Department of Electrical Engineering
School of Science and Engineering

EE240 Circuits I - Fall 2020

ASSIGNMENT 3

Due Date: 23:55, Monday. November 23, 2020 (Submit online on LMS)
Format: 8 problems, for a total of 100 marks

Instructions:

- This is a group assignment, you are only allowed to corroborate between your speci

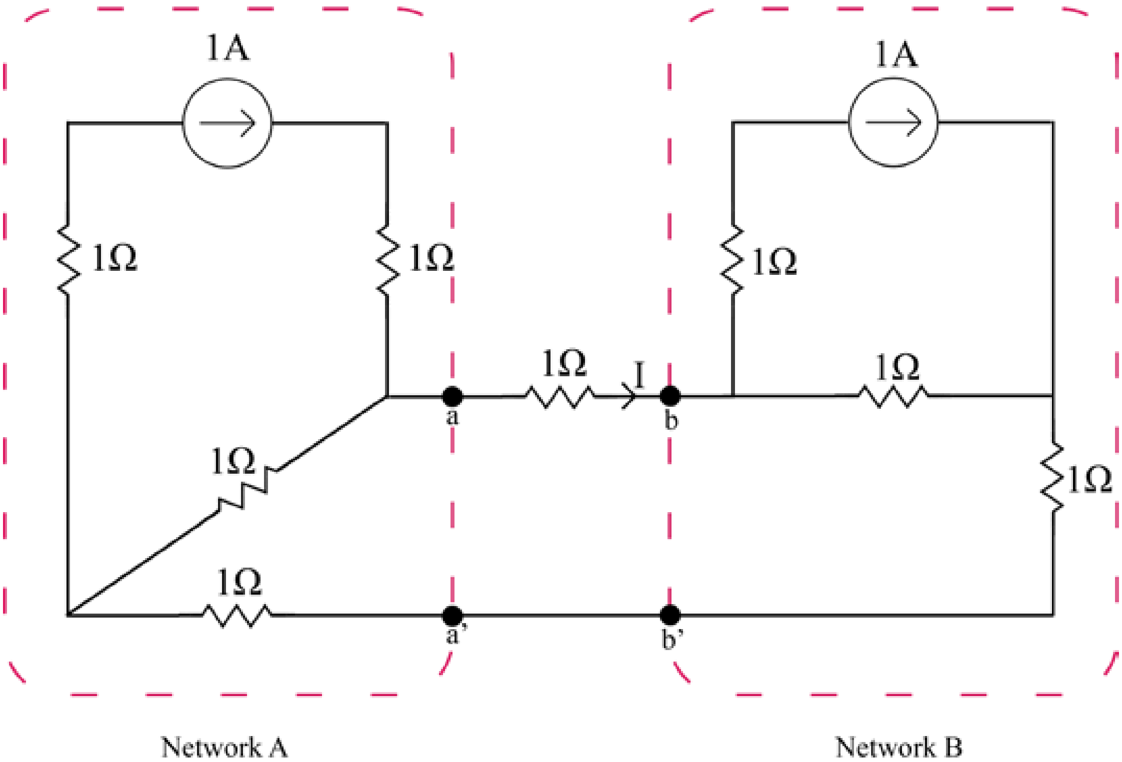
  ed groups.
- The predesignated group list will be mailed well in advance.
- Solve the assignment on blank A4 sheets and either scan the document using a scanner or use CamScanner proficiently.
- One individual from every group must upload the solved assignment on LMS in the "Assignments" tab under Assignment 3.
- Naming convention should be as follows: "Name_GroupName_Assignment_3.pdf"
- Feel free to contact the instructor or the teaching assistants if you have any concerns.
- You represent the most competent individuals in the country, do not let plagiarism come in between your learning. In case any instance of plagiarism is detected, the disciplinary case will be dealt with according to the university's rules and regulations.

Course Learning Outcomes Covered:

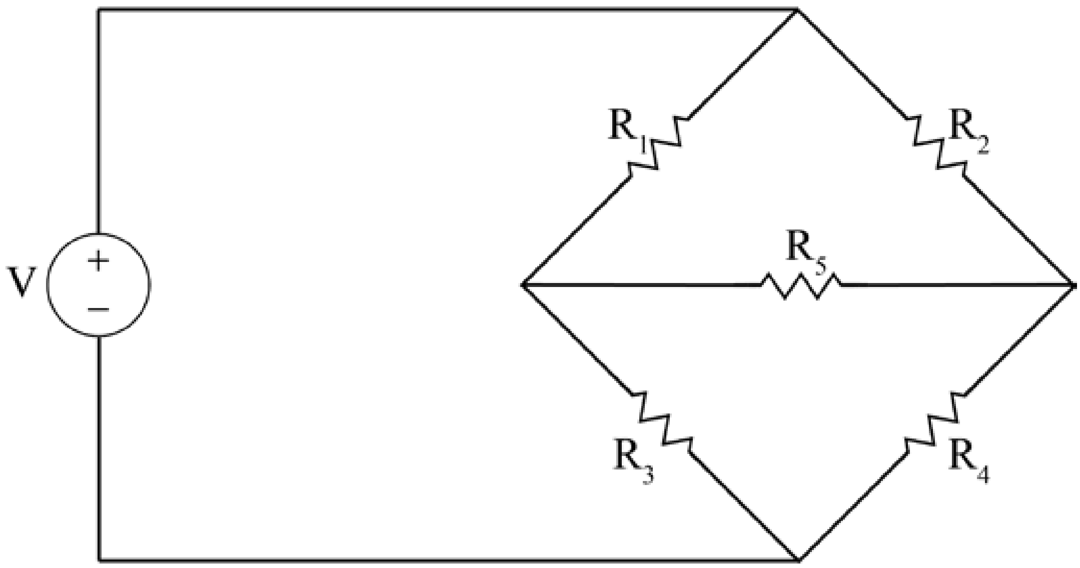
Formulate network equations based on the understanding of Kirchhoff's voltage and current laws.

Problem 1 [12 marks]: Thevenin Theorem

(a) **[6 marks]** Determine the current I in the branch a-b in the circuit by simplifying Network A and Network B in their Thevenin equivalent networks at terminals a-a' and b-b' respectively.

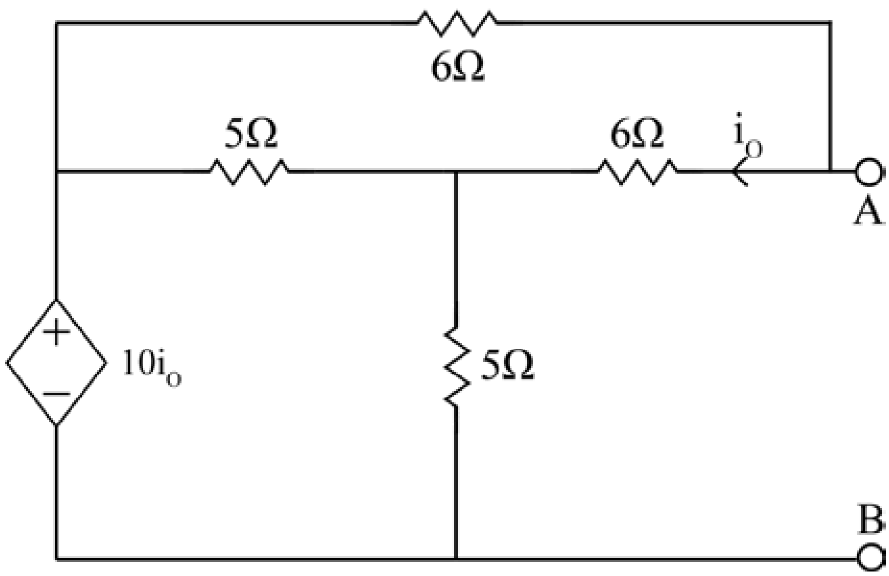


(b) **[6 marks]** For the bridge circuit shown in the figure, determine the Thevenin equivalent circuit across resistor R_5. Then find the condition on other resistor values that will make voltage across R_5 zero.



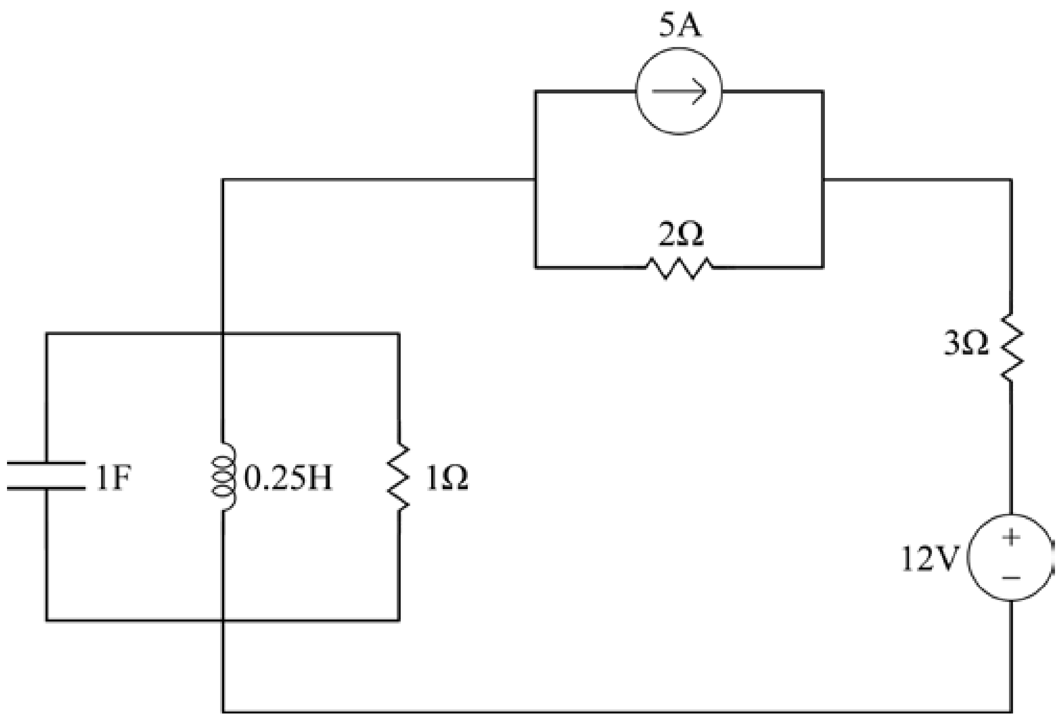
Problem 2 [7 marks]: Thevenin Theorem

Draw the Thevenin equivalent of the following circuit.



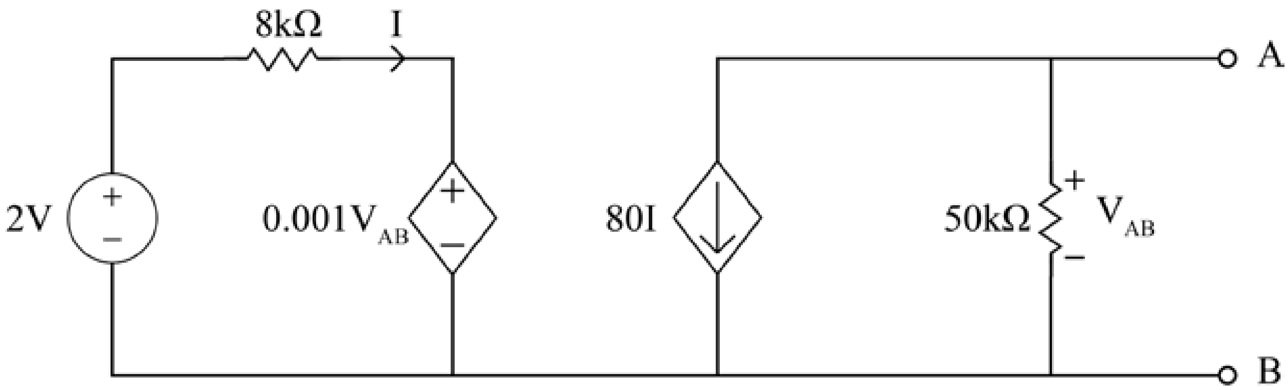
Problem 3 [6 marks]: Dual Circuits

Draw the dual of the following circuit.



Problem 4 [10 marks]: Norton Theorem

Obtain the Norton equivalent circuits at terminals A-B.

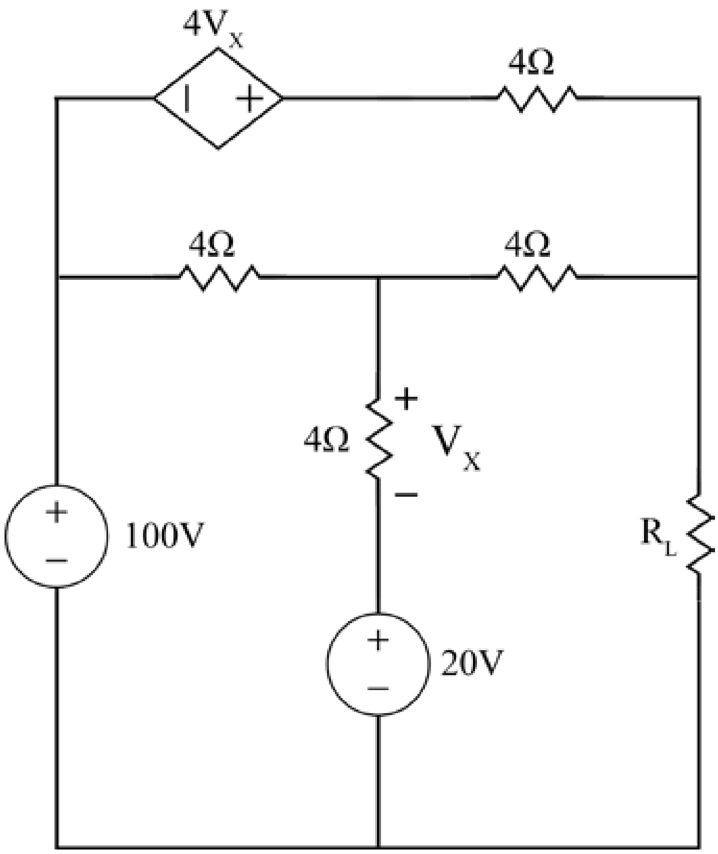


Problem 5 [21 marks]: Maximum Power

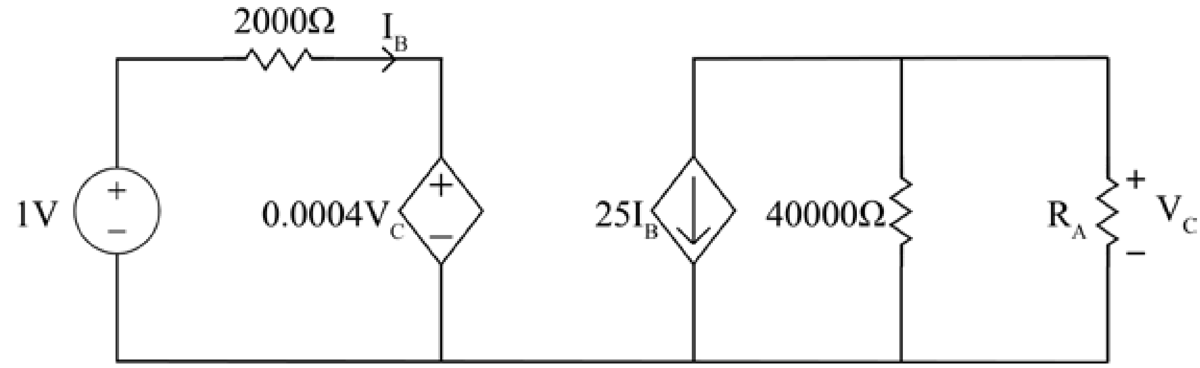
There are situations in circuit design where it is impertinent to select a load so that the maximum power can be transferred to it for instance the power utility systems, since they are concerned with the generation, transmission and distribution of large quantities of electric power. In case, the system is inefficient, a large percentage of power will be wasted.

(a) **[2 marks]** Determine the resistance for maximum power will be transferred to the load using the relation: $P = I^2 * R$

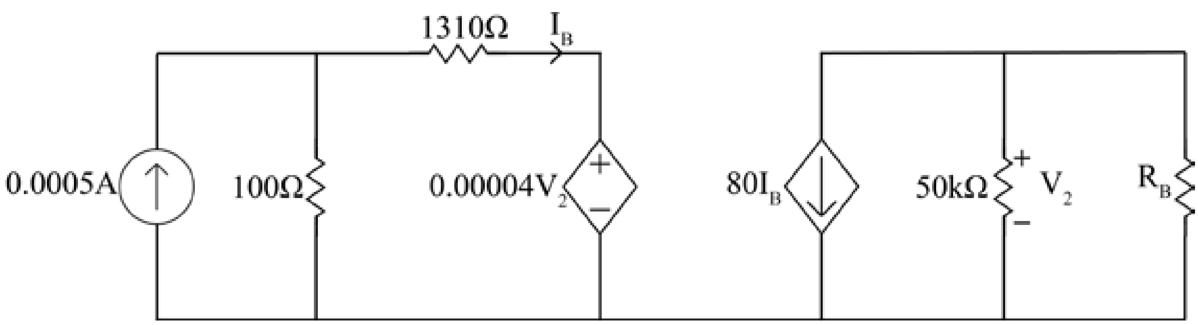
(b) **[5 marks]** Calculate the maximum power that can be transferred to R_L in the network below.



(c) **[7 marks]** Find the value of R_A for which maximum power is transferred to the load in the network below.

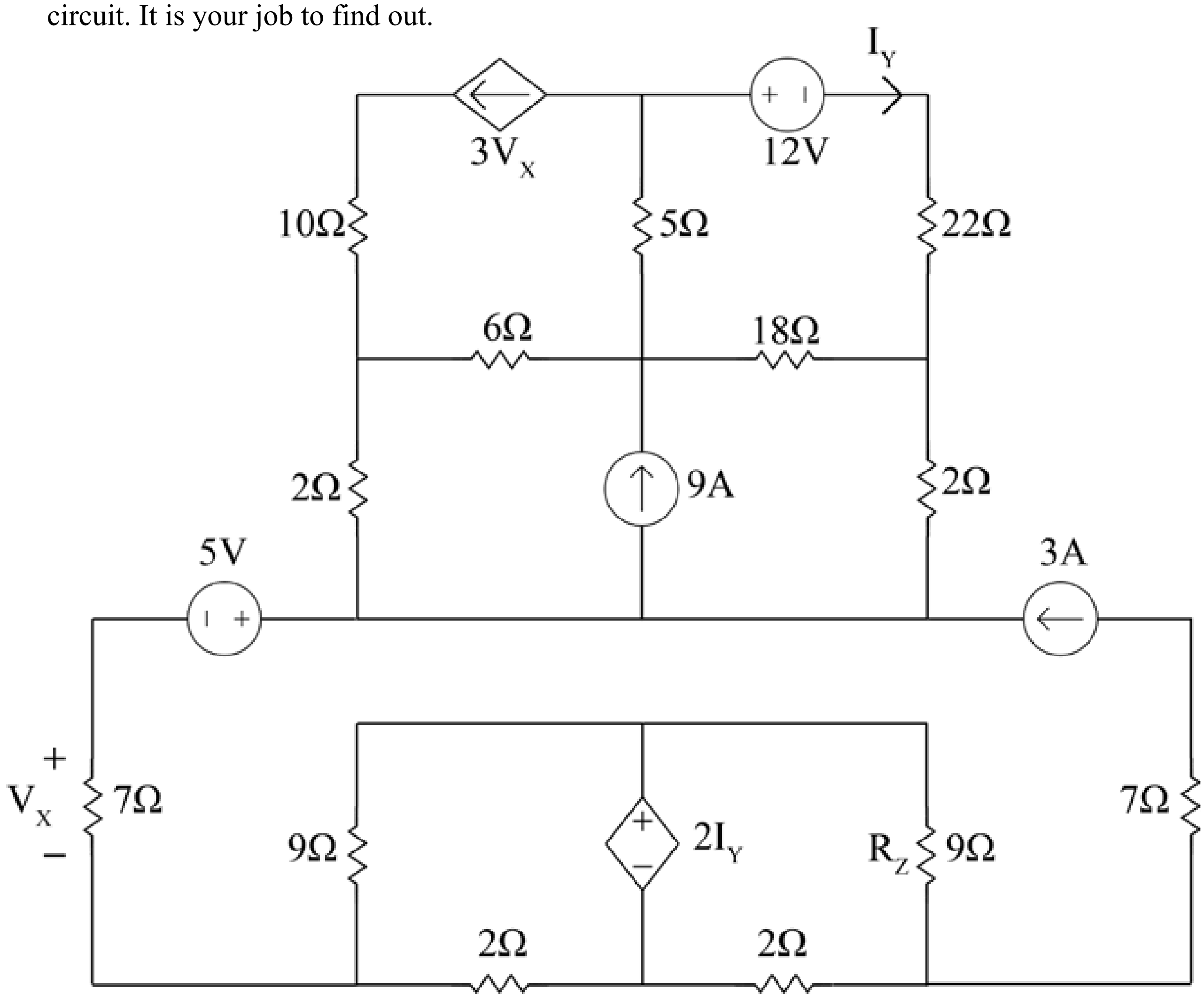


(d) **[7 marks]** Find the value of R_B for which maximum power transfer occurs. Find the max power that is transferred to the load.



Problem 6 [20 marks]: Loop Analysis

Resistors come in different resistance and power values. Other than knowing which resistance value to pick for your circuit, its important to know it's power tolerance as well. Working in an R&D team, your project partner provides you the circuit given below. They are however, unsure if the resistor 'Z' has appropriate power tolerance (currently 50W), i.e. if it is lower than the power being dissipated across it, the resistor will blow and damage the circuit. It is your job to find out.



(a) **[9 marks]** For the given circuit,
  (i) **[1 mark]** Label all loops in clockwise direction.
  (ii) **[8 marks]** Produce the complete set of loop equations by using mesh analysis.

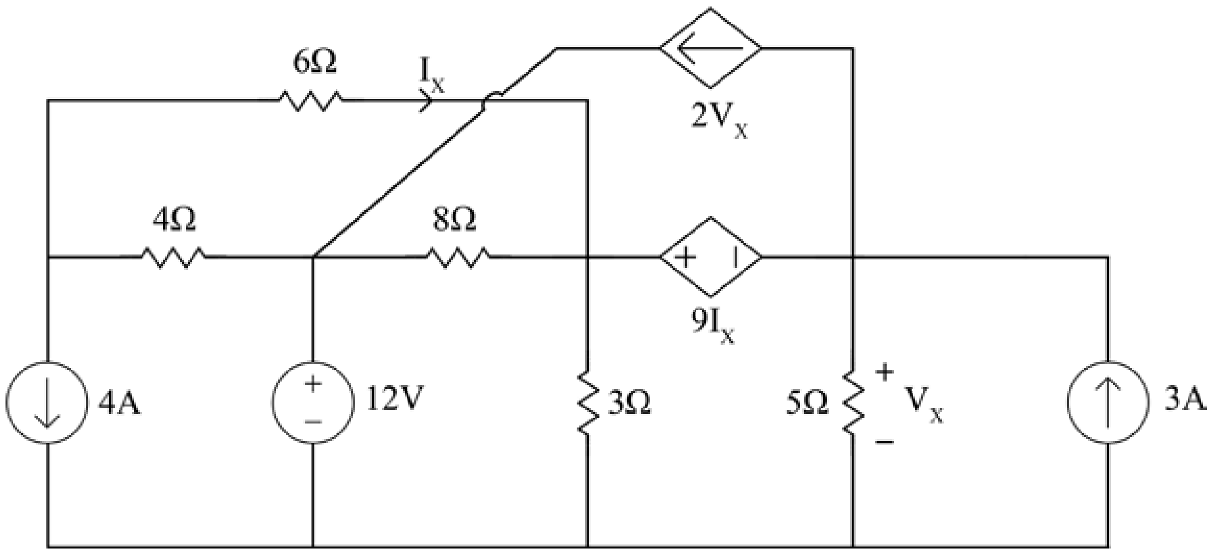
(b) **[6 marks]**
  (i) **[4 mark]** By simplifying your loop equations, express the circuit in a matrix equation of the form AI = V. Remember to exclude those loops for which you already know the currents for.
  (ii) **[2 marks]** Is the matrix 'A' symmetric? Why?

(c) **[4 marks]** Solve the matrix equation in part (b) to find all loop currents using Gauss Jordan Elimination or Cramer's Rule.

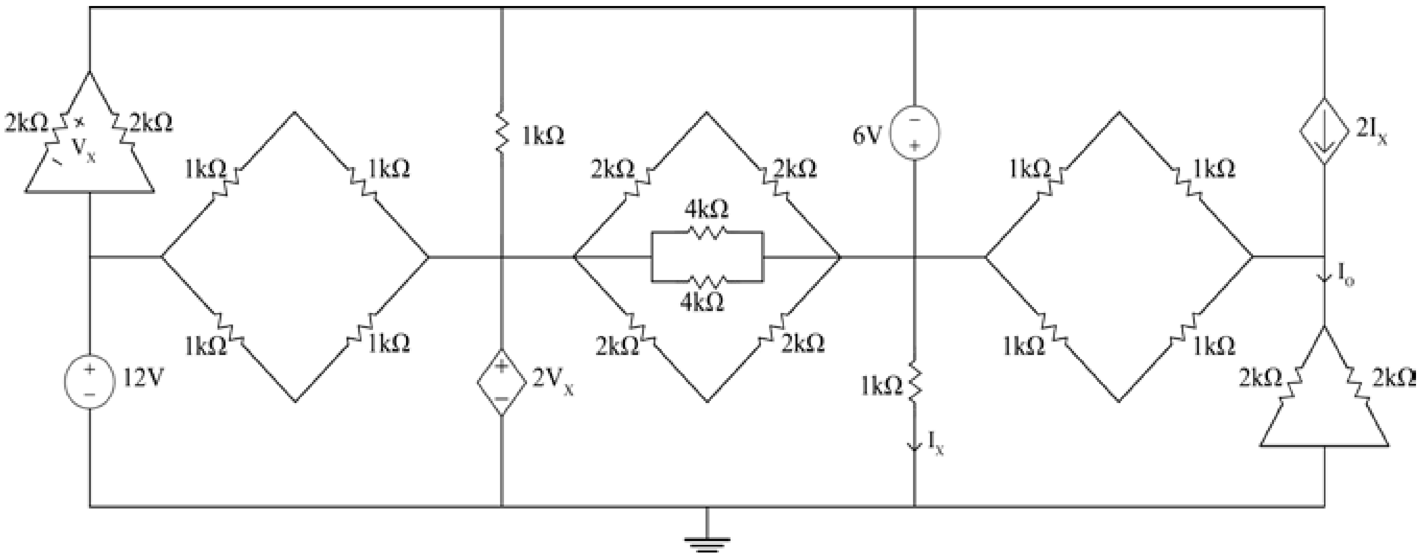
(d) **[1 marks]** Now that you know all the loop currents, explain if you need to change the resistor 'Z' to a different power rating.

Problem 7 [13 marks]: Nodal Analysis

(a) **[6 marks]** Use nodal analysis to find all the nodal voltages in the following network.

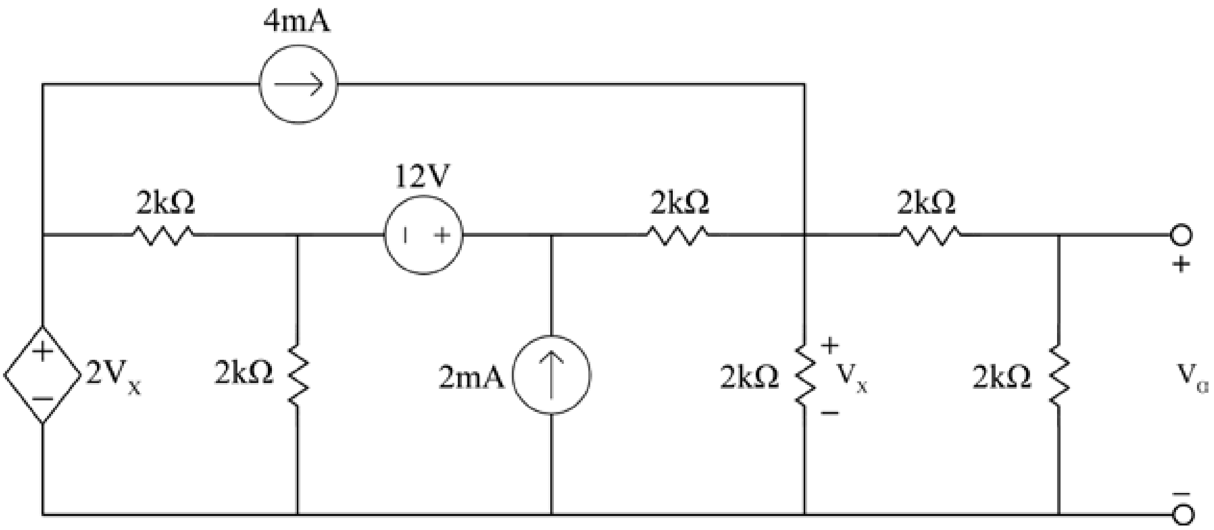


(a) **[7 marks]** Apply nodal analysis on the following network to find the current I_o.



Problem 8 [11 marks]: Thevenin Theorem

Find V_O by employing Thevenin theorem.



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