) Solve the state equations if $M = 1$, $i_s(t) = u(t)$, $v_s(t) = 0$, *and the initial state vector* $\boldsymbol{X}_0$ *is an all-one vector.*

Question 3

Write the state equations for the linear time-varying RLC circuit shown in Fig. 3, where the element values are $R(t)$**,** $L(t)$**, and** $C(t)$**.**

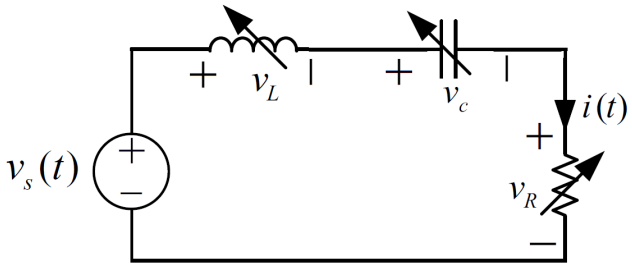

Figure 3: A linear time-varying RLC circuit.

SOFTWARE QUESTIONS

Question 4

Write a MATLAB function that plots the approximated state trajectory corresponding to the state equation

$$\boldsymbol{X}'(t) = \boldsymbol{A}\boldsymbol{X}(t), \quad \boldsymbol{X}(0) = \boldsymbol{X}_0$$

Question 4 continued on next page...

. Compare the state trajectories for a certain coefficient matrix A, a certain initial state vector X_0, and different values of the time step Δt.

BONUS QUESTIONS

Question 5

Return your answers by filling the LaTeXtemplate of the assignment. If you want to add a circuit schematic, you can draw it directly using TikZ package, or draw it in a secondary application such as Microsoft Visio and then, import it as a figure.

EXTRA QUESTIONS

Question 6

eel free to solve the following questions from the book *"Basic Circuit Theory"* by C. Desoer and E. Kuh.

1. **Chapter 12, question 3.**
2. **Chapter 12, question 4.**
3. **Chapter 12, question 5.**
4. **Chapter 12, question 7.**