THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL
CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

082 **ELECTRICAL ENGINEERING SCIENCE**

(For Both School and Private Candidates)

Time: 3Hours **Monday, 07th November 2016 p.m.**

Instructions

1. This paper consists of sections A, B and C.
2. Answer **all** the questions in sections A and B and **three (3)** questions from section C.
3. Cellular phones are **not** allowed in the examination room.
4. Non programmable calculators may be used.
5. Write your **Examination Number** on every page of your answer booklet(s).
6. Where necessary use the following constants.

   Permittivity of free space, $\mu_o = 4\pi \times 10^{-7}\left(H/m\right)$.

   Resistivity of copper may be taken as 17.5μΩ.mm.

   Specific heat capacity of water is 4.18 kJ/kgK.

   Form factor is 1.11

   1 Faraday = 96,500 coulombs.

   1 hp = 746 Watts.

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SECTION A (10 Marks)

Answer **all** questions in this section.

1. For each of items (i) – (x), choose the correct answer from among the given alternatives and write its letter beside the item number in the answer booklet provided.

(i) An atom is said to be electrically neutral if

A it loses electrons
B neutrons are positively charged
C it gains more electrons than protons
D electrons are negatively charged
E the number of protons and electrons are equal.

(ii) Which of the following electrical quantities explains the relationship according to Ohm's law in a closed electrical circuit?

A voltage, power and current
B current, voltage and resistance
C resistance, energy and current
D power, energy and kilowatt hour
E current, power and energy.

(iii) What is the purpose of a commutator in a d.c generator?

A To reduce sparking at brushes
B To convert the induced a.c into d.c
C To increase output voltage
D To provide smoother output
E To induce Voltage in brushes.

(iv) What is the relationship between voltage and current when an alternating voltage is applied across a pure resistance?

A Voltage is out of phase.
B Current is leading voltage by 90°
C Voltage is leading current by 90°.
D Voltage is in phase with current.
E Angle between voltage and current is 90°.

(v) What type of cooling is used in high current rectifiers?

A Natural cooling system.
B Forced air cooling system.
C Heat sink cooling system.
D Oil cooling system.

(vi) Which of the following can be connected in a circuit in order to extend range of a voltmeter?

A A parallel resistor
B A shunt resistor
C A fuse link
D A series resistor
E A parallel resistor of high value.

(vii) The correct formula for converting Fahrenheit to Centigrade is:

A $(F-32)\times 5/9$
B $(F+32)\times 9/5$
C $(F-32)\times 9/5$
D $(F\times 9/5)+32$
E $(F\times 5/9)+32$.

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(viii) The cathode ray tube consists of two sets of deflection coils known as

A scanning coils B focusing coils C electrostatic coils
D brightness coils E reflection coils.

(ix) Which of the following is the correct definition of the current density of a conductor?

A The temperature of the air surrounding the conductor.
B A factor which takes into consideration the type of a metal.
C The increase in the resistance of a 1 Ω resistor of a material when subjected to a rise in temperature of 1^0C.
D The amount of current which the conductor can carry safely without excessive heating per unit cross-section area.
E The current carrying capacity of the conductor.

(x) What will happen if the cross-sectional area of a conductor is doubled?

A The length of that conductor will be halved.
B The resistivity of that conductor will be halved.
C The resistance of that conductor will be halved.
D Resistivity of the conductor will be doubled.
E The length of the conductor will be doubled.

SECTION B (30 Marks)

Answer **all** questions in this section.

2. (a) State the laws of electrostatic charges.
   (b) Name the two particles of an atom and state their electrical charges.

3. Define the following terms as applied in electrical heating:
   (a) Quantity of heat.
   (b) Temperature.
   (c) Specific heat capacity.

4. (a) Define the term "grounding" as applied in electrical equipment.
   (b) Briefly explain the difference between constant current system and constant voltage system as used in charging systems of secondary cells.

5. A 2-core copper cable supplies current to a 240 V single phase load of 18 kW at 0.78 power factor. The cable is 40 m long and each conductor has a cross-sectional area of 35 mm^2. Calculate;
   (a) Load current
   (b) Conductor resistance.

6. (a) Define the term ''armature reaction'' as used in d.c machines.
   (b) Give two disadvantages of armature reaction on d.c machines.

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7. If the equation of an alternating current flowing through a certain circuit is given by $i = 50 \sin 628t$, Determine the
   (a) maximum value of current
   (b) frequency.

8. Briefly describe three major parts of cathode ray tube.

9. Two cells each 1.5 V e.m.f and internal resistances of 1 Ω are connected in series to a load of 3 Ω. Calculate the load current.

10. Study Figure 1 carefully, then find the branches current and total current.

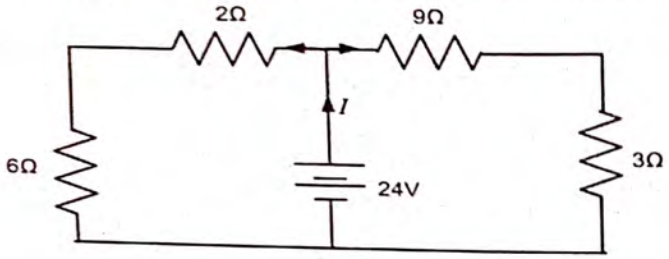

Figure 1

11. The magnetic flux in the core of an electromagnetic is 1.5 mW. The flux density in the core is 0.75 T. If the cross sectional area of the magnetic core is square, find the length of one side.

SECTION C (60 Marks)

Answer **three (3)** questions from this section.

12. (a) Briefly describe four differences between magnetic and electric circuits. **(04 marks)**
   (b) A wooden ring of mean length 200 m and cross-section area of 5 cm^2 has a coil A of 1500 turns wound over it. A second coil B of 3000 turns is closely wound over the first coil. Take coefficient of coupling and relative permeability for vacuums as unity. Calculate;
   (i) the self-inductance of coils A and B
   (ii) the mutual inductance if the coils are closely coupled
   (iii) the total inductances of the arrangement if the coils are connected in series
   (iv) the total energy stored in the ring if current flowing is 10 A. **(16 marks)**

13. (a) Define the following terms as used in d.c generator: **(04 marks)**
   (i) Conductor
   (ii) Coil
   (iii) Turns
   (iv) Single layer winding.

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(b) (i) An 8-pole, d.c generator has 320 conductors and its flux and speed are such that the average e.m.f generated in each conductor is 2 V. The current in each conductor is 100 A. Find the total current and generated e.m.f, when the winding is lap connected and when it is wave connected.

(ii) Find the total power generated in each case. **(10 marks)**

(c) A circuit of shunt generator shown in Figure 2 has no load induced e.m.f of 150 V and when it is loaded, the terminal voltage decreases to 140 V. The armature resistance and field resistances are 0.2 Ω and 100 Ω respectively. Find the load current. **(06 marks)**

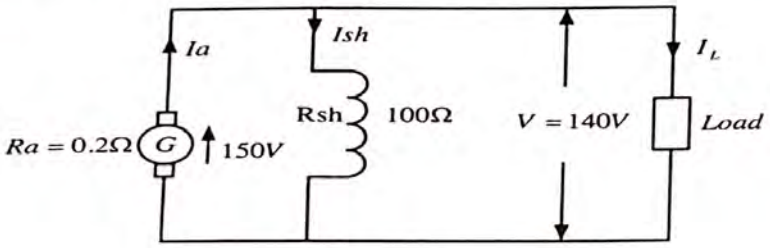

Figure 2

14. (a) Two metal filament lamps, with luminous intensities of 150 cd and 300 cd are fixed 10 m apart on a level bench. A double sided matt with screen is placed on the line between the lamps so that each side directly faces one lamp. The screen is positioned so that both sides of the screen are equally illuminated. With the aid of a simple diagram, calculate;

(i) The distance between the screen and the large lamp.

(ii) The illumination on each side of the screen if it were positioned half way between the lamps. **(10 marks)**

(b) A drawing office containing a number of boards and having a total effective area of $70m^2$ is lighted by a number of 40W incandescent lamps giving $11\,lm/W$. An illumination of 80lux is required on the drawing boards. Assuming that 60% of the total light emitted by the lamps is available for illuminating the drawing boards, estimate the number of lamps required. **(10 marks)**

15. A current of 5 A flows through a non-inductive resistance in series with a choking coil when supplied at 250 V, 50 Hz. If the voltage across the resistance is 125 V and across the coil is 200 V; with the help of a vector diagram, calculate

(a) Impedance.

(b) Resistance of the coil.

(c) Reactance.

(d) The power absorbed by the coil.

(e) The total power. **(20 marks)**

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16. (a) A battery of 60 cells is charged from a supply of 250 V. Each cell has an e.m.f of 2 V at the start of charge and 2.5 at the end. If the internal resistance of each cell is 0.1 Ω and if there is an external resistance of 19 Ω in the circuit. Calculate: **(14 marks)**

(i) initial charging current.

(ii) final charging current.

(iii) additional resistance which must be added to give a finishing charge of 2A rate.

(b) A storage cell is charged at 5 A for 3.5 hours. If it is discharged through resistance R Ohms for a duration of 12 hours, the terminal voltage being 12 V and the ampere-hour efficiency of the cell is 85%. Calculate the value of resistance R. **(06 marks)**

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