

IEEE Carleton



Carleton UNIVERSITY

FINAL EXAMINATION  
DECEMBER 2002

05/12/02 YU A DVK

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Released [Signature]

TAR, Dec. 1, 2003

DURATION: 3 HOURS

No. of Students: 415

Department Name & Course Number: ELEC 2501 (97.251\*) A, B and C  
Course Instructor(s) V. Devabhaktuni, T. Kwasniewski and A. Steele

AUTHORIZED MEMORANDA

self-contained electronic calculator with the memory cleared

Students MUST count the number of pages in this examination question paper before beginning to write, and report any discrepancy to a proctor. This question paper has sixteen pages.

This examination question paper may not be taken from the examination room.

In addition to this question paper, students require: an examination booklet yes  no   
a Scantron sheet yes  no

INSTRUCTIONS:

1. PRINT YOUR NAME AND STUDENT NUMBER.

STUDENT NAME

STUDENT NUMBER :

(1 mark)

2. ATTEMPT ALL THE QUESTIONS.

3. QUESTIONS DO NOT CARRY EQUAL MARKS.

4. ANSWER A QUESTION IN THE SPACE PROVIDED IMMEDIATELY FOLLOWING THE QUESTION.

5. A COUPLE OF EXTRA SHEETS (PAGES 15 AND 16) HAVE BEEN PROVIDED IN CASE YOU NEED ADDITIONAL SPACE FOR CALCULATIONS.

6. TOTAL MARKS = 100.

For professor's use only:

Question | 1      2      3      4      5      6      7      8      9

number

Marks

scored

Q1. Find the current  $i_0$  in the circuit in Figure Q1 using nodal analysis. Note:  $V_A$  and  $V_B$  are the voltages at the respective nodes. (11 marks)

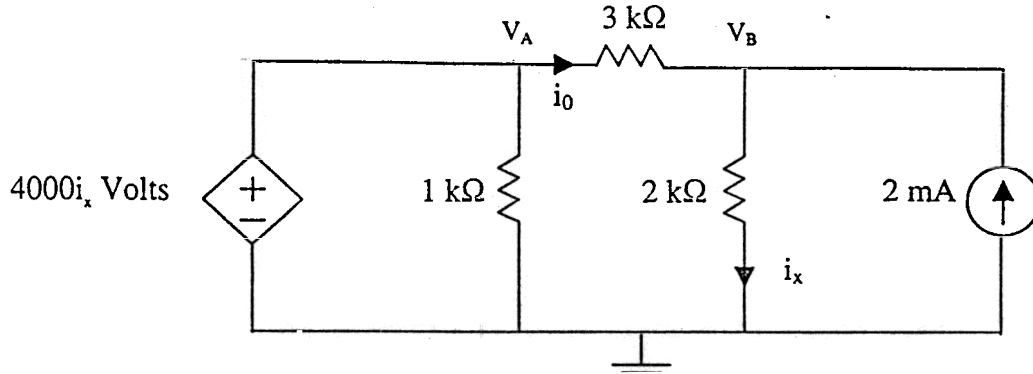


Figure Q1

- Q2. (i) State the *principle of superposition* as applied to linear circuits.  
(ii) Find the current  $i$  in the circuit in Figure Q2 by applying the technique of superposition.

(11 marks)

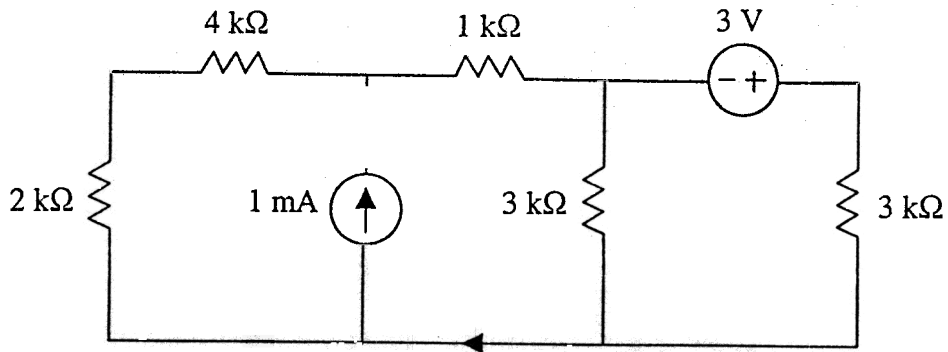


Figure Q2.

- Q3. (i) Given the circuit in Figure Q3, determine the Thevenin equivalent circuit across the points A-B (i.e., for the circuit to the left of A-B). Also draw the equivalent circuit that includes  $R_L$ .
- (ii) Determine the value of  $R_L$  for maximum power transfer and calculate the maximum power transferred for that value. (11 marks)

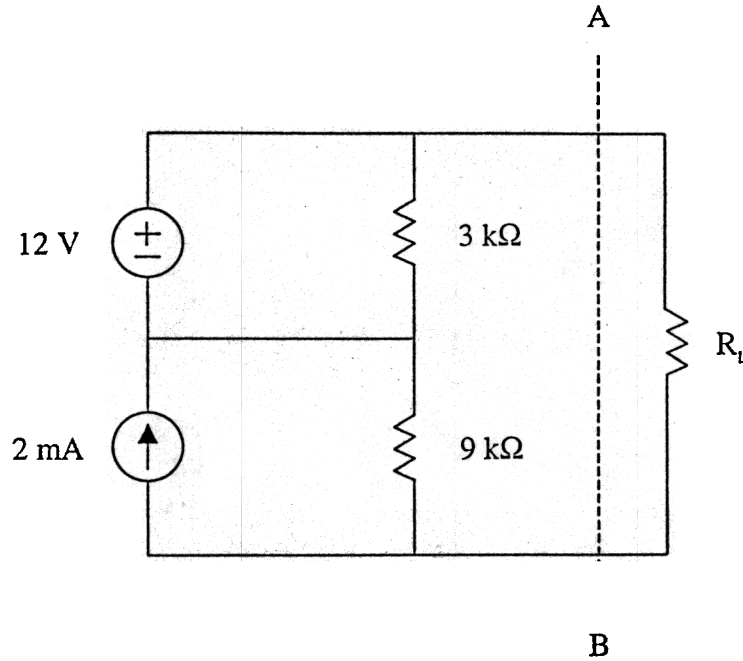


Figure Q3.



- Q4. (i) For the given circuit in Figure Q4, determine the currents through the capacitor and the inductor in the phasor notation (i.e., phasors  $I_C$  and  $I_L$ ).
- (ii) Using these values, calculate the total current  $i(t)$  drawn from the source. (10 marks)

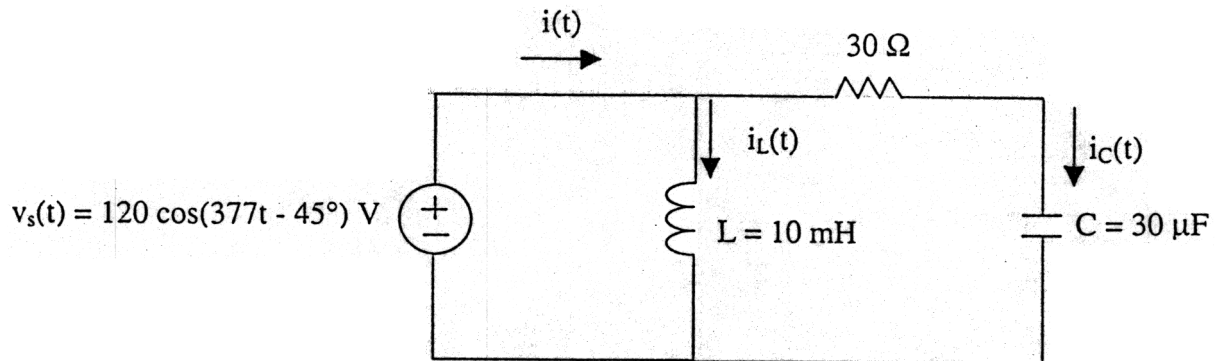


Figure Q4.

Q5. A parallel RLC circuit with a voltage source has the following parameters:

$R = 2\text{k}\Omega$ ,  $L = 20\text{mH}$  and  $C = 150\ \mu\text{F}$ .

- (i) Draw the parallel circuit indicating the component values.
- (ii) Determine resonant frequency  $\omega_0$ , quality factor  $Q$ , and bandwidth of the resonant circuit.
- (iii) Given the supply voltage  $V_s = 10 \angle 0^\circ$ , sketch a phasor diagram at resonant frequency  $\omega_0$  showing all the currents in the circuit. (9 marks)

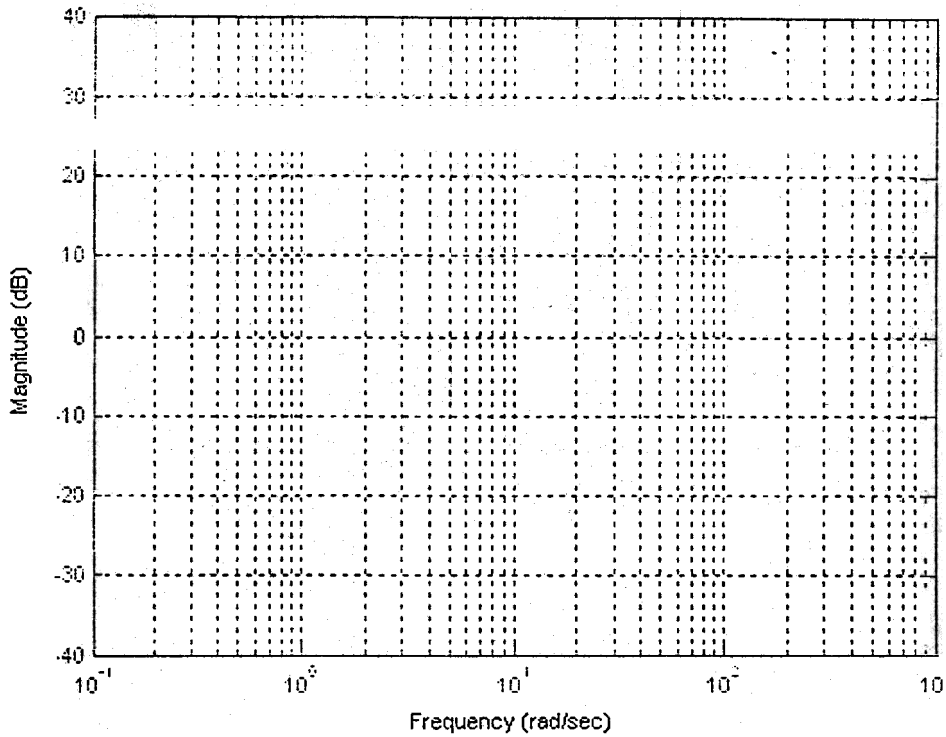
Q6. For the voltage transfer function  $G_v(j\omega) = \frac{10 (1 + 0.1j\omega)}{(1 + j\omega) (1 + 0.02j\omega)}$

- (i) Determine the magnitudes and the phases of  $G_v(j\omega)$  for  $\omega \rightarrow 0$  and  $\omega \rightarrow$  infinity.
- (ii) Determine the corner frequencies (i.e., break points) of the transfer function.
- (iii) Use the graphs provided on page 9 to draw magnitude and phase Bode components of each of the individual terms.
- (iv) On the same graphs, also draw the composite magnitude and composite phase Bode plots of the transfer function.

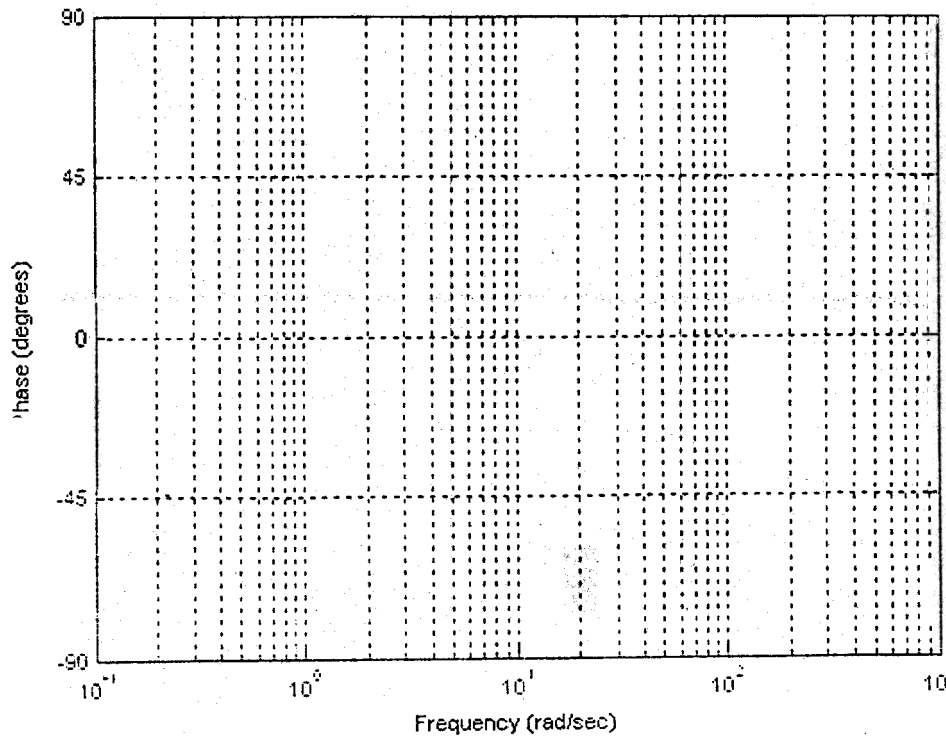
(14 marks)

(Graph sheets are provided on the next page)

Graph sheet for drawing individual and composite magnitude Bode plots



Graph sheet for drawing individual and composite phase Bode plots



- Q7. In the circuit in Figure Q7, switch S is closed for all  $t < 0$ . At  $t = 0$ , switch S is opened.
- Derive an expression for the current  $i(t)$  for  $t > 0$ .
  - Sketch  $i(t)$  from  $t = -0.5\text{s}$  to  $t = +2\text{s}$  clearly showing the time constant and its relation to the current waveform.
- (15 marks)

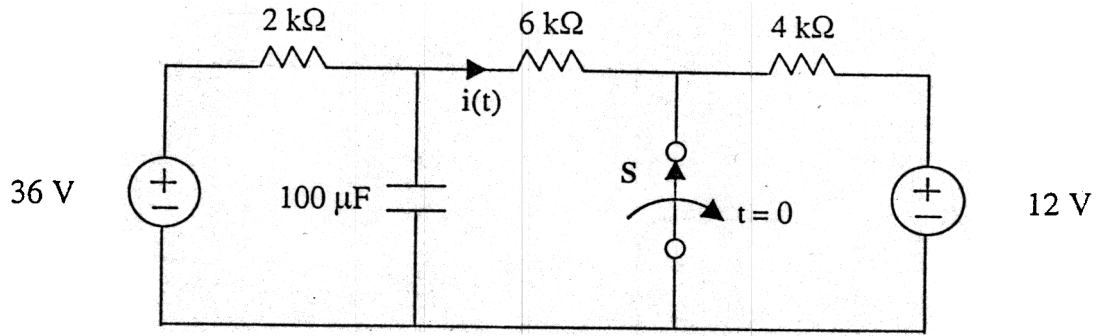


Figure Q7.

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- Q8. (i) Express the periodic current waveform  $i(t)$  in Figure Q8 in the form of mathematical equations for one period.
- (ii) Using these equations calculate the RMS value of the current.
- (iii) If  $i(t)$  represents current through a 5H inductor, sketch the waveform of inductor voltage.
- (12 marks)

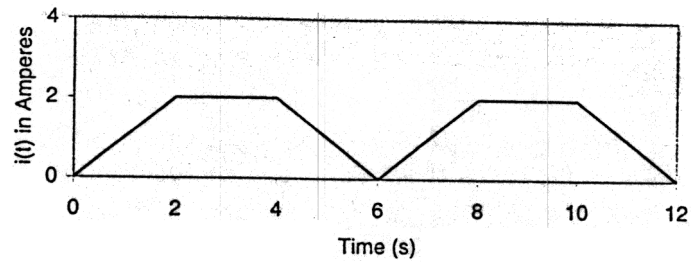


Figure Q8.

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- Q9. For the circuit in Figure Q9, calculate the average power dissipated in the  $4\ \Omega$  resistor. Also report the average power dissipated in the capacitor. (6 marks)

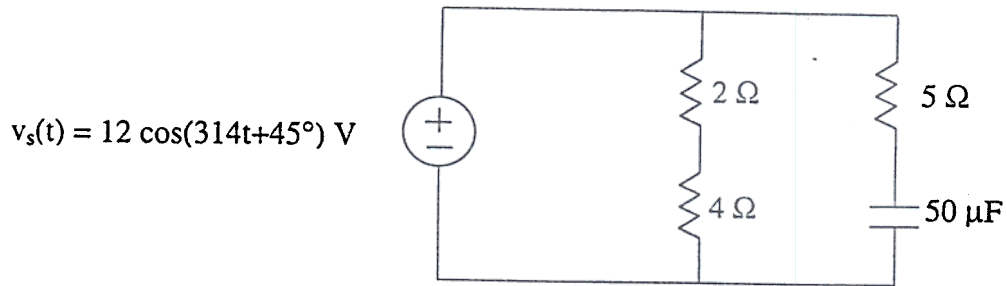


Figure Q9.

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