EE240 – Circuits I

Mid Examination (Fall 2017)

November 2, 2017 06:00 pm–08:00 pm

INSTRUCTIONS:

- Do not flip this page over until told to do so.
- **The exam consists of TWO Parts.**
- **The first part is worth 36 pts, and is to be solved on the exam sheet. It is to be returned to the exam staff in the first 40 minutes.**
- **The second part is worth 60 pts and is to be solved on question sheet. Blue answer books are only provided for rough work.**
- Read all the questions before you start working on the exam.
- The exam is closed book and notes. You are allowed to bring calculator and one A4 sheet with you with *hand-written* notes on both sides.
- You cannot keep your mobile phones with you (even on silent mode or switched off).

EE240 – Circuits I
Mid Examination Fall 2017

Part - 1 (40 pts)

Student ID _____ Name _____

Signature _____

Instructions: This part needs to be solved on this sheet, and is to be returned to the exam staff in the first 40 minutes.

Problem 1. (36 pts) For each of the following multiple choice question, circle the correct choice. There is only correct choice for each question. You must show your working for the questions where mentioned explicitly.

(1) Consider the circuit shown in Fig. 1 and assume that $V_{\text{out}}(0^-) = 0$ and capacitors are ideal. The switch is moved from position A to position B at $t = 2$ sec, back to position A at $t = 4$ sec, and then back to position B at $t = 6$ sec and it remains at B forever. $V_{\text{out}}(100)$ is:

(a) 20 (b) 30 (c) 40 (d) 0

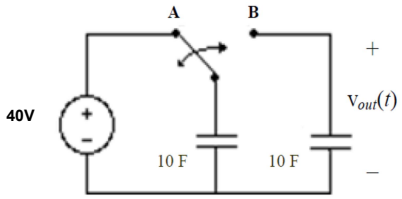


Figure 1:

(2) For a circuit shown in Fig. 2, if $R_1 = R_2 = R_3 = R_4 = 10\Omega$ and $R = 20\Omega$, the equivalent resistance of the circuit between the terminals A and B is:

(a) 25Ω (b) 20Ω (c) 30Ω (d) 35Ω

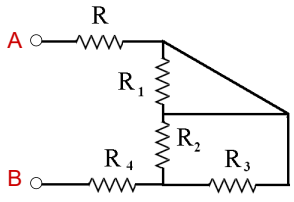


Figure 2:

(3) Consider a circuit with two inductors $L_1 = 10$H, $L_2 = 30$H, one resistor $R_1 = 20\Omega$ and a DC voltage source of voltage $V_o = 10$V connected in series. Determine the amount of energy (in Joules) stored in two inductors after being connected for a long time.

(a) 20 (b) 10 (c) 5 (d) 0

(4) Consider a circuit with three capacitors $C_1 = 10\mu$F, $C_2 = 12\mu$F, $C_3 = 15\mu$F and a DC voltage source of voltage $V_o = 7$V connected in series. Determine the charge on the capacitor C_1 (in μC). You must show your working in the space provided below.

(a) 5 (b) 28 (c) 52 (d) 70

show your working here

(5) Consider a circuit of network in Fig. 3 with DC voltage source of voltage V_o connected across terminals A and B. If all the resistors have same value, which resistor dissipates the most power?

(a) R_1 (b) R_2 (c) R_3 (d) R_5

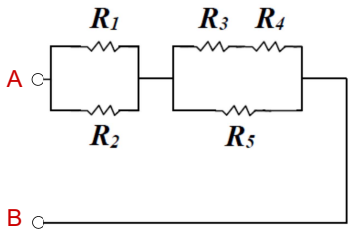


Figure 3:

(6) For a network with seven nodes and five independent loops, the number of branches in the network is
(a) 7 (b) 11 (c) 5 (d) 2

(7) If an ideal voltage source and an ideal current source are connected in series, what are the properties of the combination?
(a) The same as voltage source
(b) The same as current source
(c) Different from either a voltage source or current source

(8) The inductance of an inductor connected in the series RLC circuit depends upon:
(a) The amount of current that flows through the inductor.
(b) The time rate of change of current in the inductor.
(c) The geometry of the inductor.
(d) The frequency of the alternating current or voltage source that drives the circuit.

(9) Partial circuit is shown in Fig. 4, where the node voltages are relative to some unknown reference node. The value of the voltage V_x (in volts) is

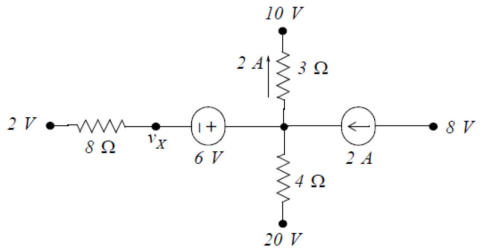


Figure 4:

(a) 6 (b) 24 (c) 8 (d) 10

You must show your working in the space provided below.

show your working here

(10) If an ideal voltage source and an ideal current source are connected in parallel, what are the properties of the combination?

(a) The same as voltage source

(b) The same as current source

(c) Different from either a voltage source or current source

(11) For the circuit given in Fig. 5, the current i (in amperes) is

(a) -2 (b) 5 (c) 3 (d) 4

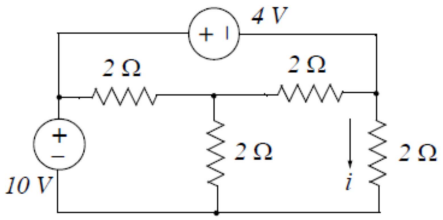


Figure 5:

You must show your working in the space provided below.

show your working here

(12) Consider a solenoid with radius r and length ℓ such that $r \ll \ell$. The magnetic field at the center of the solenoid is B_o. A second solenoid is constructed that has twice the radius, twice the length, and carries twice the current as the original solenoid, but has the same number of turns per meter. The magnetic field at the center of the second solenoid is

(a) B_o (b) $B_o/2$ (c) $2B_o$ (d) $4B_o$

(13) Consider a circuit containing resistor, inductor, and capacitor connected in parallel across an alternating voltage source of voltage $V_o \sin 10t$. Which of the following statement is correct?

(a) The instantaneous current through each element must add up to the instantaneous current provided by the driving source.

(b) The instantaneous voltages across each element must add up to the instantaneous voltage of the driving source.

(c) The voltage across capacitor is 90 degrees out of phase with the voltage across resistor.

(d) The voltage across capacitor is 180 degrees out of phase with the voltage across inductor.

(14) Partial circuit is shown in Fig. 6, where the node voltages are relative to some unknown reference node. The value of the current i (in amperes) is

(a) -4 (b) $\frac{8}{3}$ (c) -5 (d) -6

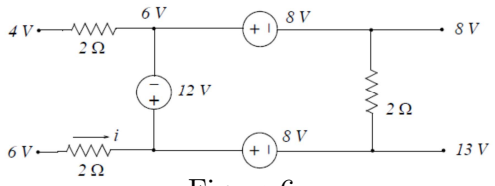


Figure 6:

You must show your working in the space provided below.

show your working here

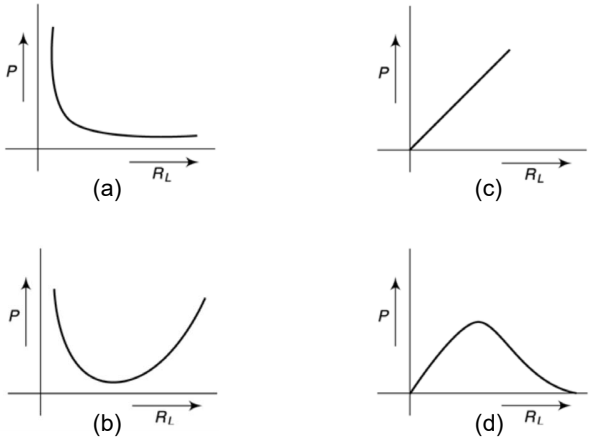
(15) If a two terminal element in a circuit has voltage and current variables that follows the associated reference directions and its power is negative, which of the following is true

(a) The element is supplying energy to the rest of the circuit

(b) The element is receiving energy from the rest of the circuit

(c) Either (a) or (b) could be true

(16) The voltage source with internal resistance r_s supplies power to the load of resistance R_L. The power to the load R_L varies with R_L as



(17) The value of the current (in amperes) for the circuit in Fig. 7 is

(a) 1 (b) 1.25 (c) 0.75 (d) 1.5

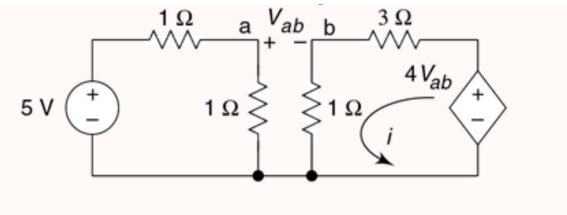


Figure 7:

You must show your working in the space provided below.

show your working here

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Part - 2 (60 pts)

Student ID _____ Name _____

Signature _____

Instructions: This part needs to be solved on this sheet and not on blue book. If you need the blue book for rough work, please ask the exam staff.

Problem 2. (**20 pts**)

(a) (**14 pts**) Consider a network shown in Fig. 1. Calculate the power *input* to a voltage source $V_o = -160V$ when it is connected across A and B such that the positive terminal of the voltage source is connected to terminal A.

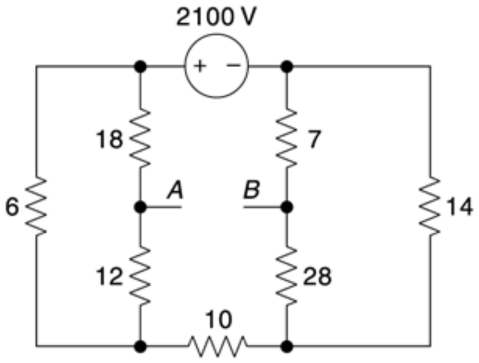

Figure 1: Problem 2(a)

(b) (**6 pts**) The bridge circuit is shown in Fig. 2 where D represents a current meter (with very small internal resistance). Find the value of R which makes $i_d = 0$.

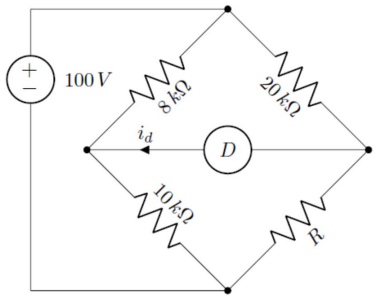

Figure 2: Problem 2(b)

Problem 3. (**20 pts**)

(a) (**9 pts**) For the circuit given in Fig. 3, use nodal analysis to determine the voltage V_x.

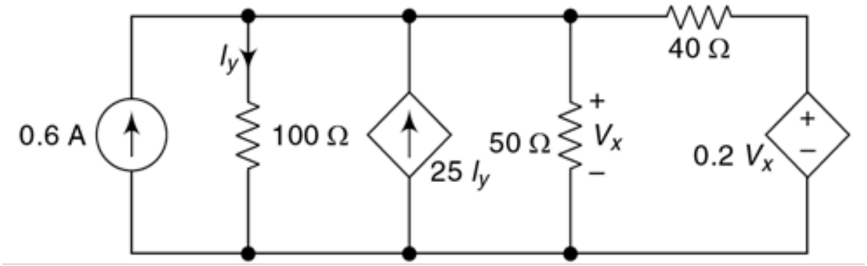

Figure 3: Problem 3(a)

(b) (**9 pts**) Draw the dual of the circuit given in Fig. 4.

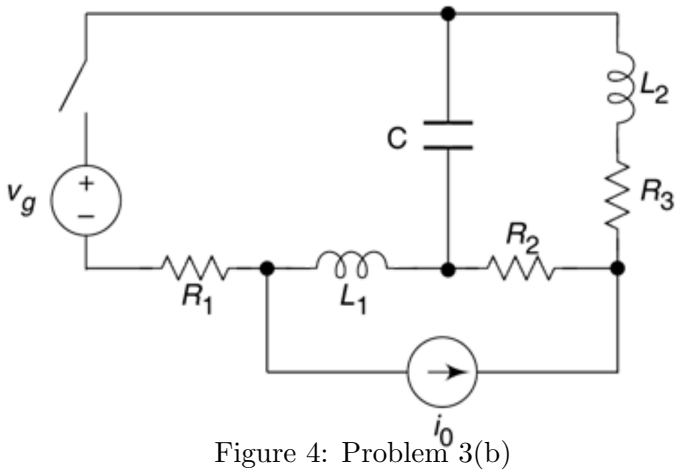

Figure 4: Problem 3(b)

(c) (**2 pts**) Do you agree with the following statement (support your answer with the justification)?

The two equivalent circuits may not be be topologically equivalent but two 'topologically equivalent' circuits are equivalent.

Problem 4. (**20 pts**) In this problem consider the network shown in Fig. 5. Note that the network has two parts that are mutually coupled.

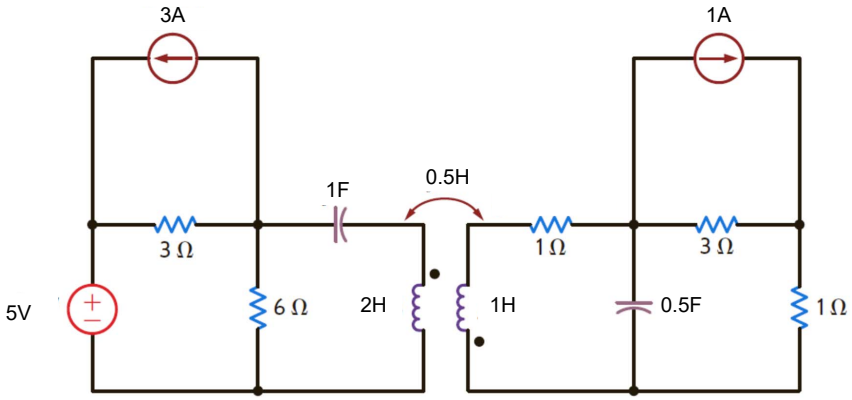

Figure 5: Problem 4

(a) (**7 pts**) Draw the graph and two trees of the circuit.

(b) (**3 pts**) Using the graph of the circuit or otherwise, determine the number of nodes, number of branches and number of independent loop equations.

(c) (**10 pts**) Identify the loops required to represent the circuit and write down the loop equations.