THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING
(POWER OPTION)
(TELECOMMUNICATION OPTION)
(INSTRUMENTATION OPTION)

MODULE II

ENGINEERING DRAWING AND CIRCUIT ANALYSIS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
  Answer booklet;
  Mathematical tables/Non-programmable scientific calculator;
  Drawing instruments;
  Drawing paper size A2;
  Computer installed with Auto CAD, electronic CAD software and printer.
*This paper consists of **EIGHT** questions in **TWO** sections; A and B.*
*Answer any **THREE** questions from section A and any **TWO** questions from section B in the answer booklet and drawing papers provided.*
All questions carry equal marks.
Maximum marks for each part of a question are as indicated.
All drawing dimensions are in mm.
Candidates should answer the questions in English.

This paper consists of 6 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

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SECTION A: CIRCUIT ANALYSIS

Answer any THREE questions from this section.

1. (a) Define 'Harmonics' as used in complex waveforms.

   (1 mark)

   (b) A complex wave of r.m.s value 240 V has 22% third harmonic and 5% fifth harmonic content. Determine the r.m.s values of:

   (i) fundamental wave;
   (ii) third and fifth harmonics.

   (7 marks)

   (c) (i) Describe a 'Two-Port Network'.
   (ii) List **three** examples of Two-Port networks.
   (iii) **Figure 1** represents a passive Two-Port network which gives rise to input impedance equal to load impedance Z_o. Show that the input impedance:

   $$\frac{V_1}{I_1} = Z_s = [Z_1(Z_1 + 2Z_2)]^{\frac{1}{2}}$$
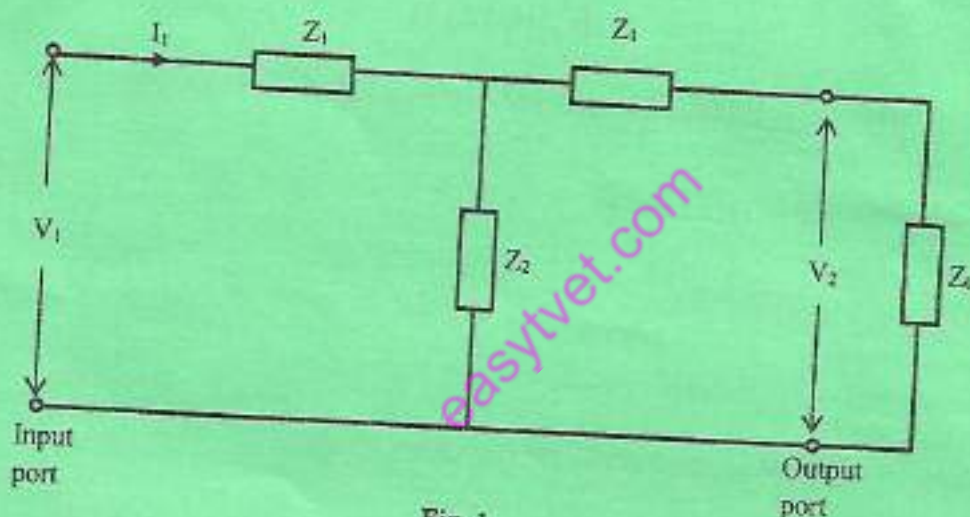
   (12 marks)

Fig. 1

2. (a) (i) State **two** advantages of three phase systems over single phase systems.
   (ii) Explain each of the following as used in three phase systems:

   I. phase sequence;
   II. double subscript notation V_{gy}.

   (4 marks)

   (b) A balanced three-phase delta connected load has per phase impedance of $(25 + j40)\,\Omega$. If 400 V, three phase supply is connected to the load, determine the:

   (i) phase current;
   (ii) line current;
   (iii) power factor;
   (iv) power supplied to the load.

   (8 marks)

(c) (i) State **two** properties of an ideal transformer.

(ii) Explain the need for carrying out a short circuit test on a three phase transformer.

(iii) Draw the circuit diagram for the test in (c)(ii). (8 marks)

3. (a) (i) State **two** advantages of three phase induction motors.

(ii) Sketch the power flow stages for a three phase induction motor, indicating the power losses in each stage. (10 marks)

(b) (i) Explain the need for a starter in a three phase induction motor.

(ii) List any **two** methods of starting a three phase induction motor. (4 marks)

(c) (i) Sketch the equivalent circuit diagram of a capacitor start, capacitor run single phase induction motor.

(ii) List **two** types of single phase synchronous motors. (6 marks)

4. (a) (i) Explain the reason why a three phase synchronous motor is supplied with both A.C and D.C voltages.

(ii) A 1200 kW load at 0.6 p.f lagging is connected across a three phase synchronous motor. If the power factor of the load is improved to unity, determine the kVAr rating of the motor. (6 marks)

(b) (i) Draw a labelled diagram of the pony motor method of starting a three phase synchronous motor.

(ii) State **two** applications of the motor in (b)(i). (7 marks)

(c) **Figure 2** shows a series R -C circuit. Derive an expression for the supply voltage E at any time during charging of the capacitor. (7 marks)
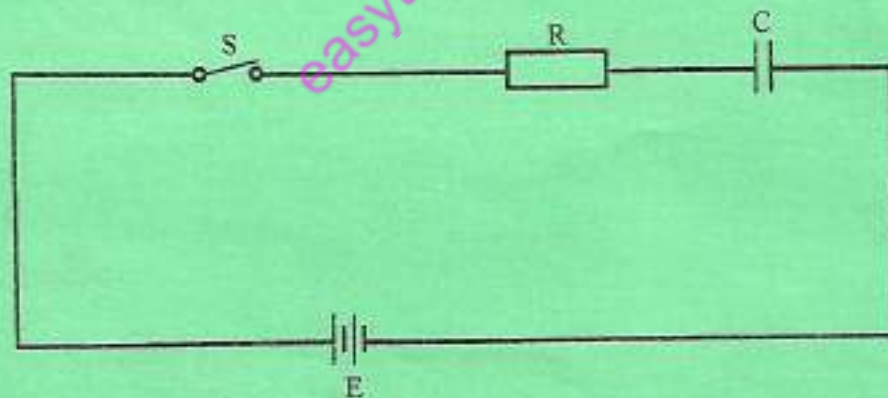

Fig. 2

5. (a) (i) Distinguish between an amplidyne and a metadyne machine.

(ii) Explain the function of each of the following parts of a d.c motor:

I. stator poles;
II. rotor. (4 marks)

(b) (i)   State **two** effects of armature reaction in d.c generators.
     (ii) With the aid of diagrams, explain the process of commutation in d.c generators.

(8 marks)

(c) (i)   Draw a labelled diagram of a three point starter for a d.c shunt motor.
     (ii) State **two** applications of d.c compound motors.   (8 marks)

SECTION B: ENGINEERING DRAWING

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

6. (a) Construct a regular pentagon in a circle of diameter 120 mm.   (6 marks)

    (b) **Figure 3** shows three points A, B and C.

Fig. 3

Construct a circle to pass through the three given points.   (6 marks)

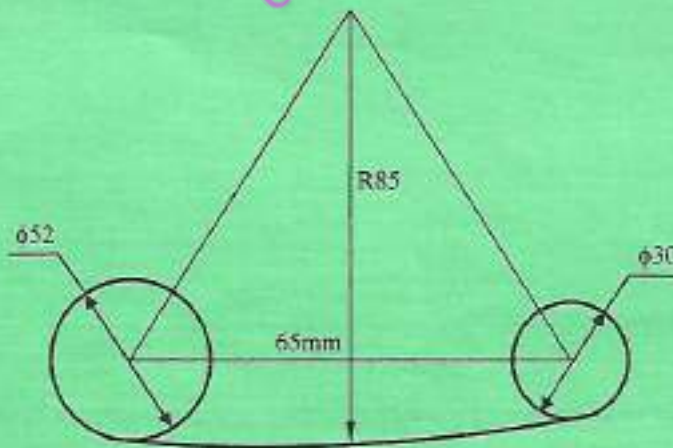   (c) **Figure 4** shows two circles blending with an arc.

Fig. 4

Draw the profile clearly showing the centre of the arc.   (8 marks)

7. (a) Draw a ladder diagram for a forward-reverse three phase motor starter. (10 marks)

(b) Sketch the following BS3939 symbols:

    (i)   switched socket outlet;
    (ii)   one gang two way switch;
    (iii)   push button;
    (iv)   motor;
    (v)   inductor.   (5 marks)
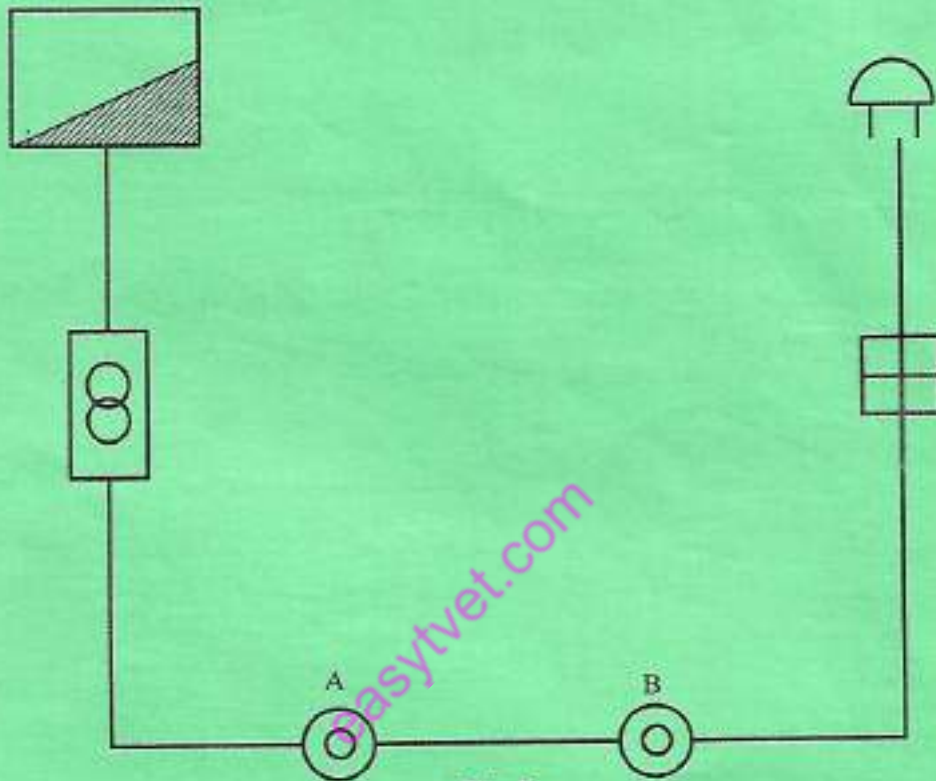
(c) **Figure 5** shows a bell circuit.

Fig. 5

Draw the wiring diagram such that push buttons A and B controls the bell independently via a relay. (5 marks)

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8.   (a)   **Figure 6** shows an electronics circuit.
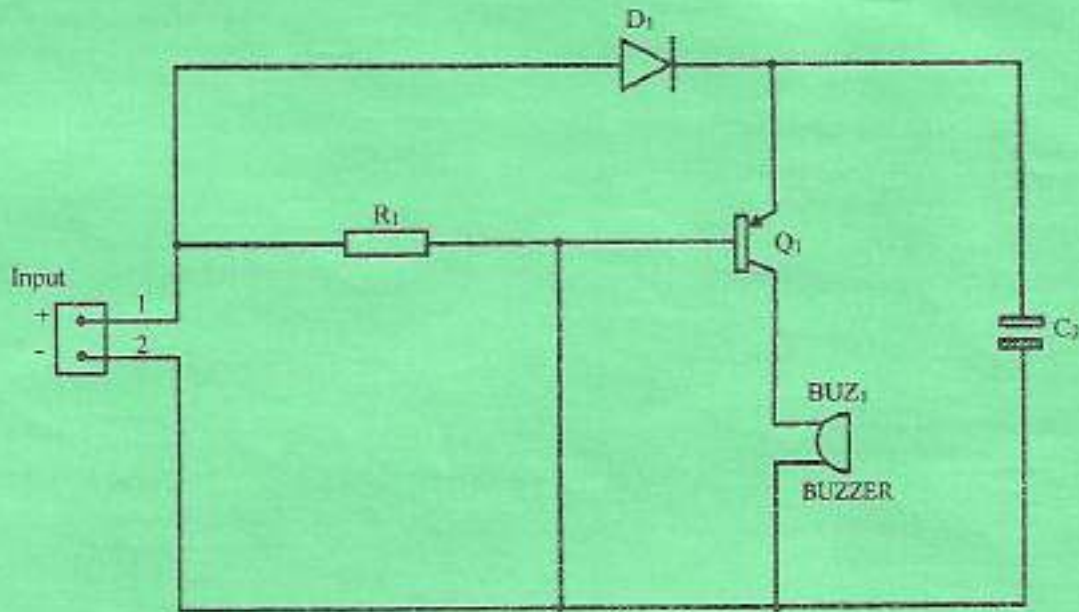

Fig. 6

(i)   Using an appropriate computer software, design the printed circuit board layout (PCB).

(ii)   Print and hand over the hard copy.   (10 marks)

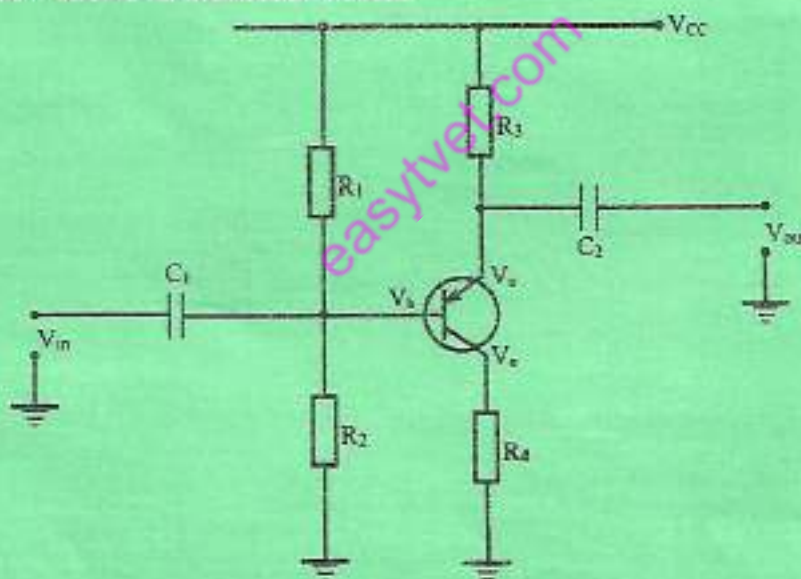(b)   **Figure 7** shows an electronic circuit.

Fig. 7

(i)   Using an appropriate computer software, draw the circuit.

(ii)   Print and hand over the hard copy.   (10 marks)

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