NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OFAPPLIED SCIENCES

DEPARTMENT OF APPLIED PHYSICS

BSc (Hon) in EARTH SCIENCE PART 1

ELECTRIC CIRCUITS AND INSTRUMENTATION

SPH 1107

First Semester Examination Paper

December 2024

This examination paper consists of 4 pages

Time Allowed: **3 hours**

Total Marks: **100**

Special Requirements:None

Examiner's Name: **Mr Z. Zulu**

INSTRUCTIONS

ANSWER ALL PARTS OF QUESTION 1 IN SECTION A AND ANY THREE QUESTIONS FROM SECTION B. SECTION A CARRIES 40 MARKS AND SECTION B CARRIES 60 MARKS.

MARK ALLOCATION

QUESTION	MARKS
1.	**40**
2.	**20**
3.	**20**
4.	**20**
5.	**20**
6.	**20**
Maximum possible mark	**100**

SECTION A

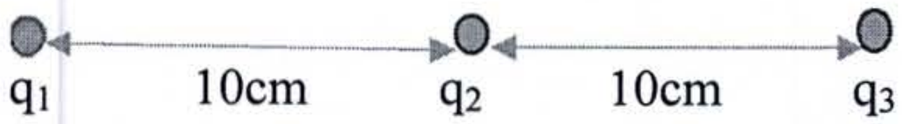
1. (a) State the properties of a point charge [3]

(b) State 4 uses of an Op- amp in an electronic circuit. [5]

(c) (i) State the significance of the time constant in RC circuits. [2]
(ii) Calculate the time constant τ of a circuit with resistor of 10Ω and capacitance of 5μF. [5]

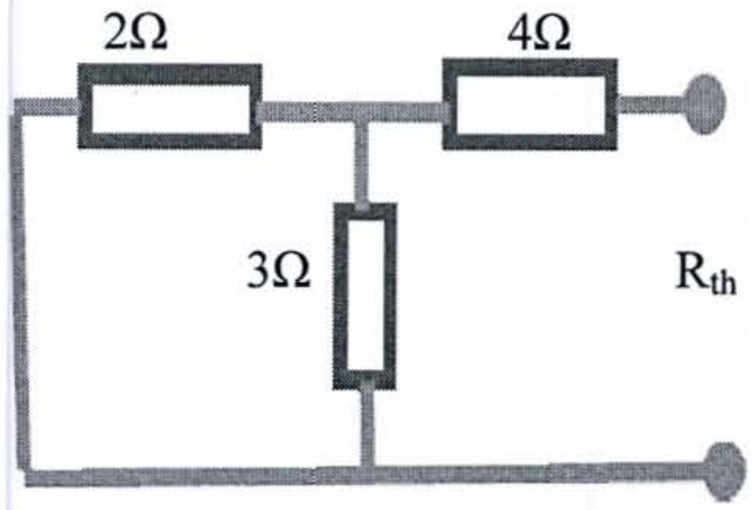
(d State the following Laws
(i) Kirchhoff's voltage law [4]
(ii) Kirchhoff's current law [3]
(iii) Faraday's Law of induction [3]
(iv) Coulomb's law [3]

(f) From the diagram below, calculate the force on charge q_3 given that $q_1 = +3\mu C$, $q_2 = -2\mu C$ and $q_3 = 1\mu C$



[7]

(g)



Calculate the thevenin resistance of the circuit above. [5]

SECTION B

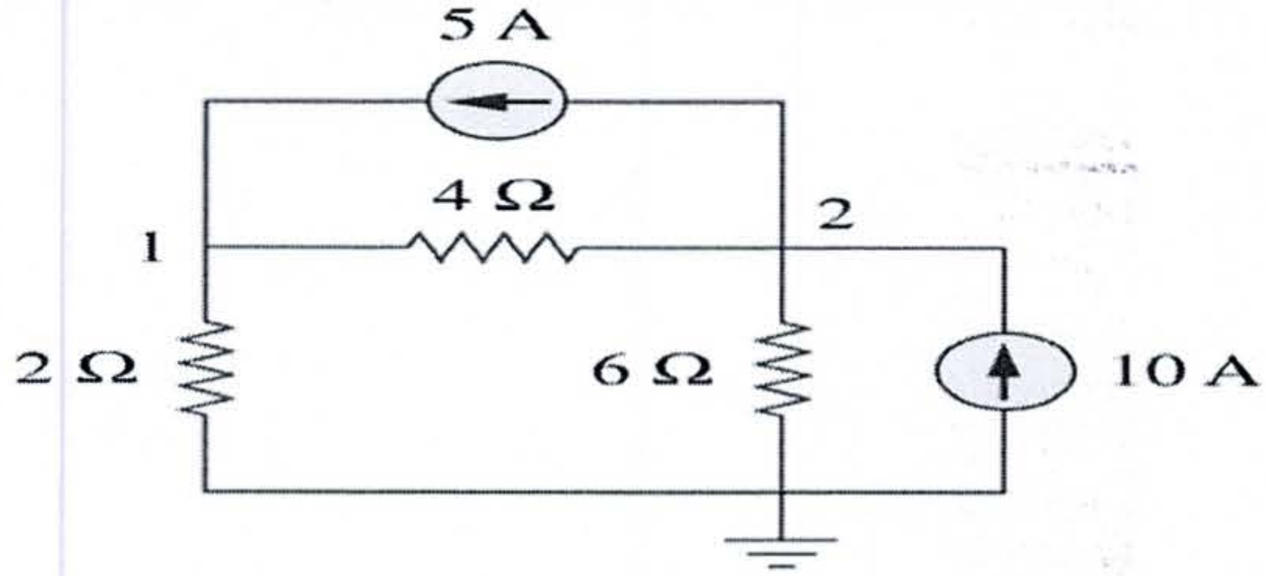
2. (a) Draw symbols to show an independent voltage source and a dependent voltage source [4]

(b) Use source transformation technique to transform the following sources

(i) 8mA source with a 5kΩ resistor [3]

(ii) 15V source [3]

(c) Calculate the nodal voltages at the two numbered nodes in the circuit below.



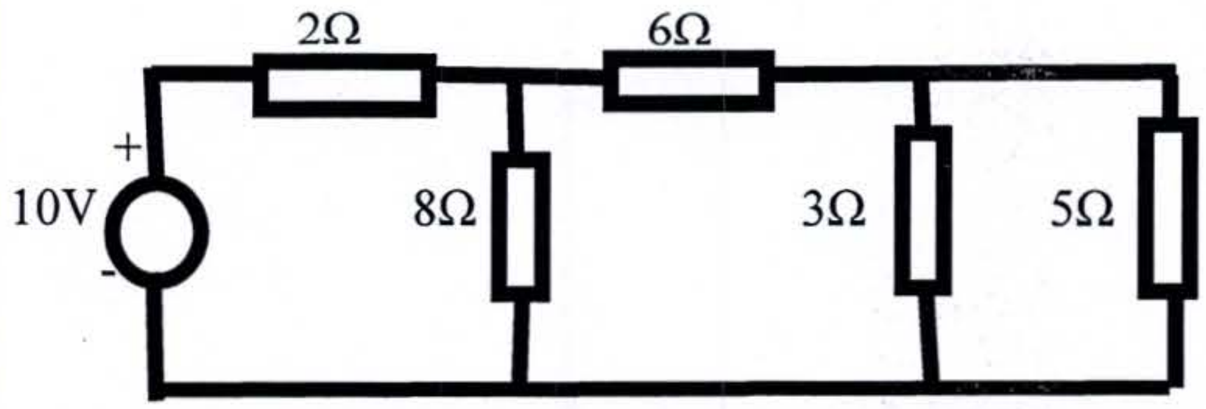
[10]

3. (a) State any two properties of an op-amp. [2]

(i) State any two uses of an op-amp. [4]

(ii) Draw a diagram to show a voltage follower and state its gain. [4]

(b) Using Kirchhoff's laws give 5 equations formed from analyzing the circuit below.



[10]

4. (a) Calculate the value equivalent to

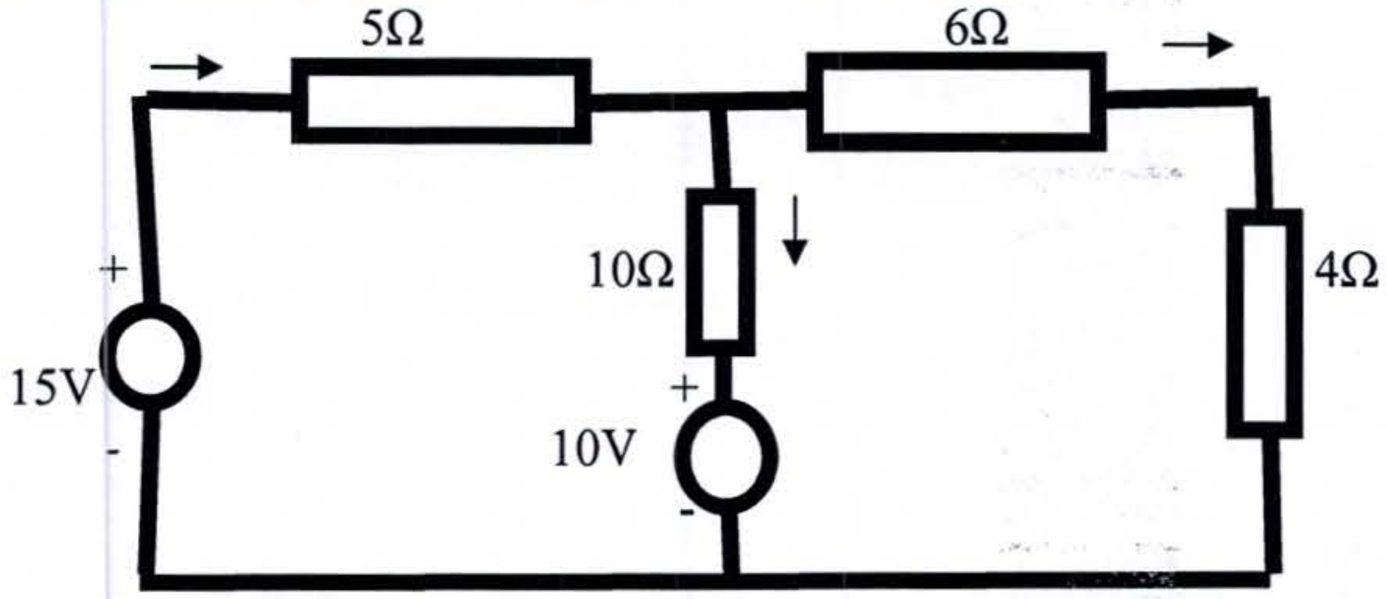
(i) 2F ,3F and 4F capacitors connected in series [4]

(ii) 2H,3H and 4H Inductors connected in series [4]

(b) Draw the symbol for a BJT transistor. [2]

(c) Derive the period of motion T of a particle in a Cyclotron and show that it is dependent only on the magnetic field B, the mass m and charge q of the particle. [10]

5. (a) State the factors affecting the value of capacitance. [4]
(b) Give Maxwell's equations stating each parameter in them. [8]
Calculate the value of the three currents in the circuit below



[8]

6. (a) State two uses of capacitors. [4]
(b) Calculate the energy and charge stored in a 3pF capacitor connected to a 20V power supply. [6]
(c) State the difference between first order and second order circuits and draw one second order circuit [10]

END OF PAPER