THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

181 ELECTRICAL INSTALLATION

(For Both School and Private Candidates)

Time: 3 Hours **ANSWERS** **Year: 2004**

Instructions

1. This paper consists of SIXTEEN questions.

2. Answer all questions in section A and B and THREE questions from section C.

(i) A victim of an electrical shock may be given first aid by ---------- method(s):
C. Kiss of life and Faraday's
Correct answer: This method includes both artificial respiration and cardiac massage which are essential in resuscitating a shock victim.

(ii) A flexible cord is a flexible cable in which the cross-sectional area of each conductor does not exceed ---------- mm^2:
C. 2.5
Correct answer: According to wiring standards, flexible cords used for portable appliances usually do not exceed 2.5 mm^2 per conductor.

(iii) The purpose of a chart circuit found inside the distribution board is to provide information about:
B. Type of circuit protective device and earthing facility
Correct answer: Distribution board charts are used to label the protective devices and details of earthing for easy identification during maintenance or emergency.

(iv) A double-wound transformer has 240 volts in primary side which consists of 2400 turns with 120 V in secondary. What is the transformer ratio?
A. 2 : 1
Correct answer: Ratio = Vp/Vs = 240/120 = 2:1

(v) Which one of the following power stations generates electrical power by waterfalls?
B. Hydroelectric
Correct answer: Hydroelectric power plants use falling water to rotate turbines and generate electricity.

(vi) The purpose of adding salt and charcoal around the earth electrode in a dry land is to:
A. Decrease the conductivity of earthing
Correct answer: Salt and charcoal improve the soil conductivity, which enhances the effectiveness of the earth electrode.

(vii) The stationary part of an induction motor is called:
A. Stator
Correct answer: The stator is the stationary part of the motor that produces a rotating magnetic field to induce current in the rotor.

(viii) The ratio of minimum breaking current to current rating is known as:
A. Fusing factor
Correct answer: The fusing factor is the ratio of minimum fusing current to the rated current of the fuse.

(ix) For a new and completed electrical installation, its minimum insulation resistance allowed, must not be less than:
E. 1.5 MΩ

Correct answer: Standards specify a minimum insulation resistance of 1.5 MΩ to ensure safety and insulation integrity in new installations.

(x) In a room where fluorescent lamps are installed near a rotating machine, the machine might appear to be stationary. This is due to:
C. Stroboscopic effect
Correct answer: The stroboscopic effect is an optical illusion caused by flickering lights, especially from fluorescent lamps, making rotating objects appear stationary.

2. Distinguish between the following switch gears:
(a) Switch fuse
A switch fuse is a device that combines a switch and a fuse in a single unit, where the fuse provides protection and the switch allows manual disconnection of the circuit. It ensures protection and control in one mechanism.

(b) Fused switch
A fused switch is a switch that contains a fuse within the switch housing, often with the fuse being integral to the switch operation. It functions more like a switch that has fuse protection as part of its switching mechanism.

3. State two (2) tests performed in a transformer in order to determine its losses.
Open circuit test is used to determine the core (iron) losses of a transformer, as it measures the power loss when the transformer operates without a load.

Short circuit test is conducted to determine the copper losses of the transformer by applying a reduced voltage to the short-circuited secondary winding.

4. How many switches and which type must be used to control lights from two different positions?
Two two-way switches are required to control a light from two different positions. These switches allow the current path to be altered depending on the position of each switch.

5. How can you reverse the direction of a rotation of a D.C. series motor?
The direction of rotation of a D.C. series motor can be reversed by reversing either the field winding connections or the armature winding connections, but not both.

6. State three (3) ways of transferring heat energy.
Conduction is the transfer of heat through direct contact between molecules, typically occurring in solids.

Convection is the transfer of heat through the movement of fluids such as liquids and gases due to differences in temperature and density.

Radiation is the transfer of heat in the form of electromagnetic waves without the need for a medium.

7. State two (2) types of starters commonly used by the discharge lamps.
Glow starter is commonly used in fluorescent lamps to preheat the filaments before the arc is struck.

Electronic starter provides a more reliable and faster start by using electronic circuits to preheat and initiate the discharge process.

8. Outline three (3) methods of improving a low power factor in a factory.
Installing capacitors helps to compensate for inductive loads by providing leading reactive power, thus improving power factor.

Using synchronous condensers, which are overexcited synchronous motors, can improve power factor by supplying reactive power.

Optimizing load operation by avoiding underloading of machines and operating motors near their rated capacity also helps improve power factor.

9. Outline two (2) types of instrument transformers.
Current Transformer (CT) is used to step down high current to a lower measurable current for metering and protection systems.

Potential Transformer (PT) steps down high voltage to a lower value suitable for standard voltage measuring instruments.

10. Calculate the synchronous speed of a 6-pole motor if the supply frequency is 50 Hz.
Synchronous speed $N_s = (120 \times f) / P = (120 \times 50) / 6 = 60000 / 6 = 1000$ rpm

11. The resistance of a conductor is determined by various factors including the nature of its material (resistivity). What are the other factors?
Length of the conductor affects resistance directly; the longer the conductor, the higher the resistance.

Cross-sectional area affects resistance inversely; the larger the area, the lower the resistance.

Temperature affects resistance in most conductors; as temperature increases, resistance increases due to increased atomic vibration.

12. A 240 V electric furnace is used to raise the temperature of a 3.6 kg of brass from 16°C to annealing temperature of 593°C in a time of 25 minutes at an overall efficiency of 78 percent. The specific heat capacity of brass may be taken as 377 J/kg K. Calculate the:
(a) Energy used.
$\Delta T = 593 - 16 = 577°C$
$Q = m \times c \times \Delta T = 3.6 \times 377 \times 577 = 783{,}227.4$ J or 783.23 kJ

(b) Input power of furnace.

Time = 25 min = 1500 s
Energy input = Q / Efficiency = 783227.4 / 0.78 = 1,003,112.2 J
Power input = Energy / Time = 1,003,112.2 / 1500 = 668.74 W

(c) Resistance of heating element.
$P = V^2 / R \Rightarrow R = V^2 / P = 240^2 / 668.74 = 57600 / 668.74 = 86.14\ \Omega$

(d) Supply current.
$I = P / V = 668.74 / 240 = 2.79$ A

13. A small workshop 6 m × 4 m is to be illuminated by 110 lux. The lamp efficiency is 40 lumens per watt. The coefficient of utilization is 0.5 and maintenance factor is 0.7. Calculate the:
(a) Total lumen.
Area = $6 \times 4 = 24\ m^2$
Lumen = Illuminance × Area = 110 × 24 = 2640 lumens

(b) Total power required.
Effective efficiency = 40 × 0.5 × 0.7 = 14 lm/W
Power = Total lumens / effective efficiency = 2640 / 14 = 188.57 W

(c) Number of lamps if each lamp is rated at 60 W.
Number = 188.57 / 60 = 3.14 → Use 4 lamps

14. A 40 kVA 3300/240V, 50 Hz single phase transformer has 660 turns on primary winding. Determine the:
(a) Transformer ratio.
Ratio = Vp / Vs = 3300 / 240 = 13.75

(b) Secondary turns.
Ns = Np / Ratio = 660 / 13.75 = 48 turns

(c) Secondary and primary currents.
Ip = S / Vp = 40000 / 3300 = 12.12 A
Is = S / Vs = 40000 / 240 = 166.67 A

15. A six pole 3 phase alternator driven at 1000 rev per minute supplies power to an 8 pole 3 phase induction motor. Calculate the:
(a) Synchronous speed.
Ns = 120 × f / P = 120 × 50 / 6 = 1000 rpm

(b) Rotor speed if the slip is 3 percent.
Slip = (Ns - Nr)/Ns
Nr = Ns × (1 - s) = 1000 × (1 - 0.03) = 970 rpm

(c) Rotor frequency.
fr = s × f = 0.03 × 50 = 1.5 Hz

16. An 8-pole d.c. shunt generator with 778 wave connected armature conductors, runs at 500 r.p.m. while supplying a load of 12.5 Ω at terminal voltage of 250 V. The armature and field resistance are 0.24 Ω and 250 Ω. Calculate the:
(a) Field current.
If = V / Rf = 250 / 250 = 1 A

(b) Load current.
IL = V / Rload = 250 / 12.5 = 20 A

(c) Armature current.
Ia = IL + If = 20 + 1 = 21 A

(d) Generated e.m.f.
Eg = V + Ia × Ra = 250 + 21 × 0.24 = 250 + 5.04 = 255.04 V

(e) Flux per pole.
Eg = (Z × N × Φ × P) / (60 × A)
Z = 778, N = 500, P = 8, A = 2 (wave winding)
Rearranging: Φ = (Eg × 60 × A) / (Z × N × P)
Φ = (255.04 × 60 × 2) / (778 × 500 × 8)
Φ = 30,604.8 / 3,112,000 = 0.00983 Wb or 9.83 mWb per pole