SECTION A: APPLIED SCIENCE

*Answer **ONE** question from this section.*

1. (a) State **four** types of optical instruments. (4 marks)

   (b) (i) Differentiate between 'compound' and 'mixture'.

   (ii) Explain **two** types of chemical bonds in the structure of Ammonium ion. (8 marks)

   (c) (i) Define the term 'pressure'.

   (ii) The level of water in a storage tank is 1.8 m. If the density of the water is 1.1 g/cm^3, determine the pressure at the bottom of the tank.
   (Take g = 10 N/kg and atmospheric pressure, P_{atm} = 100,500 N/m^2).
   (8 marks)

2. (a) (i) State **two** factors that contribute to loss of efficiency in a pulley system.

   (ii) A block and tackle system has a velocity ratio of 4 and an efficiency of 85%. The machine is used to lift a load of 1200 N.

   Determine the:

   (I) mechanical advantage;

   (II) effort applied.

   (8 marks)

   (b) With the aid of a labelled diagram, explain the term 'eletromagnetic spectrum'. (5 marks)

   (c) (i) Define the term 'heat capacity'.

   (ii) A cylindrical metal block of mass 0.5 kg is heated electrically by a 45 W heater for 10 minutes. The temperature of the metal block rises from 20 °C to 85 °C during this period. Determine its specific heat capacity. (7 marks)

SECTION B: ELECTRICAL PRINCIPLES

*Answer any **TWO** questions from this section.*

3. (a) State:

(i) **two** factors that affect the resistance of a conductor;

(ii) Kirchoff's laws

(6 marks)

(b) Figure 1 shows a d.c electric circuit. Using Kirchoff's laws, determine the branch currents. (10 marks)

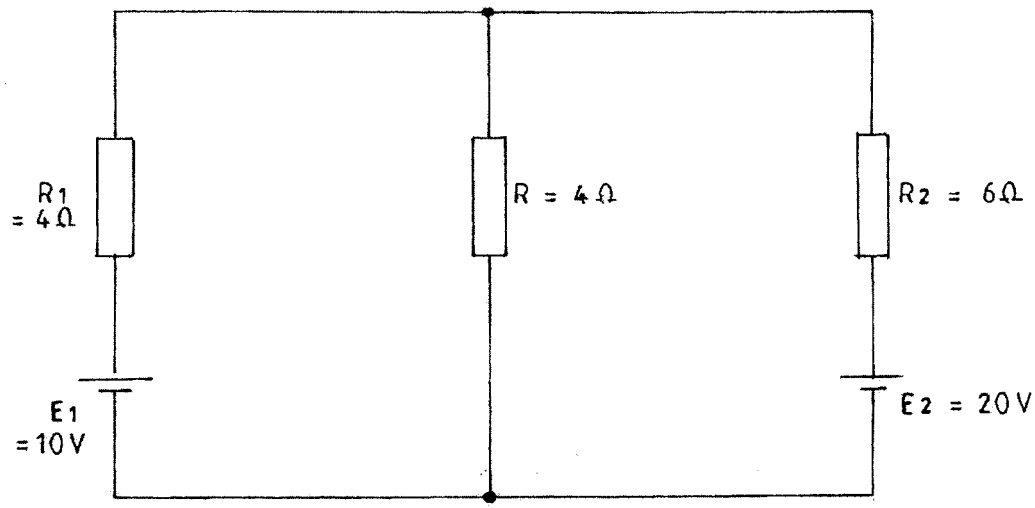

Fig. 1

(c) Explain the following terms as used in chemical cells:

(i) polarization;
(ii) local action. (4 marks)

4. (a) (i) Define the term 'farad' as used in electrostatics.

(ii) Figure 2 shows two capacitors connected in series. Show that the voltage across C_1 is given by $V_1 = V\left(\frac{C_2}{C_1 + C_2}\right)$ volts. (8 marks)

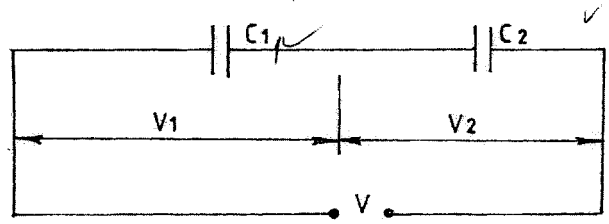

Fig. 2

(b) Figure 3 shows an electrical circuit. Determine the:

(i) total equivalent capacitance;
(ii) total charge;
(iii) voltage across capacitor C_3;
(iv) energy stored in capacitor C_2

(8 marks)

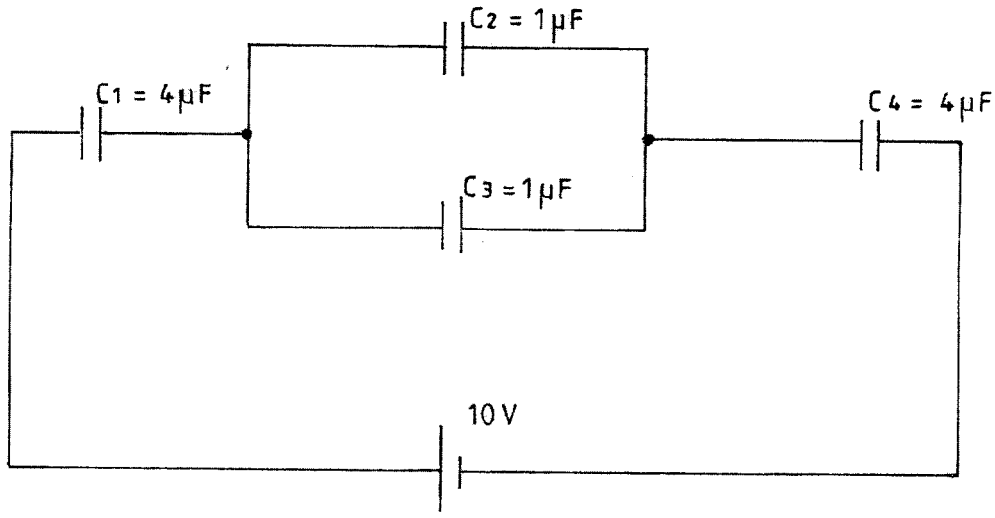

Fig. 3

(c) A two parallel plate capacitor has plates measuring 20 cm x 20 cm spaced 5 mm apart and carry a charge of 0.2 μC. The voltage between the plates is 250 V d.c. Determine the:

(i) electric flux density;
(ii) electric field strength.

(4 marks)

5. (a) State:

(i) Lenz's law;
(ii) four factors that determine the force acting on a current conductor in a magnetic field.

(6 marks)

(b) Figure 4 shows conductors carrying current in a magnetic system. Determine the:

(i) polarity of the magnets in figure 4(a);
(ii) direction of force on the conductor in figure 4(b) (4 marks)

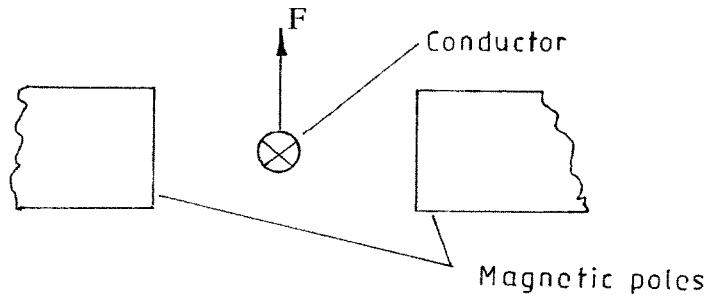

Fig. 4 (a)

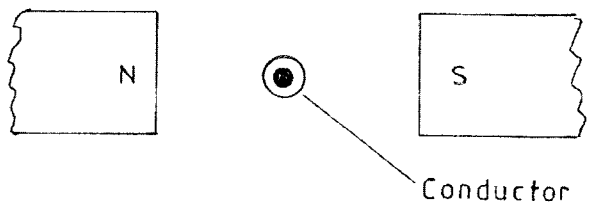

Fig. 4 (b)

(c) With the aid of diagrams, distinguish between a shell type and core type transformer. (4 marks)

(d) (i) Explain **two** types of iron losses in transformers.

(ii) A 400 kVA single phase transformer has a full-load copper loss of 2.5 kW and iron loss of 2 kW.
Determine the efficiency at full load and 0.85 power factor. (6 marks)

SECTION C: ELECTRONICS

*Answer any **TWO** questions from this section.*

6. (a) (i) State **three** classifications of materials.

(ii) Differentiate between intrinsic and extrinsic semiconductors. (7 marks)

(b) With aid of a diagram, explain the V/I characteristics of a P-N junction diode. (7 marks)

(c) (i) State **three** properties of an ideal operational amplifier.

(ii) With aid of a labelled diagram, show the connection of biasing voltages of a PNP transistor. (6 marks)

7. (a) (i) State the reason for the application of voltage regulators in d.c power supplies.

(ii) Sketch a block diagram of a stabilised d.c power supply.

(6 marks)

(b) Figure 5 shows a Zener diode stabilizer circuit. Determine the output voltage with no load current. (7 marks)

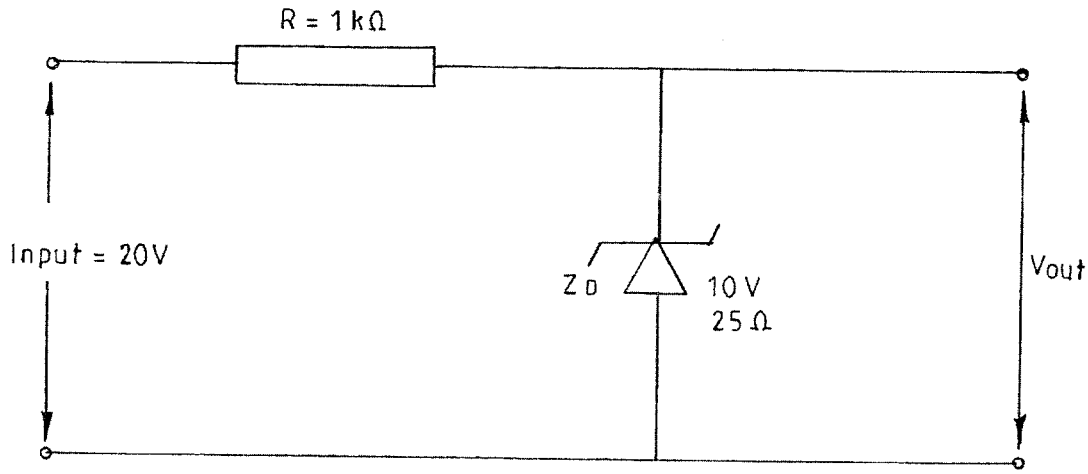

Fig. 5

(c) (i) State **three** advantages of negative feedback in amplifiers.

(ii) In a negative feedback amplifier, the gain A = 100, β = 0.05. Determine the gain with feedback.

(7 marks)

8. (a) Covert the hexadecimal number F8E6 to the corresponding decimal number.

(3 marks)

(b) State **three** types of logical families. (3 marks)

(c) With aid of a schematic diagram, explain the operation of a capacitive transducer.

(6 marks)

(d) (i) Draw clocked S-R flip-flop using NAND gates.

(ii) Write the truth table for the flip flop in d(i).

(8 marks)

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