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: 2013**

Instructions

1.   This paper consists of SIXTEEN questions.

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

(i) The function of gang in a switch is to
A. provide good current
B. close and open the circuit
C. neutralize the effect of transient
D. interrupt any value of current
E. limit the flow of flux

Correct answer: B. close and open the circuit
Reason: Gang switches are designed to operate multiple circuits simultaneously by opening and closing them.

(ii) Voltmeter must have very high internal resistance so that
A. accuracy of the meter is high
B. range of the meter is high
C. loading effect is minimum
D. sensitivity of the meter is high
E. minimum current passes through the meter

Correct answer: C. loading effect is minimum
Reason: High resistance prevents the voltmeter from drawing current from the circuit, preserving voltage accuracy.

(iii) Which of the following tests are commonly used in electrical installation?
A. Earth resistance, polarity and energy
B. Polarity, conductivity and resistivity
C. Energy, continuity and conductivity
D. Conductivity, polarity and earth resistance
E. Conductivity, earth resistance and energy

Correct answer: D. Conductivity, polarity and earth resistance
Reason: These are standard safety and performance tests done during and after electrical installation.

(iv) The capacity of generator energy depends on the
A. capacity of generators installed
B. kWh generation in a month
C. resistance of the given conductor
D. limitation of power in kVA
E. power output of the engine

Correct answer: A. capacity of generators installed
Reason: The energy capacity depends on the generator's size and power rating installed.

(v) The voltage rating of a cable depends on the

A. diameter of the conductor

B. thickness of the insulation

C. strength of insulation

D. resistance of the conductor

E. cross-sectional area of the conductor

Correct answer: B. thickness of the insulation

Reason: Higher insulation thickness increases the voltage the cable can safely withstand.

(vi) The purpose of a grid system is to

A. supply energy to remote areas

B. make distribution of energy at reasonable cost

C. inter-connect the power stations

D. make high voltage available to consumers

E. reduce the running cost of conductor

Correct answer: B. make distribution of energy at reasonable cost

Reason: Grid systems distribute electricity efficiently across wide areas at optimized cost.

(vii) For an adequate hand-hold, a ladder should extend above the stepping off point by a minimum of

A. 1.00 m

B. 2.50 m

C. 3.00 m

D. 4.5 m

E. 5.00 m

Correct answer: A. 1.00 m

Reason: Safety standards recommend a 1 m extension for proper support while transitioning off the ladder.

(viii) If a battery acid is accidentally spilled on the skin, the affected part should immediately be

A. washed with methylated spirit

B. flooded with cold water

C. seen by a doctor

D. covered with a sterile dressing

E. covered with antiseptic cream

Correct answer: B. flooded with cold water

Reason: Immediate flushing with water dilutes and removes the acid to minimize skin damage.

(ix) Which of the following is a suitable wiring system for high-roofed building?

A. Cutanary

B. Cleat

C. House-service overhead

D. Casing capping
E. Metal sheathed

Correct answer: C. House-service overhead
Reason: Overhead wiring is practical and cost-effective for high-roofed or industrial structures.

(x) The factor that determines the current rating of the fuse or circuit breaker that should be installed in a lighting circuit is the
A. voltage of the individual lamps
B. capacity of the largest wire in the circuit
C. voltage drop of the circuit
D. capacity of the smallest wire in the circuit
E. total resistance of the circuit

Correct answer: D. capacity of the smallest wire in the circuit
Reason: To prevent overheating or damage, protection devices must match the capacity of the smallest conductor.

2. Mention six measures which must be taken into consideration to ensure safety before doing any electrical maintenance job.
- Disconnect power supply before starting work.
- Use insulated tools and personal protective equipment.
- Test for absence of voltage before touching conductors.
- Place safety signs and barriers to prevent accidental access.
- Ensure proper grounding and earthing.
- Follow lockout and tagout (LOTO) procedures.

3. (a) Why copper is largely used to manufacture cables in preference to other metals? Give two reasons.
- Copper has high electrical conductivity, reducing power losses.
- It has good mechanical strength and flexibility, making it durable in installations.

(b) What type of insulator material is used as transformer bushing on the high tension side?
Porcelain or polymer composite materials are used due to their high dielectric strength and resistance to weathering.

4. (a) State two areas in the building where normal heat loss can take place.
- Through windows and doors
- Through walls and ceilings

(b) Calculate the quantity of heat required to raise the temperature of 20 kg of water from 30°C to 100°C. Take specific heat capacity of water as 4.2 kJ/kg°C.
$Q = mc\Delta T = 20 \times 4.2 \times (100 - 30) = 20 \times 4.2 \times 70 = 5880$ kJ

5. (a) What is the difference between inspection and testing of an installation?
Inspection is the visual examination to verify compliance with regulations, while testing involves measurements to ensure safety and functionality.

(b) What should be checked while doing an inspection of a completed electrical installation?
- Correct connection and labeling
- Proper earthing and bonding
- Integrity of insulation and cable routing
- Operation of protective devices

6. (a) State three important characteristics of materials used for fuse wire.
- Low melting point
- Consistent and predictable melting behavior
- High conductivity

(b) Mention three factors which should be considered when determining the size of the fuse wire required for an installation.
- Rated current of the circuit
- Type of load connected
- Possible short-circuit current

7. (a) (i) What is tariff?
Tariff is the rate or pricing structure set by the electricity provider to charge customers for the electrical energy consumed.

(ii) Give the main objective of tariff.
To recover the cost of generation, transmission, and distribution while encouraging efficient use.

(b) Mention two types of cost of producing electric power incurred by the supply company.
- Fixed cost (e.g., infrastructure and staff salaries)
- Variable cost (e.g., fuel and maintenance)

8. (a) What is an electric shock?
It is a sudden stimulation of nerves and muscles caused by the passage of electric current through the body.

(b) What are the four necessary steps to be taken in case of an electric fire?
- Disconnect the power supply
- Use a CO_2 or dry powder extinguisher
- Do not use water to extinguish the fire
- Evacuate and call emergency services if fire spreads

9. (a) Give two factors which synchronous speed of the stator field of an a.c motor depends on.
- Number of poles in the motor

- Frequency of the supply voltage

(b) The speed of an a.c motor is 1500 rpm when supplied at 240 V. Find the frequency of the motor if it has eight poles.

$N_s = 120f / P$

$1500 = 120f / 8$

$f = (1500 \times 8) / 120 = 100$ Hz

10. (a) State two differences between a stranded conductor and a bunched conductor.
- Stranded conductor has wires laid uniformly in layers; bunched conductors are twisted randomly.
- Stranded provides higher mechanical strength; bunched is more flexible.

(b) Why are indicator boards necessary in bell circuits?
To visually indicate the location of the call or signal origin when multiple bells are connected to one system.

11. (a) Where can the trunking wiring systems be used in electrical works?
In commercial or industrial buildings for organized cable management and ease of maintenance or extension.

(b) Mention four methods of installing a wiring system.
- Surface wiring
- Concealed wiring
- Trunking system
- Conduit system

12. (a) Give the difference between coefficient of utilization and maintenance factor.
- Coefficient of utilization is the ratio of the luminous flux reaching the working plane to the total light emitted by the source.
- Maintenance factor accounts for the reduction in light output over time due to dirt accumulation and lamp aging.

(b) (i) Draw a circuit diagram showing the working principle of fluorescent lamp.
[Diagram expected showing power source, choke (ballast), starter, and fluorescent tube]

(ii) Explain the use of a starter in a fluorescent lamp.
It provides initial current to preheat the electrodes and then opens the circuit to create a voltage surge for striking the arc inside the tube.

(iii) Why fluorescent lamp is most popular compared to incandescent lamp? Give two reasons.
- Higher energy efficiency (more lumens per watt)
- Longer life span and less heat generation

(c) (i) Calculate the illumination on the bench.
Given: intensity I = 500 cd, distance h = 2.5 m

E = I / h² = 500 / (2.5)² = 500 / 6.25 = 80 lux

(ii) With the help of a diagram, find the position along the bench where the illumination will be half the value found in (i) above.
E = 40 lux = 500 / d² → d² = 500 / 40 = 12.5 → d = √12.5 = 3.54 m

13. (a) Explain the principles used in the operation of the following measuring instruments:
(i) Moving iron instruments – Based on the attraction or repulsion of a soft iron piece in a magnetic field created by current flow.
(ii) Moving coil instruments – Operate on the principle that a current-carrying coil in a magnetic field experiences a deflecting torque.

(b) With the aid of diagram, explain how the range of an ammeter and voltmeter can be extended.
- Ammeter: Add low-value shunt resistor in parallel to carry excess current.
- Voltmeter: Add high resistance in series to measure higher voltages.

(c) A moving coil instrument has a resistance of 5 Ω and gives full scale reading of 50 mV.
(i) Shunt resistance to increase range to 200 A
V = 50 mV, I = 200 A, Ig = 0.05 / 5 = 0.01 A
Rs = V / (I - Ig) = 0.05 / (200 - 0.01) = 0.05 / 199.99 = 2.5 × 10⁻⁴ Ω

(ii) Series resistance for use as voltmeter of 750 V
R = V / Ig - Rm = 750 / 0.01 - 5 = 75000 - 5 = 74995 Ω

14. (a) Mention four categories of d.c generators and describe the application of each category.
- Series generator – Used for street lighting and arc welding.
- Shunt generator – Battery charging and lighting.
- Compound generator – Industrial applications with variable load.
- Separately excited generator – Used in laboratories and experiments.

(b) (i) What is a separately excited generator?
A DC generator in which the field winding is supplied with external independent DC power source.

(ii) A separately excited generator at 1000 rpm gives 1000 A at 500 V. What is its speed when it gives 500 A at 500 V? Armature resistance = 0.02 Ω
Ea1 = 500 + (1000 × 0.02) = 520 V
Ea2 = 500 + (500 × 0.02) = 510 V
N2 = (Ea2 / Ea1) × N1 = (510 / 520) × 1000 = 980.8 rpm

15. (a) (i) What is meant by service line?
A service line is the power line that connects the distribution network to the consumer's premises.

(ii) Distinguish between transmission and distribution systems.

- Transmission carries high-voltage electricity over long distances from generating stations.
- Distribution delivers low-voltage electricity to consumers from substations.

(iii) Briefly explain four advantages of interconnection of electrical power stations to a national grid system.
- Improved reliability
- Efficient power sharing and load balancing
- Reduced cost due to optimal resource use
- Better voltage regulation

(b) Explain five factors to consider when selecting the location of hydroelectric power station.
- Availability of sufficient water supply
- Topography for constructing dam/reservoir
- Geological stability of site
- Accessibility for maintenance and construction
- Proximity to load centers

(c) A power station supplies peak loads of 40 MW, 25 MW, and 30 MW to three locations. Load factor = 0.80, diversity factor = 1.8
(i) Maximum demand = 40 + 25 + 30 = 95 MW
(ii) Installed capacity = Maximum demand / Diversity factor = 95 / 1.8 = 52.78 MW
(iii) Energy supplied = Installed capacity $\times$ 8760 $\times$ Load factor = 52.78 $\times$ 8760 $\times$ 0.8 = 370043.52 MWh

16. (a) (i) Briefly explain four conditions for a transformer to act as ideal transformer.
- No core loss
- No leakage flux
- 100% efficiency
- Zero winding resistance

(ii) Give three applications of an auto transformer.
- Starting induction motors
- Voltage regulation in distribution
- Audio and radio equipment

(b) (i) A single-phase transformer rated at 160 kVA, 2300/230 V, 50 Hz
Given B_{max} = 1.2 Wb/m², A = 0.04 m², f = 50 Hz
$E = 4.44\ f\ N\ A\ B_{max}$
$2300 = 4.44 \times 50 \times N_1 \times 0.04 \times 1.2$
$2300 = 10.656 \times N_1 \rightarrow N_1 = 2300 / 10.656 = 215.8$ turns
$N_2 = (230 / 2300) \times 215.8 = 21.58$ turns

(ii) Magnetic path = 2.5 m, μ_r = 2600, L = 3 H
$\mu = \mu_r \times \mu_0 = 2600 \times 4\pi \times 10^{-7} = 3.27 \times 10^{-3}$
$L = N^2 \mu A / 1 \rightarrow 3 = N^2 \times 3.27 \times 10^{-3} \times 0.004 / 2.5$

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$N^2 = (3 \times 2.5) / (0.004 \times 3.27 \times 10^{-3}) = 7.5 / 1.308 \times 10^{-5} = 57344$

$N = \sqrt{57344} = 239.5$ turns

Emf $= L \times I^2 / 2 = 3 \times I^2 / 2 \rightarrow$ Energy stored depends on I (not given, formula used).

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