## QUESTION ONE (30 Marks)

a) State and define the units of measurement for the following electric circuit quantities: Charge, Power and Energy. **[3 marks]**

i. An electric current of 5 A flows for 2.5 minutes, find the quantity of charge transferred and the number of electron involved. **[3 marks]**

ii. A mobile phone battery is rated at 4500 mAh. A) How much charge does this rating represent? B) If the battery is Li-on rated at 3.7 V, how energy does the battery supply? C) If the current phone applications require a total of 1500 mA, how long will the battery last before recharging? **[4 marks]**

b) State and explain Ohm's law of an electric circuit. **[1 mark]**

i. Three resistors, $R_1$, $R_2$, and $R_3$ are connected in series in a DC voltage of V volts. Derive the equation that may be used to share the voltage V between these resistors. **[4 marks]**

ii. For the circuit shown in **Fig.1**, determine the circuit equivalent resistance, $R_T$, the circuit current $I$, the voltages $v_1$, $v_2$ and $v_3$ and the power developed in the $R_3$. Take $R_1 = 3\ \Omega$, $R_2 = 3\ \Omega$ and $R_3 = 6\ \Omega$ and $V_s = 12$ V. **[5 marks]**

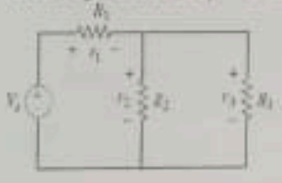

*Figure 1*

c) Define the terms magnetomotive force, Magnetic flux density, and Magnetic field strength, stating the units used in each case. **[3 marks]**

i. A coil of 100 turns is wound on a a circular magnetic former of 200 mm mean diameter. A current os 2.5 A is passed through the winding. Determine the electromagnetic force and the Magnetic field strength. **[3 marks]**

ii. State Faraday's law of electromagnetic induction. **[1 marks]**

A current of 10 A flows in a 750 turns-coil. Calculate the average e.m.f. induced in the coil when this current is reversed in 0.01 s. **[3 marks]**

## QUESTION TWO (20 Marks)

a) A copper rod, 0.4 m long and 4.0 mm in diameter, has a resistance of 550 μΩ at 20 °C.

i) Calculate the resistivity of copper at that temperature. **[2 marks]**

ii) If the rod is drawn out into a wire having a uniform diameter of 0.8 mm. Assume the resistivity to be unchanged and the temperature coefficient of resistance of copper to be 0.004 26/°C, calculate the resistance of the wire at 60 °C. **[4 marks]**

b) Define the capacitance of a parallel plate capacitor in terms of its physical features and in terms of voltage applied across the plates. **[2 marks]**

A ceramic capacitor has an effective plate area of 4 $cm^2$ separated by 0.1 mm of ceramic of relative permittivity 100. Calculate the capacitance of the capacitor in picofarads. If this capacitor is given a charge of 1.2 μC what will be the pd between the plates? The absolute permittivity as $8.85 \times 10^{-12}$ F/m **[6 marks]**

c) Capacitances of 3 μF, 6 μF and 12 μF are connected in series across a 350 V supply. Calculate (a) the equivalent circuit capacitance, (b) the charge on each capacitor and (c) the pd across each capacitor. **[6 marks]**

## QUESTION THREE (20 Marks)

a) Use the Superposition theorem to determine the direction and magnitude of the current through and the power developed in the 8 Ω resistor in figure 2a. Show the steps clearly. **[8 marks]**

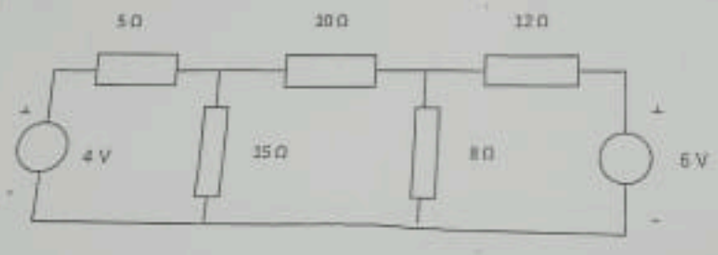


*Figure 2a*

**QUESTION FIVE [20 Marks]**

a) Explain, with the aid of diagrams, the term self-indutance. **[2 marks]**

A coil, wound with 50 turns, has a current of 10 A producing a flux of 210 μWb. Determine the inductance of the coil if the current is reversed and the emf induced when the current is reversed in 0.25 s. **[4 marks]**

b) A 15 Ω non-reactive resistor is connected in series with a coil of inductance 0.08 H and negligible resistance. The combined circuit is connected to a 240 V, 50 Hz supply. Calculate

i) The reactance of the coil and the impedance of the circuit **[4 marks]**

ii) The current in the circuit and the power factor of the circuit **[4 marks]**

iii) The active power absorbed by the circuit. **[2 marks]**

c) Draw the current and voltage waveforms and phasors for a series circuit made up of resistance, R, and inductance , L. **[4 marks]**.

b) A wheatstone bridge circuit is made up branches AB = 20 Ω, BD = 60 Ω, AC = 30 Ω, CD = 40 Ω. A load resistance of 10 Ω is to be connected between B and C, and an emf source of 12 volts is connected between A and D.

i) Draw the circuit [1 mark]
ii) Use Thevenin theorem to determine the voltage across BC. [6 marks]
iii) Derive the Norton circuit from the Thevenin equivalent. [2 marks]
iv) Determine the optimum value of the load resistor at BC that would ensure maximum power is delivered to this load, on the basis of Thevenin equivalent circuit, and what the magnitude of this power is. [3 marks]

**QUESTION FOUR (20 marks)**

a) A capacitor, 8 Farads, is connected in series with a resistor 0.5 M Ω to a voltage source of V volts through switch S. Draw the circuit and hence write down the expression for the voltage across the charging capacitor, any time after the switch S is turned on, assuming zero voltage at initial conditions. Hence determine [3 marks]

i. The circuit time constant. [2 marks]
ii. The time taken for the voltage across the capacitor to grow to 160 V after switch on. Take source voltage as 200 V. [4 marks]

b) An alternating voltage waveform is given as $v = 340\sin(314t + \varphi)$.

i. The amplitude of the waveform [1 mark]
ii. The frequency of the waveform [2 mark]
iii. The period of the waveform [1 mark]
iv. The r.m.s. value of the voltage [2 marks]
v. The time taken from $t = 0$ for the voltage to reach the value of 250 V for a first and a second time. [5 marks]