NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION

CIRCUIT THEORY (PST 2172)

Special Examination Paper

2024

This Examination Paper consists of 5 printed pages

Time allowed : 3 hours

Total Marks : 100

Special requirements : None

Internal Examiner : J. Hlongwane

INSTRUCTIONS

1. Answer **all** questions in section **A** and any three questions in section **B** (Section A carries 40 marks and section B carries 60 marks).
2. Show all your working steps clearly in any calculation.
3. Start the answer for any question on a new page.

MARK ALLOCATION

QUESTION	MARKS
1.	40
2.	20
3.	20
4.	20
5.	20
6.	20
TOTAL	100

SECTION A

1(a). Determine the magnitudes of the currents shown in Fig 1.2. [6]

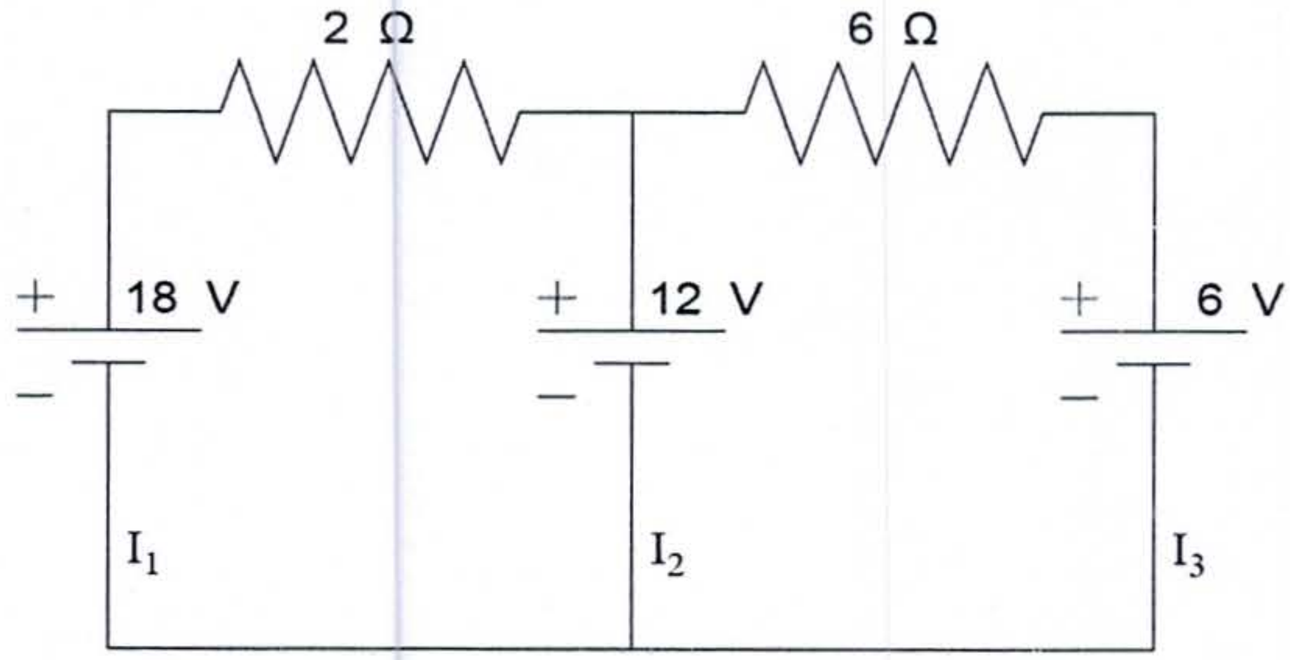


Figure 1.2

(b). for the circuit in fig 1.3, V=1.5V, $C_1 = 4.0\mu F, C_2 = 8.0\mu F, C_3 = 6.0\mu F$ calculate the following quantities:

(i). equivalent capacitance. [3]

(ii). Charge on each capacitor. [6]

(iii). The potential difference across each capacitor. [4]

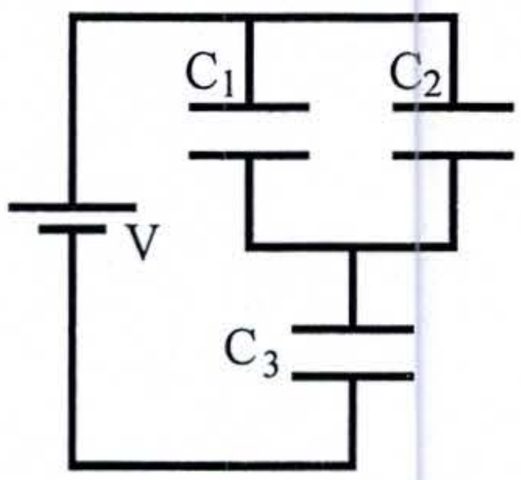


Fig 1.3

(c). For the circuit shown in fig 1.4 compute:

(i). The equivalent resistance. [4]

(ii). The current provided by the power supply. [3]

(iii). The current through and voltage across each resistor given that (V=90.0V, R_1=3.00kΩ, R_2=4.00kΩ, R_3=1.00kΩ, R_4=2.00kΩ and R_5=6.00kΩ). [10]

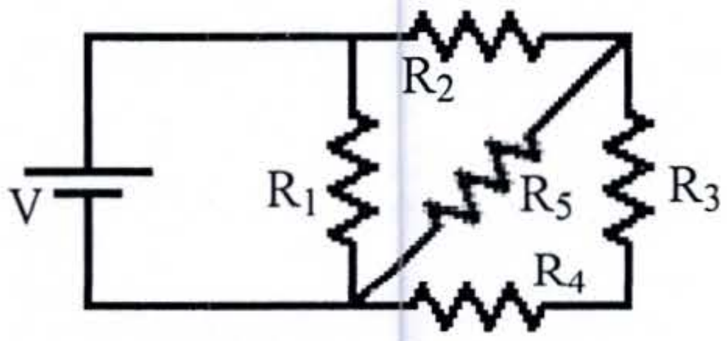


Fig 1.4

(d).Determine the resistance of a 30m copper wire with a diameter of 0.032 cm and resistivity of 1.723×10^{-8} Nm.

[2]

(e).Calculate the potential difference across a lamp that dissipates 1000J in 10 seconds if current is 0.4 A.

[2]

SECTION B

2(a).The e.m.f of a battery is 25.0 V. Compute the amount of charge that flows through it if the energy transferred is 80.0J. [2]

(b) Determine the amount of current flowing if the transfer time is 90.0 seconds. [3]

(c). Determine the resistivity of a 2.5m long Constantine wire with a diameter of

$3.2 \times 10^{-6}m$ and resistance of 100.0Ω. [3]

(d). Determine the equivalent resistance R_{ab} in Fig 2.1 [4]

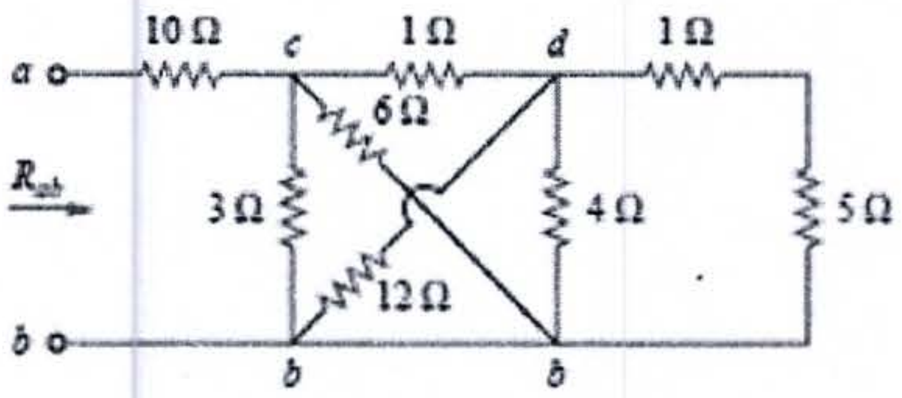


Fig 2.1

(e) Use diagrams to illustrate how Kirchhoff's laws (KVL and KCL) are used in circuit analysis. Use arbitrary letters and symbols and not actual numerical values in your analysis.

[4]

(f) Apply Ohm's law to derive three alternative expressions for electric power across a resistor. [4]

3(a). Discuss any four applications of Circuit theory concepts in the manufacture of modern technological gadgets. [10]

(b). Determine the total inductance in the circuit of Fig 3.2. [5]

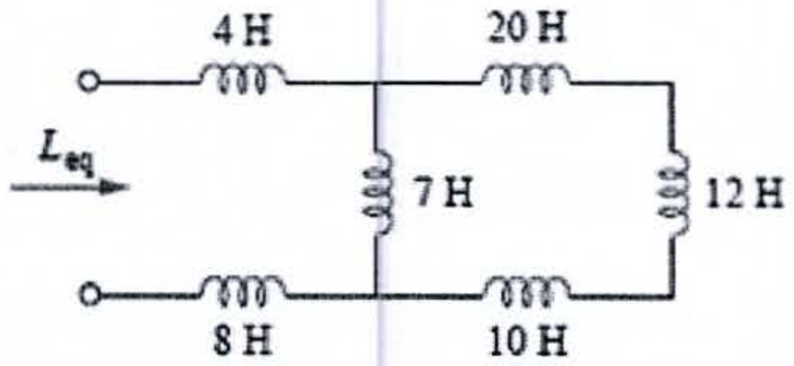


Fig 3.2

(c). Discuss the similarities and differences between the Thevenin and Norton circuit theorems. [5]

4(a). For the circuit in Figure 4.1 determine the voltage across the terminals J and H. [6]

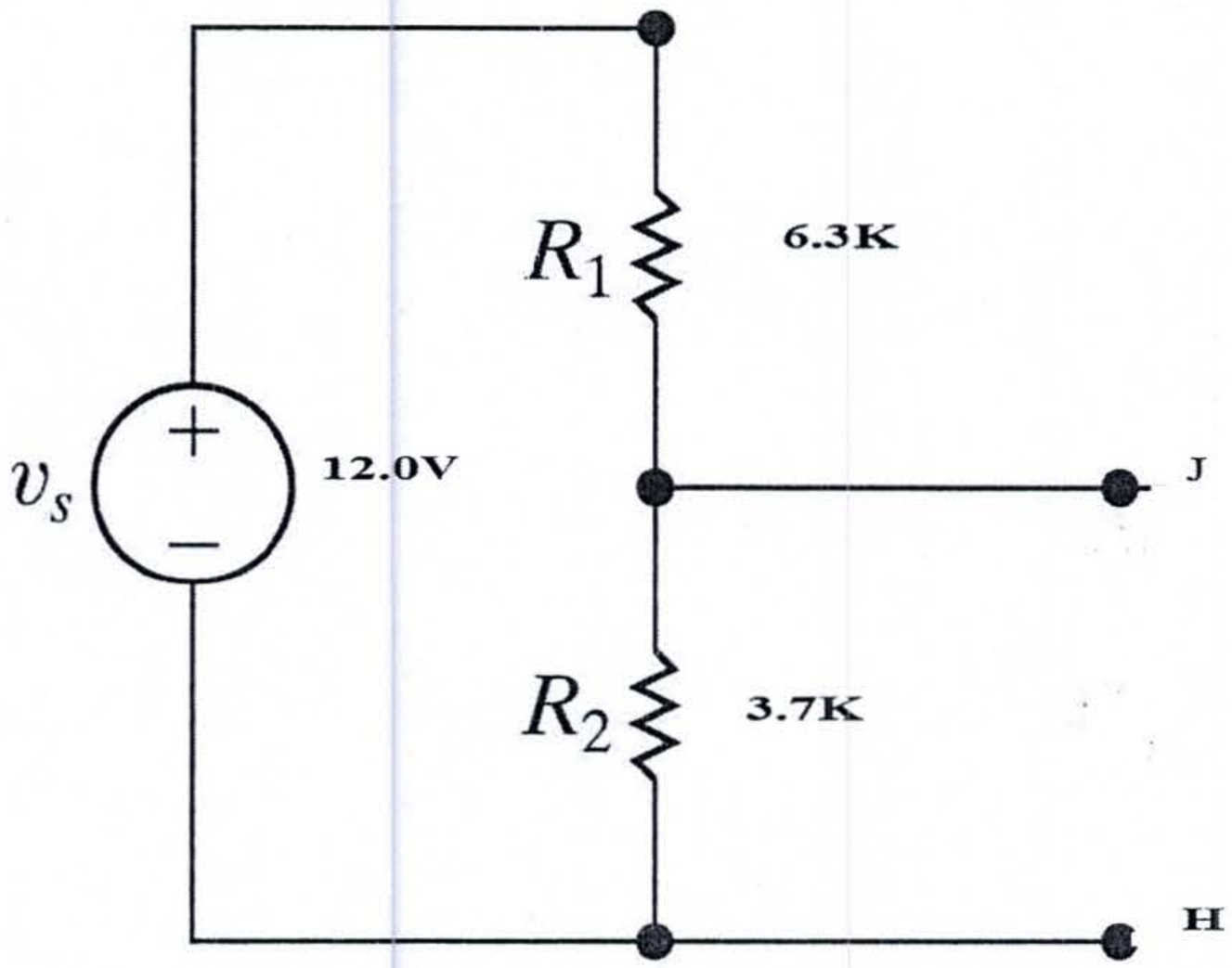


Figure 1.4

(b) Design a bridge rectifier circuit that could be used to convert a 24V a.c input into a smooth 12V d.c. output. [6]

(c). Determine the effective resistance between points a and b in Fig 4.1 [8]

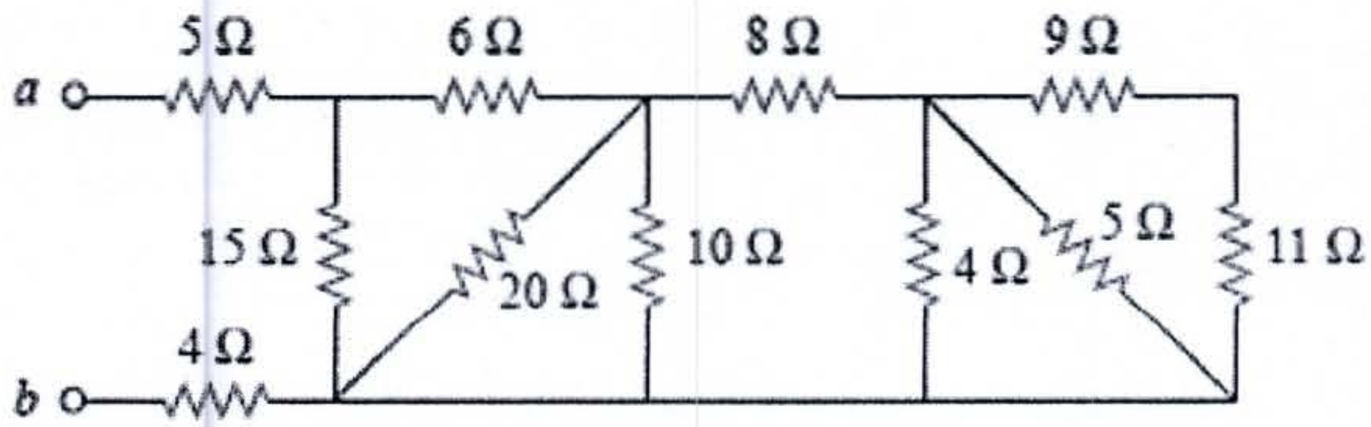


Fig 4.1

5(a). The e.m.f of a power supply is $24V_{rms}$. Calculate its peak voltage. [4]

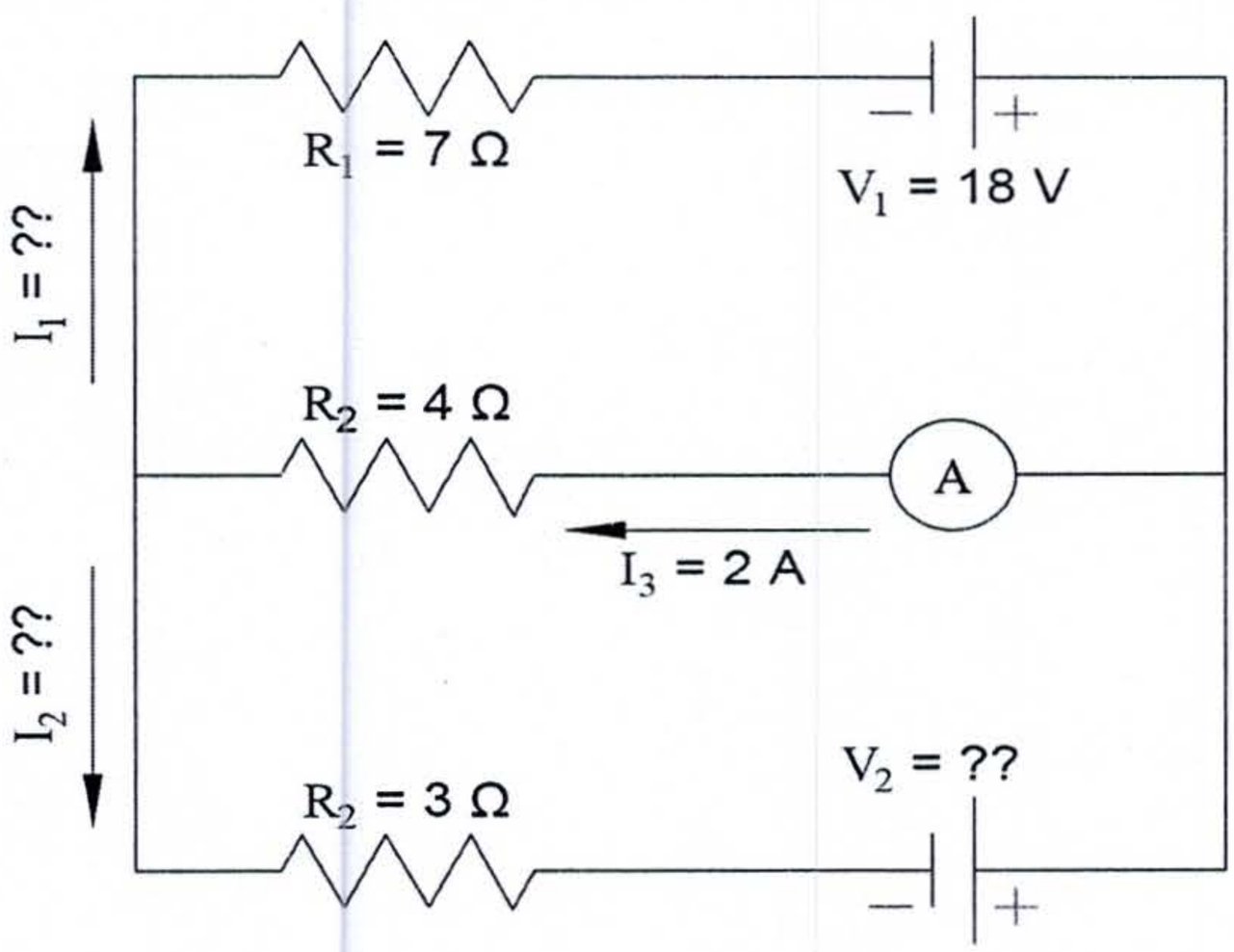
(b) Determine the maximum charge flowing through the power supply if energy transferred is 150J. [4]

(c) Calculate the peak current flowing given that the transfer time is 90.0s. [4]

(d) Outline how circuit theories and analysis methods have resulted in modern technological gadgets being physically smaller in size compared to older versions made some twenty years ago.
[8]

6(a). Find the unknown voltages and currents in Fig 6.1. [8]

Fig 6.1



(b) Outline how Kirchhoff's laws are expressions of conservation principles. Clearly stating which physical quantity is conserved in each law. [5]

(c). Determine the value of R_L that will result in maximum power transfer in the circuit shown in Fig 6.3. [7]

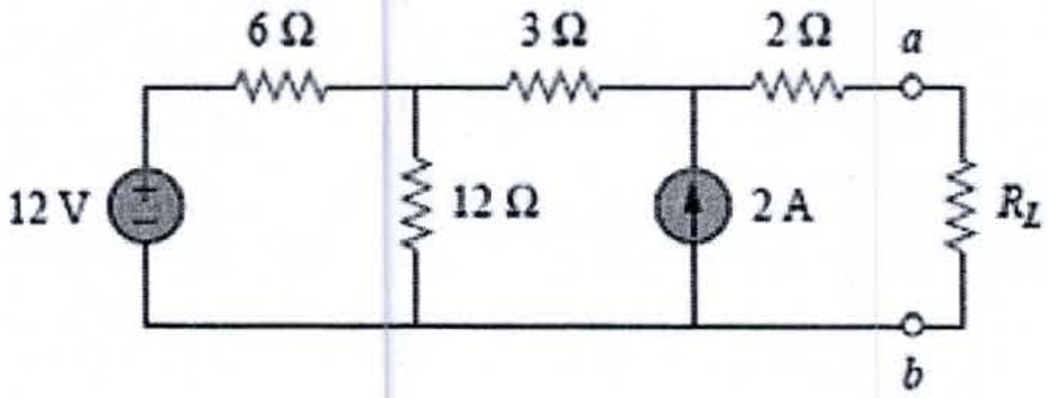


Fig 6.3

END OF EXAMINATION