TÉCNICO LISBOA

Circuit Theory and Electronics Fundamentals

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Training Test I

Download the python script **test1_datagen.py** and run it to get the test's **Datasheet**. By entering different student numbers you get variations of this test to further enhance your training.

Consider the circuit in Figure 1, where B is a black box revealed in each question, and the values given in the Datasheet.

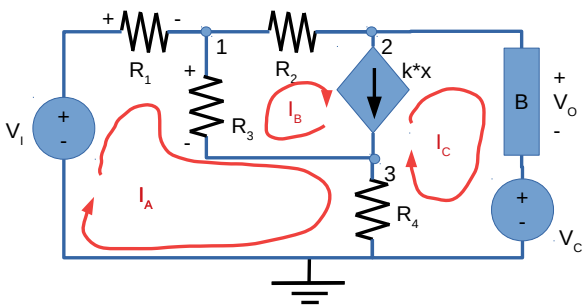

Figure 1: Circuit for analysis

1 Analysis Methods

Assume B is an open circuit. Analyse the circuit, using the method prescribed in the Datasheet, to obtain a matrix equation given by:

$$\begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} B_1 \\ B_2 \\ B_3 \end{bmatrix}$$

where

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} \; or \; \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} I_A \\ I_B \\ I_C \end{bmatrix}$$

depending on whether the Datasheet prescribes the Node or Mesh method.
Using the analysis results, compute the following quantities:

1. $A_{i,j}, i, j = 0, 1, 3$
2. $I(R_1)$
3. V_2

2 Time domain analysis

Assume the following:

- B is a single component whose impedance is $Z = jX$
- there is no energy stored in the circuit at $t = 0$
- the input voltage is given by $v_I(t) = V_I + A_I cos(2\pi f_x t + \phi)$

Compute the following quantities:

1. the time constant
2. the amplitude of v_o
3. the phase of v_o in degrees
4. the amplitude of $i(R_1)$
5. the phase of $i(R_1)$ in degrees
6. the forced solution (DC+AC) at $t = 4ms$
7. the natural solution at $t = 0$
8. the total solution at $t = 2ms$

3 Frequency domain analysis

3.1 Transfer function

The circuit's transfer function is given by

$$T(s) = \frac{V_o(s)}{V_i(s)} = K_0 \frac{1 + \frac{s}{a}}{1 + \frac{s}{b}}$$

Compute the constants

1. K_0
2. b
3. a

3.2 Frequency response

Compute the following frequency response quantities at frequency f_x:

1. the magnitude in dB
2. the phase in degrees

4 Power analysis

Ignore DC power dissipation and compute, at frequency f_x, for the circuit seen by voltage source v_I, the following quantities:

1. the power factor
2. the active power
3. the reactive power