University College Dublin
An Coláiste Ollscoile, Baile Átha Cliath

SEMESTER II EXAMINATIONS - 2014/2015

School of Electrical, Electronic and Communications Engineering

EEEN30020 Circuit Theory

Prof Green

Prof Brazil

Dr Blokhina*

Time Allowed: 2 hours

Instructions for Candidates

Answer **any three** questions. All questions carry equal marks. The distribution of marks in the right margin, shown as a percentage, gives an approximate indication of the relative importance of each part of the question.

Instructions for Invigilators

Non-programmable calculators are permitted.
Graph paper is to be provided

Question 1:

(i) What are the hybrid and inverse hybrid matrices of a two-port? How are the elements of these matrices defined? 20%

(ii) Find the hybrid and inverse hybrid matrices of the two-port in Figure 1(a). 45%

(iii) Find the transmission matrix of the two-port in Figure 1(b). What is the determinant of this transmission matrix? 35%

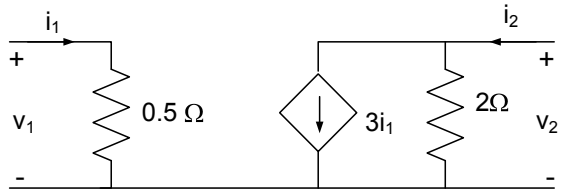

Figure 1(a)

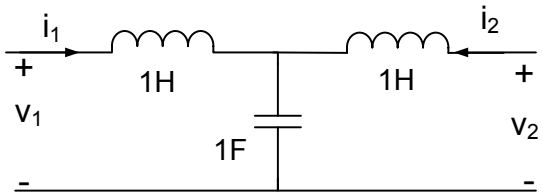

Figure 1(b)

Question 2:

(i) What is Modified Nodal Analysis (MNA)? Describe the steps involved in MNA. 20%

(ii) Write down (but do not solve) the MNA equations that a circuit simulator such as SPICE would assemble for the circuit in Figure 2. Comment on the variables that appear in the resulting equations. 60%

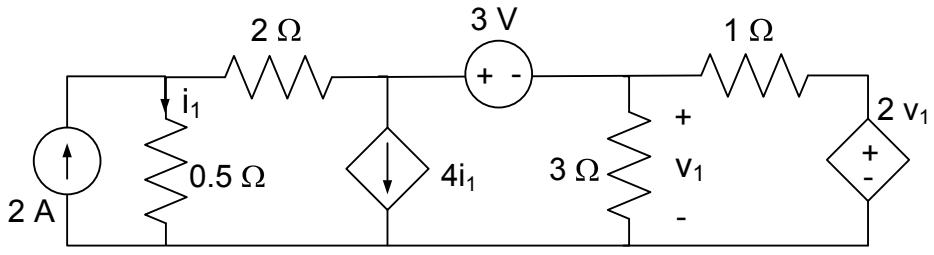

Figure 2

(iii) What is the stamp of an element in the context of MNA? Show the stamps for the 0.5Ω and 3Ω resistances resulting from the equations in part (ii). 20%

Question 3:

(i) Define the Laplace transform. If the Laplace transform of $f(t)$ is $F(s)$, write down an expression for the Laplace transform of the time derivative $df(t)/dt$. 20%

(ii) The switch in the circuit in Figure 3 has been open for a very long time prior to t = 0, at which time it is closed. Find the inductor current for t ≥ 0. 60%

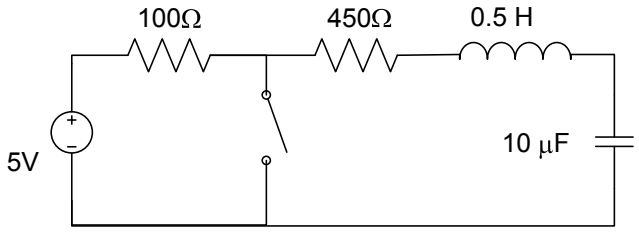

Figure 3.

(iii) What is the definition of the natural frequency of a circuit? What are the natural frequencies of the circuit in part (ii)? Is this circuit stable? 20%

Question 4:

(i) Describe ideal and practical band-pass filters and sketch their transfer functions. How are the cut-off frequencies and the bandwidth of these filters defined? 20%

(ii) Using any approach, find the transfer function of the circuit in Figure 4. 50%

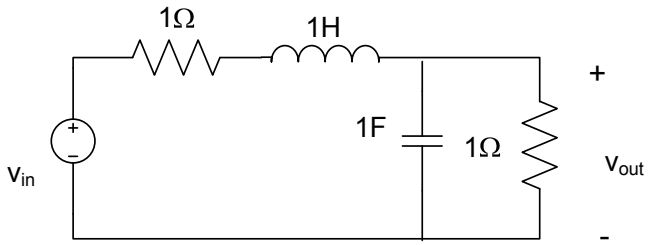

Figure 4

(iii) On graph paper, plot the transfer function of the circuit from Figure 4 (in dB). Identify the cut-off frequency and the bandwidth. Can this circuit serve as a filter? If yes, what type of a filter? 30%

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