CARLETON UNIVERSITY

EXAMPLE Final Examination
December 7th, 2010

Duration: 3 hours **# of Students:** 215
Department Name & Course #: Electronics ELEC 2501
Course Instructors: L. MacEachern and T.G. Ray

AUTHORIZED MEMORANDA:

- CALCULATORS, SELF CONTAINED, NON-GRAPHING, MEMORY CLEARED.

- STUDENTS **MUST** COUNT THE NUMBER OF QUESTIONS **BEFORE** BEGINNING TO WRITE, AND REPORT ANY DISCREPANCY IMMEDIATELY TO THE PROCTOR. THIS EXAM HAS 11 PAGES INCLUDING THIS COVER PAGE.
- THE TEST PAPERS **MAY NOT** BE TAKEN FROM THE EXAMINATION ROOM.
- IN ADDITION TO THIS QUESTION PAPER, STUDENTS REQUIRE:

  an examination booklet: **YES**
  a Scantron sheet: **NO**

INSTRUCTIONS AND INFORMATION:

- PRINT YOUR NAME AND STUDENT NUMBER CLEARLY AND PROVIDE YOUR SIGNATURE.

  Name: _____

  Student Number: _____

  Signature: _____ /1

- ATTEMPT ALL QUESTIONS.
- PUT YOUR ANSWERS ONLY IN THE SPACES PROVIDED. Your examination booklet is for rough work only and will not be marked.
- FULL MARKS FOR EACH QUESTION ARE INDICATED. Part marks are available depending on the question.
- THIS EXAM HAS 6 QUESTIONS, FOR A TOTAL OF 100 POINTS, INCLUDING 1 POINT FOR PROPERLY IDENTIFYING YOURSELF ABOVE.

For faculty use only:

Page:	Cover	1	2	3	4	5	6	7	8	9	10	Total
Points:	1	8	9	14	5	12	9	9	11	17	5	100
Score:	1											

Question 1 ..... *(17 points)*

RMS Value and Power

(a) For the periodic waveform in Figure 1 answer the following:

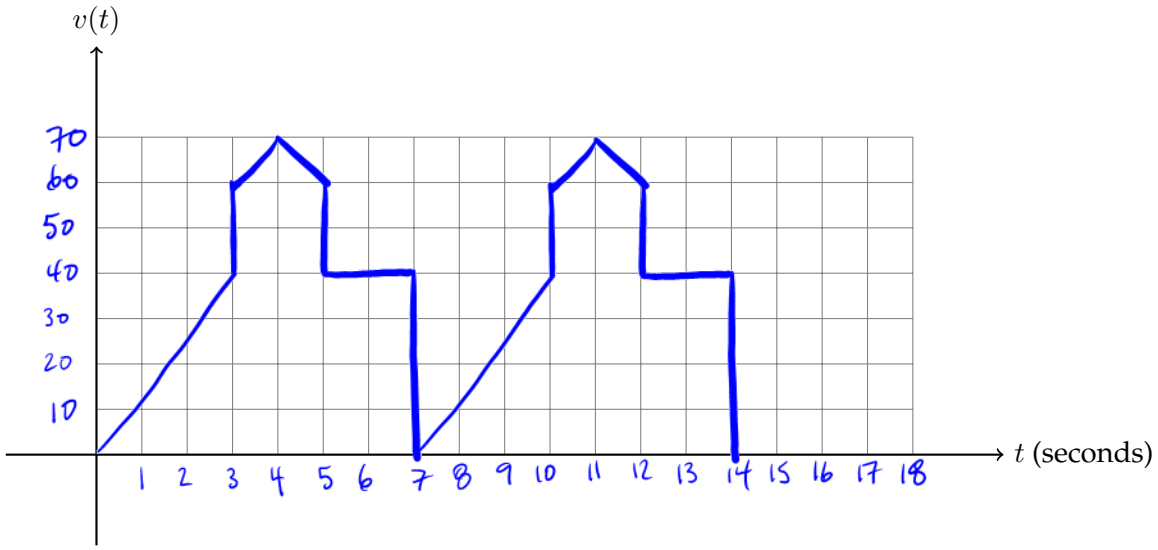

Figure 1: A periodic waveform.

a.i) For one representative period, what are the equations for the non-zero parts of the waveform?

Answer: $v(t) =$ _____

_____

/3

a.ii) Using the equations above, what is the equation for calculating the RMS value of the waveform?

Answer: RMS= _____

/3

a.iii) What is the RMS value of the waveform?

Answer: RMS= _____

/2

(b) In the circuit of Figure 2, find the power (absorbed or supplied) in each of the indicated elements.

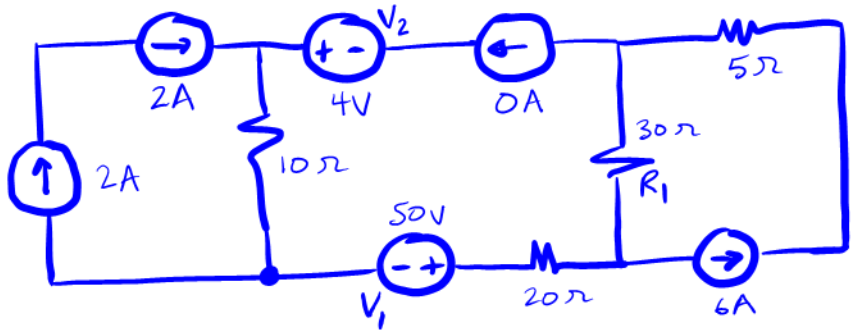

Figure 2: Circuit for power analysis.

Answer: Power in V_1 (in watts): _____

Power in V_2 (in watts): _____

Power in R_1 (in watts): _____

/4

(c) Given the circuit of Figure 3,

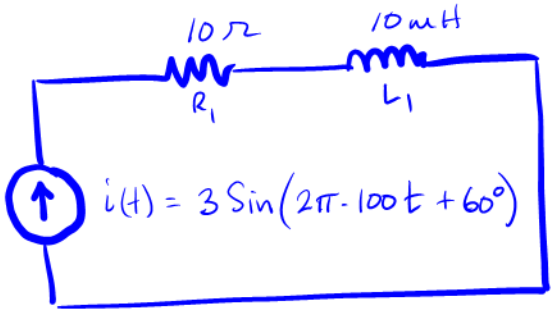

Figure 3: Circuit for power analysis.

c.i) What is the average power dissipated in R_1 ?

Answer: Power in R_1 (in watts): _____

/3

c.ii) What is the average power dissipated in L_1 ?

Answer: Power in L_1 (in watts): _____

/2

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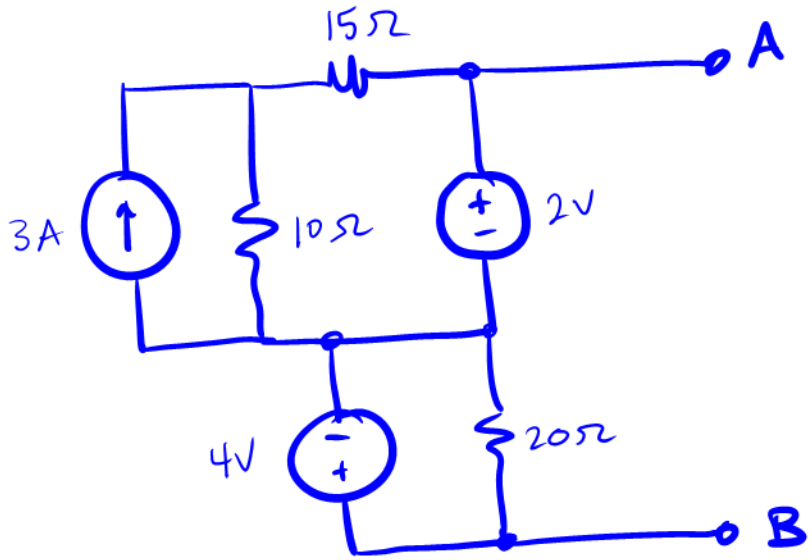
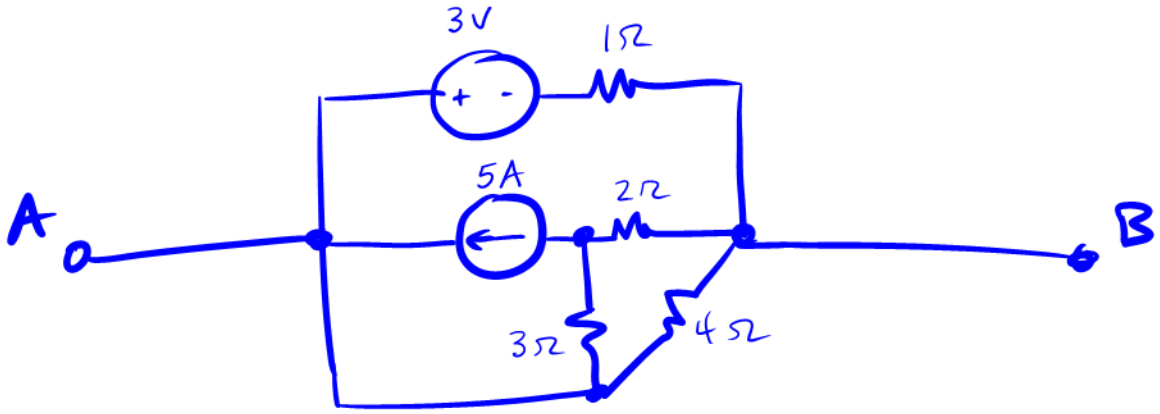
Question 2 ..... *(19 points)*

Thévenin, Norton, and Superposition

(a) For the circuit shown below find the Thévenin equivalent source between the terminals A and B. /7



(b) For the circuit shown in below find the Norton equivalent source between the terminals A and B. /7



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(c) Given the circuit of Figure 4, use superposition to find the contribution of each source toward V_{ab} and from that find the total V_{ab} .

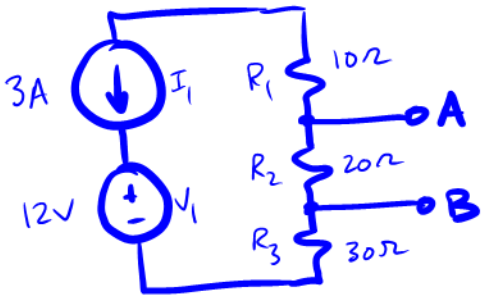

Figure 4: Circuit for superposition analysis.

c.i) Answer: Contribution of I_1 to V_{ab} : _____ /2

c.ii) Answer: Contribution of V_1 to V_{ab} : _____ /2

c.iii) Answer: Total V_{ab} using superposition: _____ /1

Question 3 ..... *(12 points)*

Nodal Analysis and Loop Analysis

(a) Given the circuit of Figure 5, write the nodal equations for nodes A, B, C using the convention that currents entering a node are considered positive. There is no need to simplify your equations.

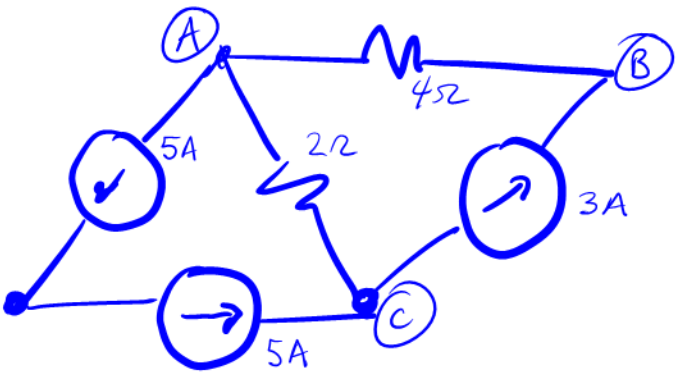

Figure 5: Circuit for Nodal analysis.

a.i) Answer: A nodal equation: _____ /2

a.ii) Answer: B nodal equation: _____ /2

a.iii) Answer: C nodal equation: _____ /2

(b) Given the circuit of Figure 6, write the loop equations for loops I_1 & I_2. There is no need to simplify your equations.

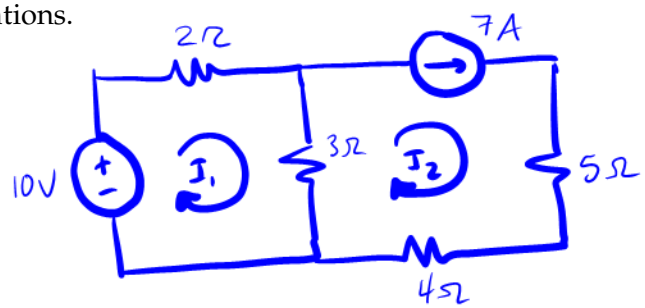

Figure 6: Circuit for Loop analysis.

b.i) Answer: Loop equation for I_1: _____ /3

b.ii) Answer: Loop equation for I_2: _____ /3

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Question 4 ..... *(18 points)*

Phasor Analysis

Note: Answers may be in either polar form (e.g. $10\angle 45^\circ$ volts) or Cartesian form (e.g. $100 - j50$ ohms), but they must still be simplified.

(a) Given the circuit of Figure 7,

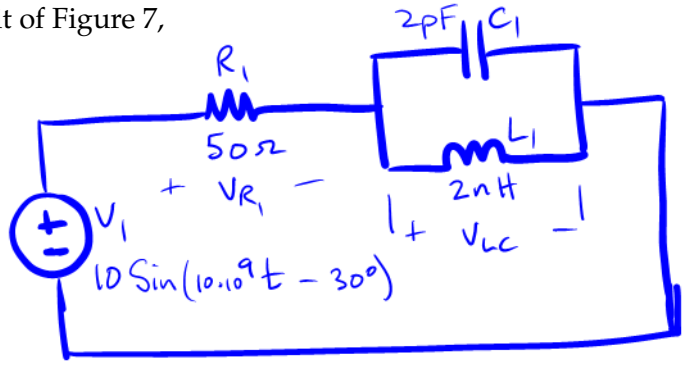

Figure 7: Circuit for phasor analysis.

a.i) Find the impedance of C_1 & L_1 .

Answer: Z_{C_1} : _____ /2

Z_{L_1} : _____ /1

a.ii) Find all of the indicated voltages, as phasors.

Answer: V_{R_1} : _____ /1

V_{LC} : _____ /1

: _____ /2

: _____ /2

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(b) Given the KCL equation $I_3 = I_1 + I_2$ in which $I_1 = 5\angle 30°$ and $I_2 = \frac{10}{\sqrt{2}} - j\frac{10}{\sqrt{2}}$

b.i) Calculate I_3 as a phasor.

Answer: I_3 _____

/2

b.ii) For $I_3 = I_1 + I_2$, show that KCL is satisfied using a clear phasor diagram, drawn approximately to scale:

Answer: Phasor diagram showing KCL:

/3

(c) A parallel resonant circuit is to have a resonant frequency of 2GHz and is to use $L = 5nH$.

c.i) What value of C is required?

Answer: $C =$ _____

/2

c.ii) If the parallel resonant CCT is operated at resonance, and the circuit's $Q = 15$, and the voltage on the capacitor is 3V what must be the voltage on the inductor ?

Answer: _____

/2

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Question 5 ..... *(11 points)*

Bode Plot Questions

Given the transfer function $H(j\omega) = \frac{10 j\omega}{60 + j\omega 30}$, answer the following:

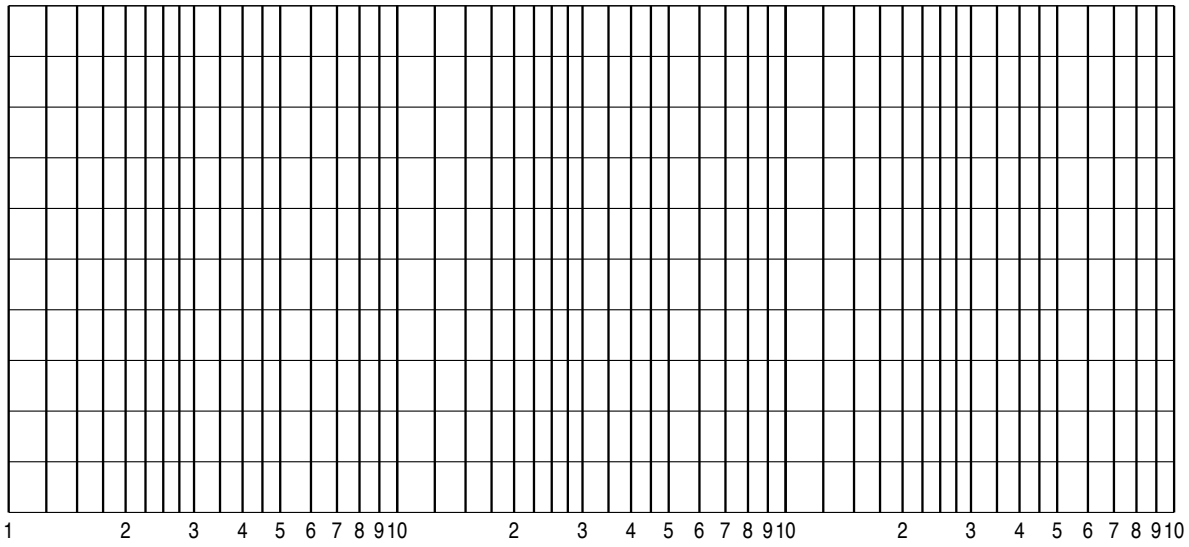
(a) What is the what is the zero frequency in rad/s? ?

Answer: _____

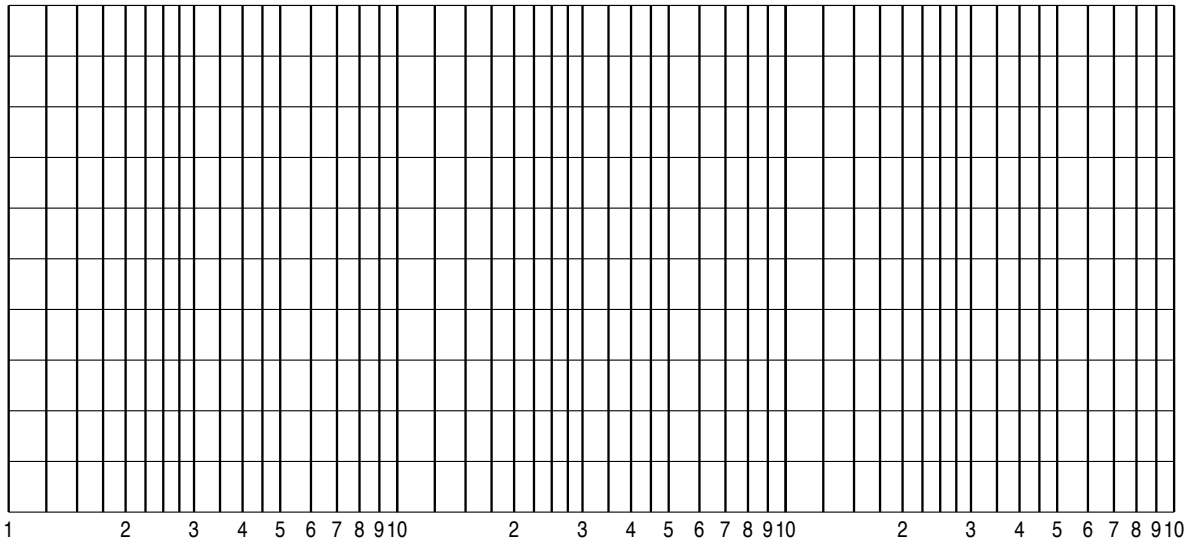
/2

(b) Draw the magnitude and phase Bode plots below. For the magnitude plot, include both the straight line (asymptotic) approximate plot as well as a sketch of the actual curve. For the magnitude plot, indicate the value of any slope(s). Label the x-axis and y-axis units, and add numbers to the x-axis and y-axis grid lines as appropriate for the magnitude and phase plots. Label all important frequencies, magnitudes, and angles. For the magnitude plot, indicate the value of the difference between the straight line approximate plot and the actual curve at the corner frequency.

b.i) Magnitude Bode plot: /5



b.ii) Phase Bode plot: /4



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Question 6 ..... *(22 points)*

Transient Analysis Questions

(a) In the circuit shown in Figure 8, switch SW1 has been open for all of time $t<0$. At time $t=0$ switch SW1 closes.

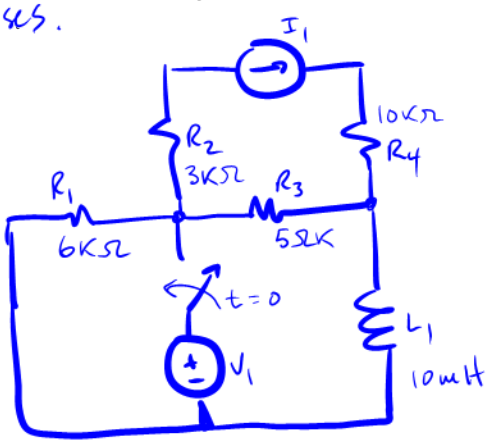

Figure 8: Circuit for transient analysis.

a.i) What is the inductor current for $t<0$?

Answer: For $t<0$, $i_{L_1}(t) =$ _____

/1

a.ii) Derive an expression for the current in R_4 for $t>0$ms.

Answer: For $t>0$, $i_{R_4}(t) =$ _____

/8

a.iii) Sketch i_{R_4} over the time interval $-10\mu s$ to $10\mu s$. Clearly show the time constant and its relationship to the waveform. /3

Figure 9: Plot of .

a.iv) Suppose the response above is interrupted by switch SW1 opening again at time $t=5\mu s$. Derive the resulting expression for $i_{R_4}(t)$.

Answer: $i_{R_4}(t) =$ _____

/5

(b) In the circuit shown in Figure 10, switch SW1 has been open for all of time $t < 0$. At $t = 0$ switch SW1 closes.

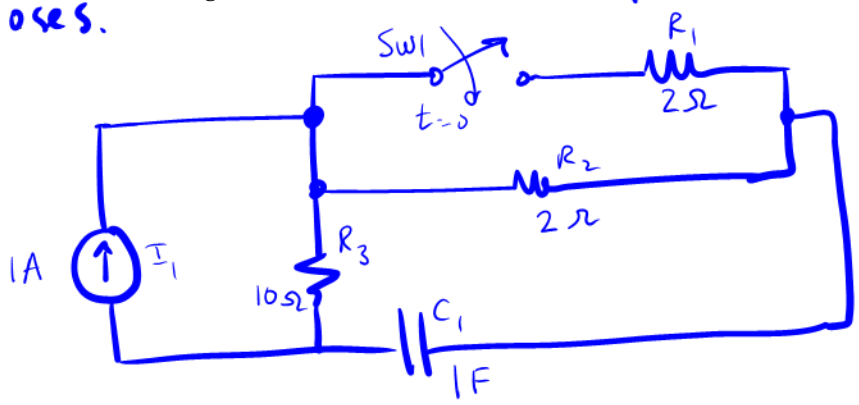

Figure 10: Circuit for transient analysis.

b.i) What is the capacitor voltage for $t = 0^-$?

Answer: : _____ /1

b.ii) What is voltage across I_1 just after the switch closes?

Answer: : _____ /3

b.iii) What is the time constant of the circuit, taking $v_{R_2}(t)$ as the output voltage?

Answer: Time constant: _____ /1

End of Exam.