## SECTION A

*Answer ALL questions in this section.*

1. (a) State the following laws as applied in D.C circuits:
   (i) Ohm's law;
   (ii) Kirchhoff's voltage law. (4 marks)

   (b) Show, with the aid of a circuit diagram, that the total resistance in a parallel circuit given by $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ (4 marks)

   (c) From the network shown in figure 1, use Kirchhoff's laws to determine the;
   (i) branch currents;
   (ii) power dissipated by $6\Omega$ resistor;
   (iii) energy consumed by $3\Omega$ resistor after 15 seconds. (12 marks)

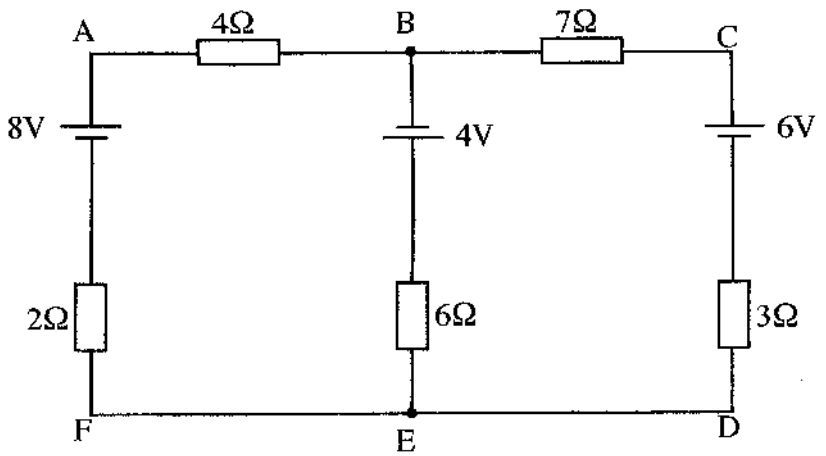



Figure 1

2. (a) Define the following terms as used in electrostatics.
   (i) relative permittivity;
   (ii) electric field strength. (4 marks)

   (b) An electrical circuit has two capacitors of $8\mu$F and $14\mu$F connected in parallel. Another capacitor of $16\mu$F is in series with the parallel section. The series-parallel combination is connected across a terminal voltage of 240V. Determine the:
   (i) total capacitance;
   (ii) p.d. across each capacitor;
   (iii) charge stored by each capacitor;
   (iv) energy stored by $16\mu$F capacitor. (10 marks)

(c) The resistance of a copper coil is 300 Ohms at $20^0$C. The room temperature increases and the resistance of the coil rises to 375 Ohms. If the temperature coefficient of resistance of copper is 0.04°C at 20°C, determine the temperature to which the coil has risen. (6 marks)

3. (a) State **three** types of transistor configurations. (3 marks)

(b) With the aid of energy band theory sketches, state the difference between the following terms:
(i) insulators;
(ii) conductors;
(iii) semi-conductors. (6 marks)

(c) With the aid of a diagram, explain the construction and operation of a photodiode. (5 marks)

(d) Simply the following boolean equation by using a Karnaugh map.
$F = \overline{A}B\overline{C}D + \overline{A}BCD + ABCD + B\overline{C}\,\overline{D}$ (6 marks)

4. (a) (i) State the law of conservation of energy. (2 marks)

(ii) Distinguish between:

(a) Renewable and non-renewable energy.
(b) Elastic and gravitational potential energy. (8 marks)

(b) Explain how each of the following natural sources of energy are harvested to produce electrical energy.

(i) sun
(ii) wind
(iii) high dam (3 marks)

(c) A body of mass 3.5Kg is pulled from rest by a horizontal force of 10.5N for 3 seconds calculate.

(i) the distance covered by the body.
(ii) the Kinetic energy gained by the body (ignore friction). (7 marks)

## SECTION B

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

5. (a) Define the term transducer. (2 marks)

(b) With the aid of a circuit diagram, explain the operation of a full-wave bridge rectifier. (7 marks)

(c) State any **three** types of feedback connections as applied to amplifiers. (3 marks)

(d) (i) Perform the following binary arithmetics.

(I) $\begin{array}{r} 110 \\ +011 \\ \hline \end{array}$ (II) $\begin{array}{r} 111 \\ \times\ 10 \\ \hline \end{array}$

(ii) Convert the following numbers as instructed.

(I) $431_{10}$ to excess 3 code.
(II) $11011_2$ to gray code. (8 marks)

6. (a) Draw the equivalent logic gates symbols for the symbols shown in figure 2 (a) and (b).

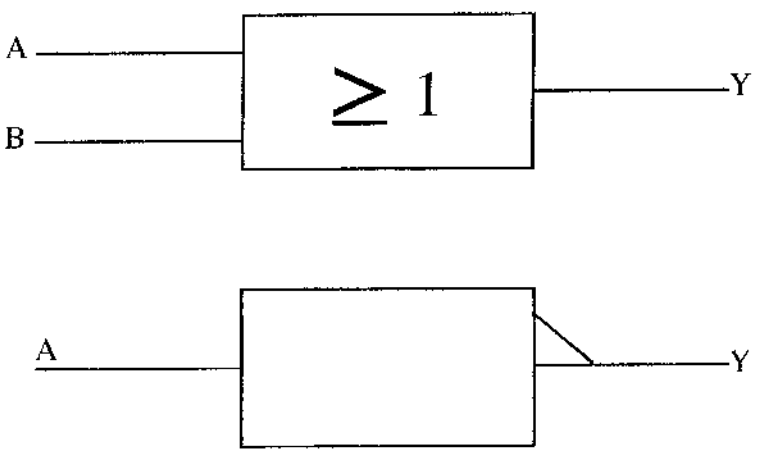


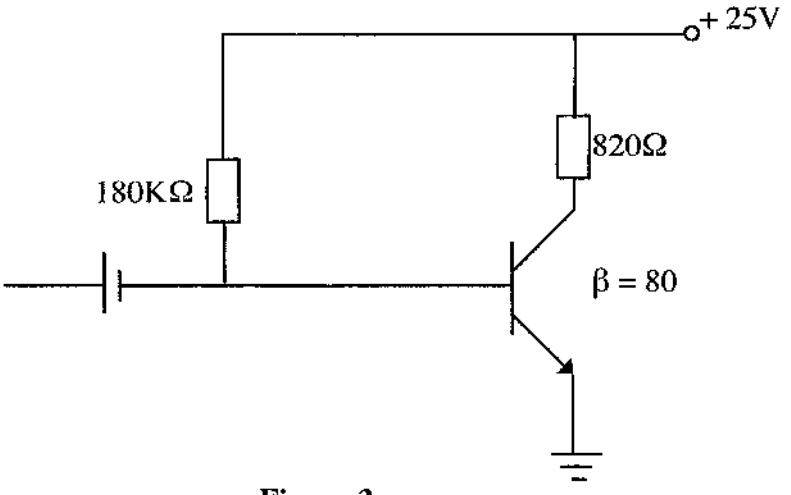

**Figure 2** (2 marks)

(b) Draw a logical circuit diagram of a SR flip-flop using NOR gates and explain its operation. (6 marks)

(c) (i) Explain with the aid of a circuit diagram, the operation of an LC low pass filter. (6 marks)

(ii) From the circuit shown in figure 3, calculate:

I. Base current.
II. Collector current.
III. Collector emitter voltage.




(6 marks)

**Figure 3**

7. (a) Define the following terms as used in magnetic circuits.
(i) magnetomotive force.
(ii) Reluctance. (4 marks)

(b) A mild steel close magnetic circuit has a mean length of 50mm and a cross-sectional area of 420mm$^2$. A current of 0.6A flows in a coil wound uniformly around the circuit, where the flux of 300 $\mu$Wb is produced. If the relative permeability steel is 400, Calculate the:

(i) Reluctance of the coil.
(ii) Number of turns of the coil.
(iii) Flux density. (8 marks)

(c) A single phase transformer has 3000 turns on the primary side and 1200 turns on the secondary side. Its no-load current is 6A at a power factor of 0.25 lagging, while the secondary current is 90 A at a power factor of 0.88 lagging.
Determine the primary current and the power factor. (8 marks)

8. (a) (i) State any **two** modes of heat transfer.

(ii) Define the term specific latent heat of vaporisation. (4 marks)

(b) (i) Outline any **four** properties of electro-magnetic waves.

(ii) An X-ray machine produces radiation of wavelength $1.0 \times 10^{-11}$M. Calculate

I. the frequency of its radiation.

II. its energy content if the planks constant is equal to $6.63 \times 10^{-34}$Js

(8 marks)

(c) The mass of a copper calorimeter and stirrer is 60g. It is filled with 100g of water at a room temperature of 25°C. Steam is passed until the temperature of the water reaches 45°. When the calorimeter is reweighed, its mass is 163.5g.
Calculate the specific latent heat of vaporisation of water.
(Specific heat capacity of copper is 400J/kg°C and that of water is 4200J/kg°C).

(8 marks)