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 each of the following as used in A.C circuits:

   (i)   Q-factor;
   (ii) selectivity.   (4 marks)

   (b) (i)   Show that the resonant frequency of an A.C series connected R - L - C circuit is given by:
   $$f_r = \frac{1}{2\pi\sqrt{LC}}$$

   (ii) Sketch the phasor diagram for (b)(i).   (6 marks)

   (c) **Figure 1** shows a D.C circuit in which the capacitor C is to be charged through resistor R.
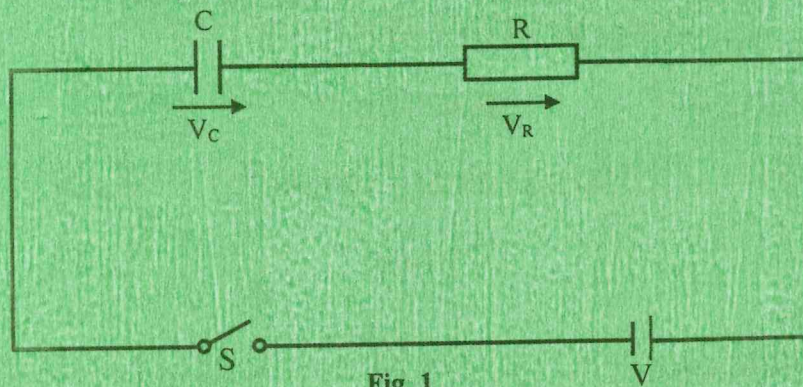

Fig. 1

When the switch is closed, draw the curves for:

   (i)   capacitor voltage transient;
   (ii) resistance voltage transient.   (6 marks)
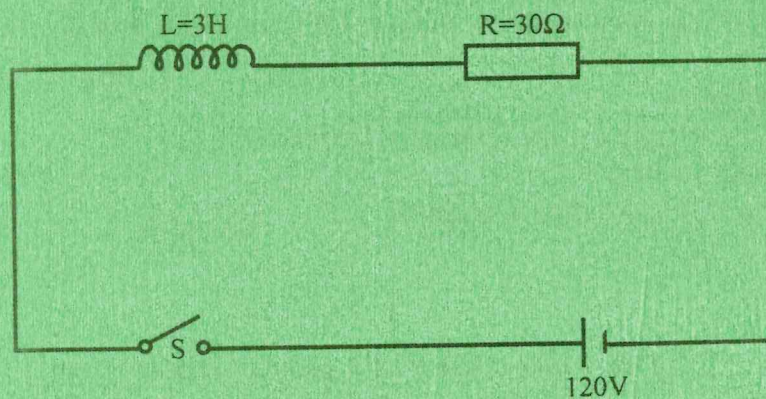
   (d) **Figure 2** shows a series L-R D.C circuit.

Fig. 2

When the switch is closed, determine the:

    (i)   steady state value of current flowing in the coil;

    (ii)   time constant of the circuit;

    (iii)   value of induced e.m.f after 0.1 sec.   (4 marks)

2.   (a)   Distinguish between wave winding and lap winding in relation to D.C machines.

                                                                 (4 marks)

    (b)   Draw schematic diagram of each of the following D.C machines:

        (i)   separately excited D.C generator;

        (ii)   shunt motor;

        (iii)   long shunt compound motor.   (6 marks)

    (c)   A 120 V D.C shunt motor takes a current of 40 A and runs at 1000 rev/min. The iron, friction and windage losses amount to 1000 W. The shunt field resistance is $30\,\Omega$ and armature resistance is $0.2\,\Omega$.

        (i)   Determine the:

              I.   field current;

              II.   armature current;

              III.   efficiency of the motor.

        (ii)   Sketch the speed / armature current characteristics of the D.C shunt motor.

                                                                 (10 marks)

3.   (a)   State **two** reasons for having skewed rotor slots.   (2 marks)

    (b)   With the aid of a diagram, explain the production of torque in a three phase induction motor.   (8 marks)

    (c)   A three phase induction motor is supplied from a 50 Hz A.C supply and runs at 1500 rev/min. If the slip and the rotor copper losses are 4% and 0.25 kW respectively, determine the:

        (i)   synchronous speed:

        (ii)   power input to the rotor   (6 marks)

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(d)   Draw schematic diagrams of each of the following two port networks:

    (i)   Π - network;

    (ii)   T - network.   (4 marks)

4.   (a)   State the relationship between line and phase values of voltages and current in three phase delta connected loads.   (2 marks)

    (b)   (i)   Draw a labelled schematic diagram of three wattmeter method used to measure power in a three phase 4-wire system.

        (ii)   Two wattmeters connected to measure the input power to a 3-phase balanced load indicate 10 kW and 6 kW respectively. Determine the:

            I.   total power;

            II.   load power factor.   (11 marks)

    (c)   Explain the reason why a synchronous motor is not self starting.   (3 marks)

    (d)   Draw a labelled schematic diagram of a 'lamps dark method' of synchronizing a 3-phase machine to an existing three phase supply.   (4 marks)

5.   (a)   (i)   Define 'form factor' of a complex waveform.

        (ii)   A current waveform represented by:

$$i = 10\sin \omega t + 20\sin\left(3\omega t + \frac{\pi}{6}\right) + 5\sin\left(s\omega + \frac{2\pi}{3}\right)$$

        Determine the r.m.s value of the current.   (4 marks)

    (b)   Draw a labelled diagram of a capacitor start induction motor.   (5 marks)

    (c)   (i)   List **two** types of three phase transformer construction.

        (ii)   A three phase star, delta connected transformer has 400 primary windings and 40 secondary windings if the supply voltage is 11 kV, determine the:

            I.   primary phase voltage;

            II.   secondary phase voltage.   (7 marks)

    (d)   (i)   Define 'step angle' with reference to stepper motors.

        (ii)   A stepper motor has a step angle of 2.5°. Determine:

            I.   resolution;

            II.   number of steps required to make 20 revolutions.   (4 marks)

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SECTION B: ENGINEERING DRAWING

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

6. (a) **Figure 3** shows a layout of an electric circuit.
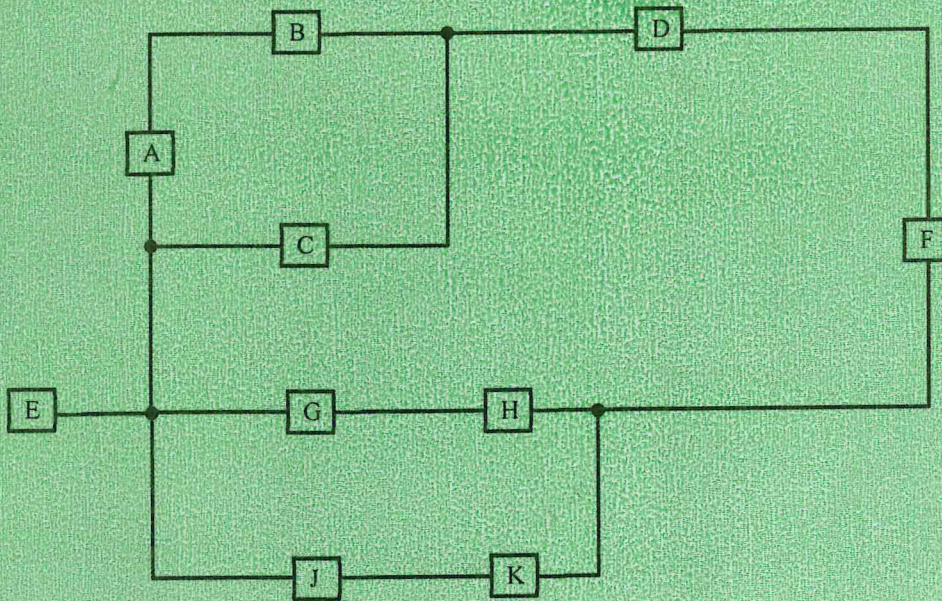
Fig. 3

Using electrical symbols, redraw the circuit with the following electrical components in lettered positions:

A   —   Ammeter;
B   —   Battery;
C   —   Voltmeter;
D   —   Switch;
E   —   Earthing;
F   —   Variable resistor;
G   —   Resistor;
H   —   LED;
J   —   Bell;
K   —   Bulb.

(10 marks)

(b) Draw the following electronic symbols:

(i)   NAND gate;
(ii)   variable inductor;
(iii) thyristor;
(iv)   tunnel diode;
(v)   thermistor.

(5 marks)

(c) Draw a direct-on-line starter control circuit diagram with run and stop indicator lamps.

(5 marks)

7. **Figure 4** shows an electronic circuit.
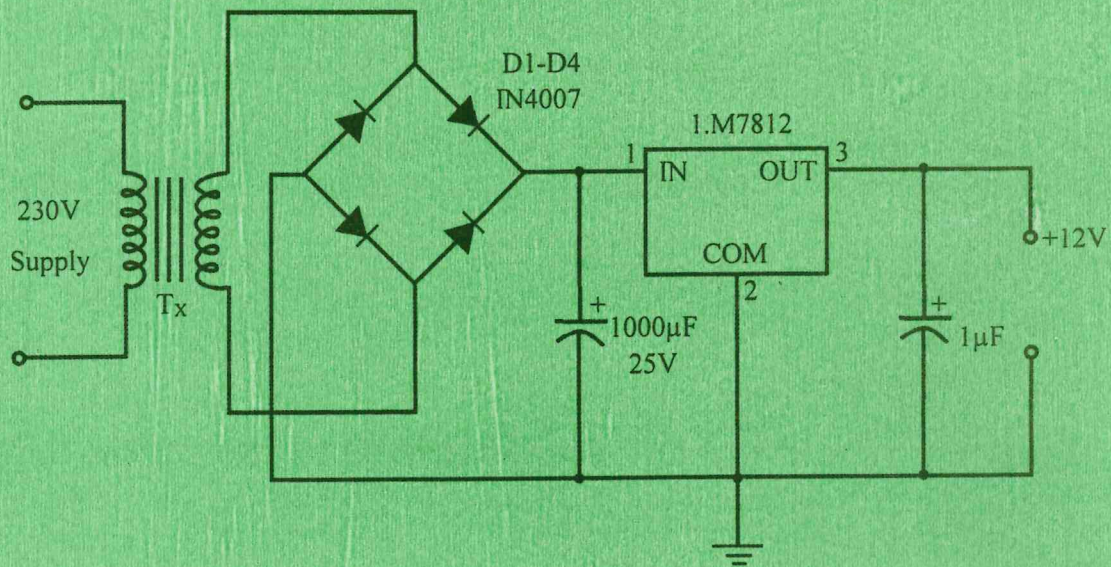

Fig. 4

(a) Using an appropriate computer software copy the circuit;

(b) Generate a printed circuit board (PCB) layout for the circuit (a).

Print and hand over the hard copy of (a) and (b). (20 marks)

8. (a) Circumscribe a circle in a triangle ABC given:

AB = 68 mm
BC = 53 mm
CD = 65 mm (6 marks)

(b) Construct a common internal tangent of two equal circles of diameters each 50 mm and with their centres 95 mm apart. (7 marks)

(c) Draw a regular hexagon given the length of one side as 60 mm. (7 marks)

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