LUMS
A Not-for-Profit University

School of Science and Engineering

EE 240 Circuits-I

ASSIGNMENT 1

Due Date: 1 pm, Tuesday, October 1, 2024.
Format: 9 problems, for a total of 100 marks
Instructions:

- You are allowed to collaborate with your peers but copying your colleague's solution is strictly prohibited. This is not a group assignment. Each student must submit his/her own assignment.
- Solve the assignment on blank A4 sheets and staple them before submitting.
- Submit in-class or in the dropbox labeled EE-240 outside the instructor's office.
- **Write your name and roll no. on the first page.**
- 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.
- We require you to acknowledge any use or contributions from generative AI tools. Include the following statement to acknowledge the use of AI where applicable.

  I have used [insert Tool Name] to [write, generate, plot or compute; explain specific use of generative AI] [number of times].

Problem 1 (8 marks)

(Power, Voltage and Current) The charge entering the positive terminal of an element is

$$q = 10 \sin 4\pi t \text{ mC}$$

while the voltage across the element (positive to negative) is

$$v = 2 \cos 4\pi t \text{ V}$$

(a) [**4 marks**] Find the power delivered to the element at $t = 0.3$ s.

(b) [**4 marks**] Calculate the energy delivered to the element between 0 and 0.6 s.

Problem 2 (15 marks)

(a) **[2 marks]** A lightning bolt with 8 kA strikes an object for 15μs. How much charge is deposited on the object?

(b) **[2 marks]** A rechargeable flashlight battery is capable of delivering 85 mA for about 12 h. How much charge can it release at that rate? If its terminal voltage is 1.2 V , how much energy can the battery deliver?

(c) **[5 marks]** The current through an element is shown in the graph in Figure 1a. Determine the total charge that passed through the element at:

(i) $t = 1$ s
(ii) $t = 3$ s
(iii) $t = 5$ s

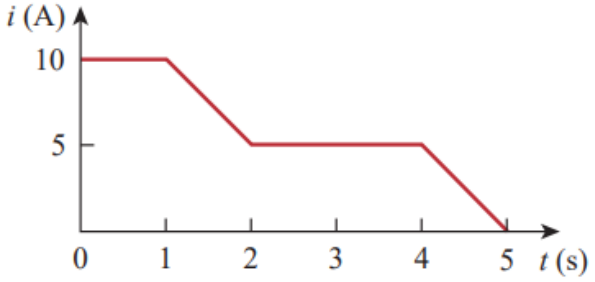


Figure 1: a

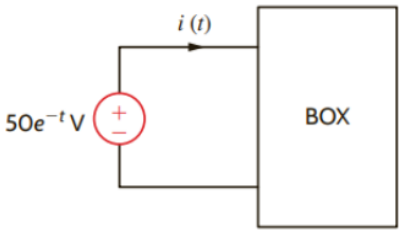
(d) **[6 marks]** If the current flowing through an element is given by

$$i(t) = \begin{cases} 3t \text{ A}, & 0 \le t < 6 \text{ s} \\ 18 \text{ A}, & 6 \le t < 10 \text{ s} \\ -12 \text{ A}, & 10 \le t < 15 \text{ s} \\ 0, & t \ge 15 \text{ s} \end{cases}$$

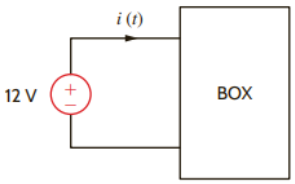
Calculate and plot the charge stored in the element over $0 < t < 20$ s.

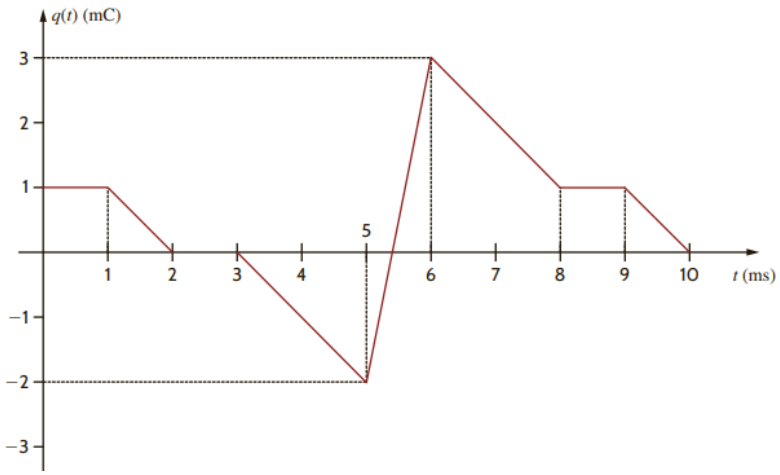
Problem 3 (15 marks)

(a) [**5 marks**] The power absorbed by the BOX is $2.5e^{-4t}$ W. Compute the energy and charge delivered to the BOX in the time interval $0 < t < 250$ ms.



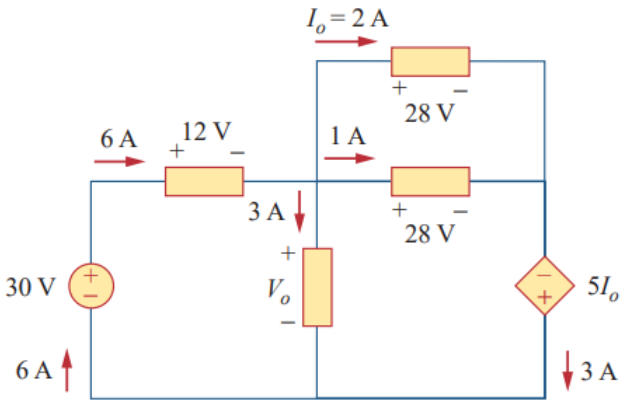
(b) [**10 marks**] The charge that enters the BOX is shown in the graph below. Calculate and sketch the current flowing into and the power absorbed by the BOX between 0 and 10 milliseconds.



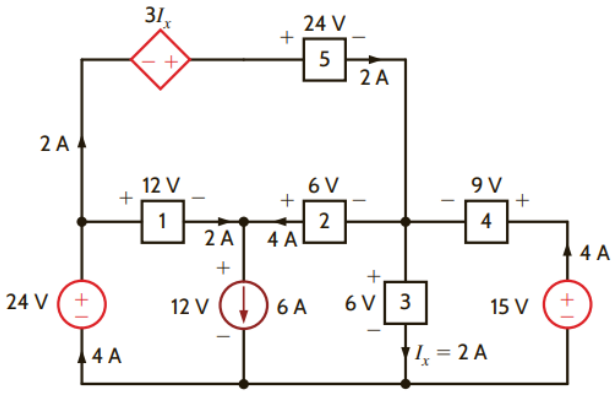


Problem 4 (15 marks)

(a) [**7 marks**] Find V_o in the circuit below using Tellegen's theorem.

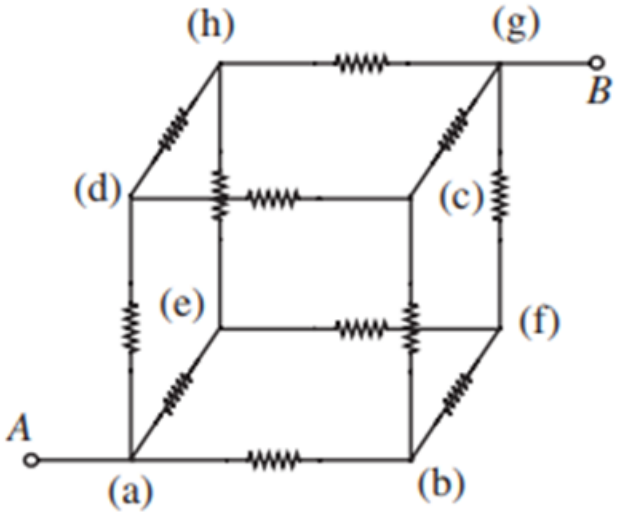


(b) [**8 marks**] Calculate the power absorbed by each element in the circuit below. Also, verify that Tellegen's theorem is satisfied by this circuit.

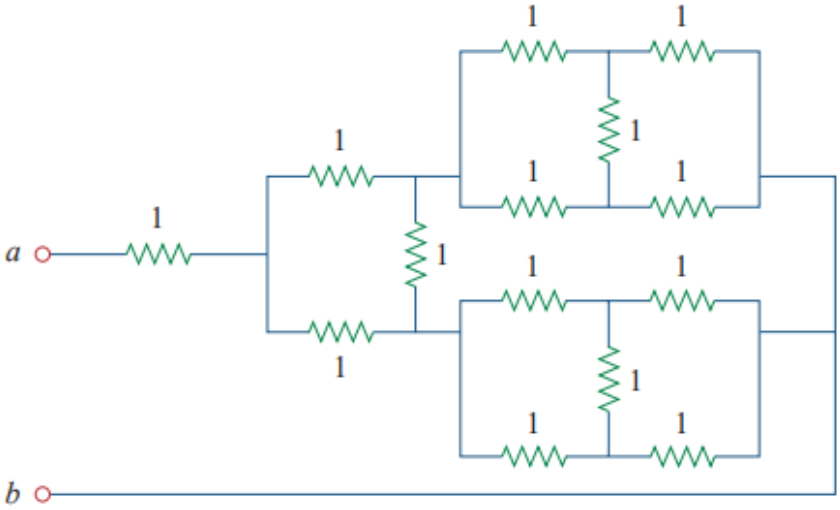


Problem 5 (12 marks)

(a) [**7 marks**] For the figure below, find the equivalent resistance of the network when looking into the A-B terminal. All resistors have the R = 2 Ω.

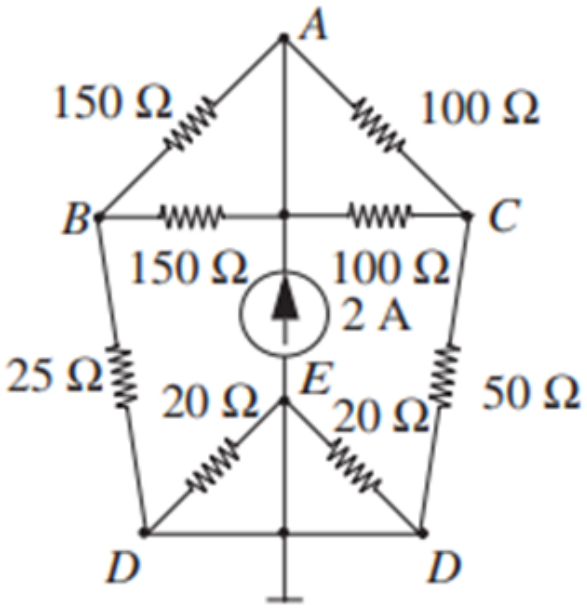


(b) [**5 marks**] Find R_{ab}. Assume all resistances to be 1 Ω.



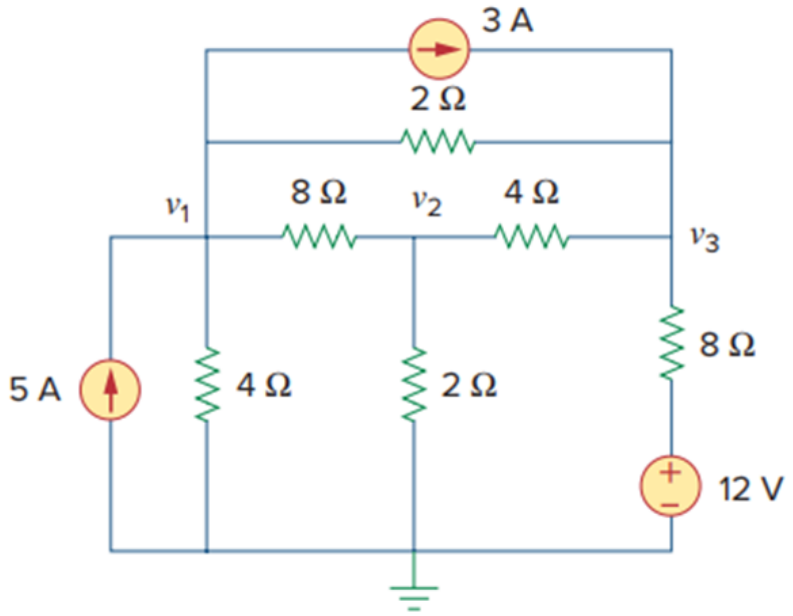
Problem 6 (10 marks)

For the figure shown below, find the voltages between each of the mentioned nodes and ground e.g. V_{ad}

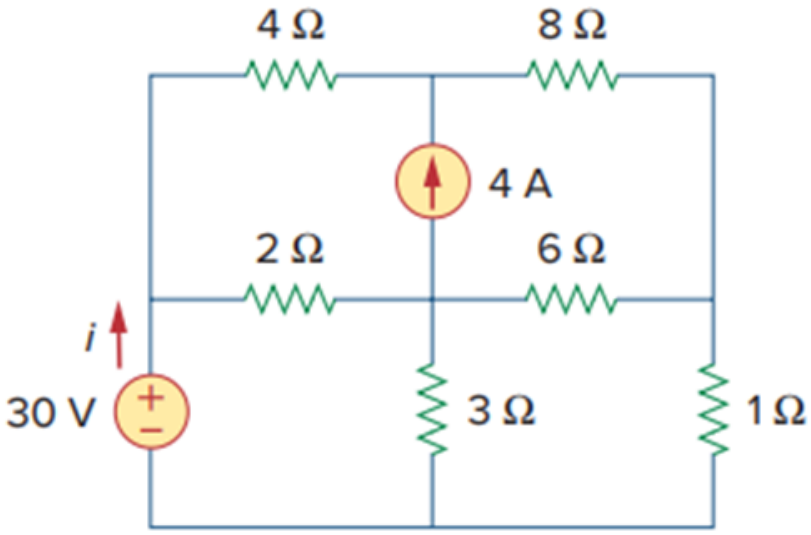


Problem 7 (10 marks)

(a) [**5 marks**] For the circuit shown, find the voltages v_1, v_2, and v_3.

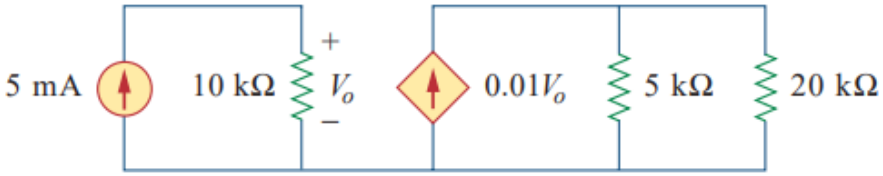


(b) [**5 marks**] For the circuit shown, find the current i.



Problem 8 (5 marks)

For the figure below, find the current, voltage, and power associated with the 20k resistor.



Problem 9 (10 marks)

Find R_{eq} and I in the circuit below.