MATHEMATICAL QUESTIONS

Question 1

For the circuit of Fig. 1,

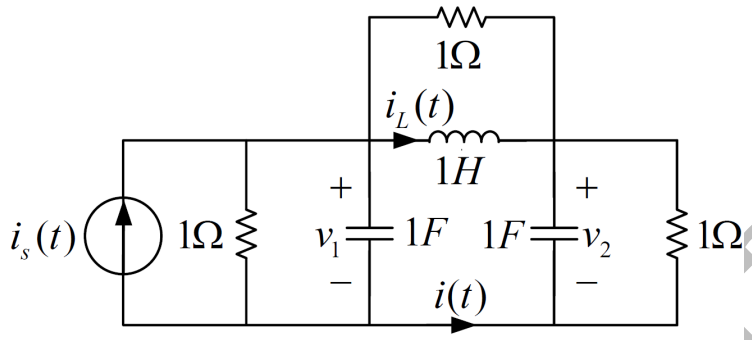

Figure 1: A circuit for which the natural frequencies are required.

(a) Find the natural frequencies of the node voltages.

(b) Find the natural frequencies of the circuit.

Question 2

Calculate the natural frequencies of the circuits shown in Fig. 2.

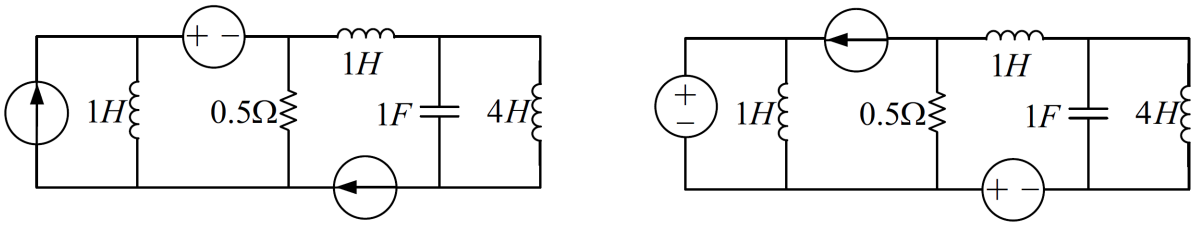

Figure 2: Two circuits with different types of independent sources.

Question 3 continued on next page...

Question 3

For the circuit of Fig. 3,

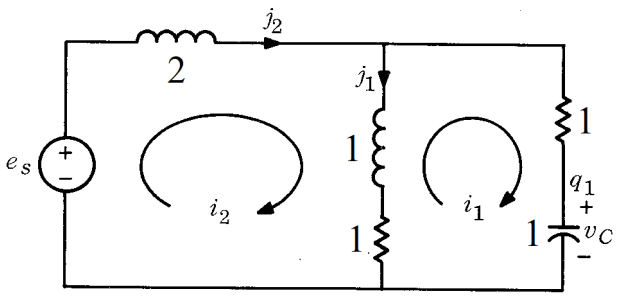

Figure 3: A circuit for which the minimal diffrential equation of j_2 is required.

(a) Find the minimal differential equation of j_2.

(b) Find the natural frequencies of j_2.

Question 4

Calculate the natural frequencies of the circuits shown in Fig. 4. How many zero natural frequencies does each circuit have?

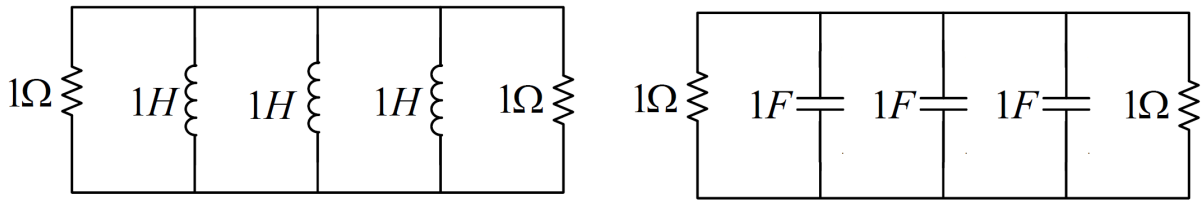

Figure 4: Two circuits with different types of energy storage elements.

Question 5

For the circuit shown in Fig. 5,

Question 5 continued on next page...

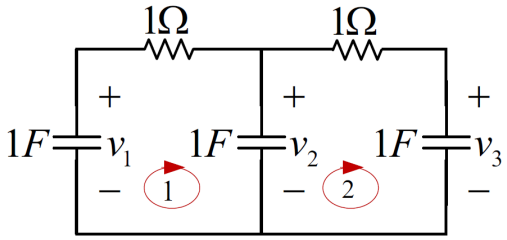

Figure 5: A circuit with three energy storage elements.

(a) Find the natural frequencies using the governing state equations.

(b) Introduce a set of initial conditions for which only one natural frequency exist in zero-input response of the state variables.

SOFTWARE QUESTIONS

Question 6

Write a MATLAB function that finds the minimal differential equation and natural frequencies corresponding to the last variable in the matrix differential equation

$$\boldsymbol{A}(D)\boldsymbol{X} = \boldsymbol{F}$$

.

Note 1: Here, we have a matrix differential equation, where the elements of $\boldsymbol{A}(D)$ are polynomials of the differentiation operator $D^n, n \geq 0$. No element contains the integral operator D^{-1}.

Note 2: A polynomial can be expressed as a vector, i.e.,

$$\sum_{i=0}^{n} p_i D^i \equiv \begin{bmatrix} p_n & p_{n-1} & \cdots & p_1 & p_0 \end{bmatrix}$$

BONUS QUESTIONS

Question 7

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 8

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

1. **Chapter 14, question 1.**
2. **Chapter 14, question 2.**
3. **Chapter 14, question 4.**
4. **Chapter 14, question 5.**
5. **Chapter 14, question 6.**