

**THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATION COUNCIL
DIPLOMA IN TECHNICAL EDUCATION EXAMINATION**

794

**ELECTRICAL INSTALLATION
(SUPPLEMENTARY)**

Time: 3 Hours.

SOLUTIONS

Year: 2020

Instructions

1. This paper consists of sections A and B with a total of **fifteen (14)** questions.
2. Answer **all** questions in section A and **three (3)** questions from section B
4. Mathematical tables and non-programmable calculators may be used
4. Cellular phones are **not** allowed inside the examination room.
5. Write your **Examination Number** on every page of your answer booklet

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SECTION A (40 Marks)

Answer all questions in this section.

1. What four factors that can cause someone not to adopt non-metallic conduits over steel conduits type of wiring system?

One factor is low mechanical strength. Non-metallic conduits such as PVC are easily damaged by impact, crushing, or rodents, especially in industrial or workshop environments where physical protection is important.

Another factor is poor resistance to high temperatures. Non-metallic conduits can soften, deform, or burn when exposed to heat, sparks, or fire, making them unsuitable for places with high thermal risks compared to steel conduits.

A further factor is lack of inherent earthing. Steel conduits can act as an earth continuity conductor, while non-metallic conduits require a separate earth wire, increasing installation complexity and cost.

Another factor is susceptibility to ultraviolet radiation and chemical attack. Non-metallic conduits may deteriorate when exposed to sunlight or certain chemicals, reducing durability in outdoor or harsh environments.

2. Why is it necessary to carry out the following tests on a newly completed installation?

Earth loop impedance test is carried out to ensure that the earth fault loop impedance is low enough to allow protective devices such as fuses or circuit breakers to disconnect the supply quickly in the event of a fault, thereby preventing electric shock and fire.

Verification of polarity test is necessary to confirm that live, neutral, and earth conductors are correctly connected. This ensures that switches and protective devices are placed on the live conductor for safe operation.

Ring circuit continuity test is done to verify that the ring final circuit is complete and continuous. This ensures that current is shared correctly in both legs of the ring and prevents overloading of conductors.

Earth electrode resistance test is carried out to confirm that the earth electrode provides an effective path to ground. This ensures that fault currents can safely dissipate into the earth.

3. Give two differences between Lump sum and Firm price as used in cost estimation.

In a lump sum contract, the contractor agrees to complete the work for a fixed total price based on detailed drawings and specifications, and this price does not change unless the scope of work is altered.

In a firm price contract, the price is fixed but may include provisions for adjustments due to specific conditions such as inflation or changes in material costs, depending on the agreement.

Another difference is that lump sum contracts place most financial risk on the contractor, while firm price contracts may share some risks between the client and contractor depending on contract terms.

4. What are the four safety regulations for floor and surface in the workshop?

The floor surface should be non-slip to prevent accidents caused by slipping, especially in areas where oil, water, or grease may be present.

The floor should be kept clean and free from obstacles such as tools, cables, and waste materials to avoid tripping hazards.

Floors must be strong and even, without cracks or holes, to support equipment and personnel safely.

Adequate drainage should be provided where liquids are used, preventing accumulation of water or chemicals on the surface.

5. Suppose you have been employed as an electrician in a certain company; how would you use the following hand tools in your works?

Hacksaw is used for cutting metal conduits, trunking, bolts, and other metallic components to the required length during installation.

Screwdriver is used for tightening and loosening screws on terminals, switches, sockets, and distribution boards to secure electrical connections.

Pliers are used for gripping, bending, twisting, and cutting electrical wires and small conductors during wiring and termination.

Centre punch is used to mark drilling points on metal surfaces to prevent the drill bit from slipping when making holes.

6. Draw a schematic diagram of two bells located at different places controlled by one push button.

The schematic consists of a power supply connected to a single push button switch. From the switch, the circuit branches into two parallel paths, each supplying one bell. When the push button is pressed, both bells are energized simultaneously and ring together.

7. You are required to join two conductors by soldering and make a crimped termination. Mention four tests which should be carried out to ensure a good result.

A visual inspection test is carried out to ensure the solder joint is smooth, shiny, and free from cracks or excess solder.

A mechanical strength test is performed by gently pulling the joint to confirm that the conductors are firmly joined and cannot separate easily.

An electrical continuity test is done using a tester or multimeter to ensure low resistance and good electrical connection across the joint.

An insulation test is carried out to ensure that insulation around the joint is intact and that there is no short circuit to other conductors.

8. State four measures that should be taken to ensure the three-phase induction motor operates for a longer time without failure.

Proper lubrication of bearings should be maintained to reduce friction and overheating during operation.

Adequate ventilation and cooling must be ensured to prevent excessive temperature rise in windings.

The motor should be protected against overloading by using appropriate protective devices such as overload relays.

Regular inspection and maintenance should be carried out to detect faults such as loose connections or insulation damage early.

9.(a) Differentiate standing cost from running cost as used in generation of electric power.

Standing cost refers to expenses that remain constant regardless of the amount of power generated, such as salaries, depreciation, and interest on capital.

Running cost refers to expenses that vary with the amount of electricity produced, such as fuel, lubricating oil, and routine operational wear.

(b) Give two examples of standing costs and two examples of running costs incurred by power supply company.

Examples of standing costs include salaries of permanent staff and depreciation of plant and equipment.

Examples of running costs include fuel consumption and maintenance costs directly related to operation.

10.(a) Why silver is the mostly preferred material for fusing element?

Silver is preferred because it has high electrical conductivity, which ensures minimal energy loss during normal operation.

It has a predictable melting point and oxidizes very little, ensuring reliable and consistent fuse operation under fault conditions.

(b) What is the minimum fusing current of a rewirable fuse which is rated at 30 A with a fusing factor of 4?

Fusing current = fusing factor \times rated current

Fusing current = 4×30

Fusing current = 120 A

Therefore, the minimum fusing current is 120 A.

SECTION B (60 Marks)

Answer three questions from this section.

11.(a) What could be the cause of sparks at the following parts of D.C. machines?

(i) Brushes

Sparking at brushes may be caused by poor contact between brushes and commutator due to worn brushes, incorrect brush pressure, or dirty surfaces.

(ii) Commutator

Sparking at the commutator can occur due to uneven commutator segments, dirt, oil contamination, or incorrect alignment of brushes.

(iii) Armature

Sparking at the armature may be caused by short-circuited coils, open circuits, or improper winding connections leading to uneven current distribution.

(b) A D.C. shunt machine when runs at 1000 r.p.m. as a motor on no load has iron and friction losses of 219.5 W. The field current and armature resistance are 1 A and 0.5Ω respectively. Calculate the efficiency of the machine when running as a generator delivering 40 A at 220 V.

Output power

$$\text{Output} = 220 \times 40$$

$$\text{Output} = 8800 \text{ W}$$

Armature current

$$I_a = 40 + 1$$

$$I_a = 41 \text{ A}$$

Armature copper loss

$$I_a^2 R = 41^2 \times 0.5$$

$$= 1681 \times 0.5$$

$$= 840.5 \text{ W}$$

Field copper loss

$$= 220 \times 1$$

$$= 220 \text{ W}$$

Total losses

$$= 219.5 + 840.5 + 220$$

$$= 1280 \text{ W}$$

Input power

$$= 8800 + 1280$$

$$= 10080 \text{ W}$$

Efficiency

$$= 8800 \div 10080$$

$$= 0.873$$

$$\text{Efficiency} \approx 87.3 \%$$

12.(a) What are the three conditions which must be fulfilled for parallel operation of alternators?

The alternators must have the same line voltage to avoid circulating currents.

They must have the same frequency to ensure synchronous operation.

The phase sequence and phase angles must be identical to prevent short circuits and mechanical stress.

13. What are the three means of protection that switchgear should be provided with? Switchgear should provide protection against overcurrent to prevent damage due to excessive current flow.

It should provide protection against short circuits to isolate faults quickly.

It should provide protection against earth faults to ensure safety of equipment and personnel.

(b) Account for the six points to be considered during installation of domestic ring circuit.

The ring circuit should be protected by an appropriate circuit breaker or fuse.

Cable size must be suitable for the current rating of the circuit.

All joints should be properly made and enclosed in suitable boxes.

Sockets should be evenly distributed to avoid overloading.

The circuit should be correctly earthed to ensure safety.

Continuity and insulation tests should be carried out after installation.

(c) Figure 1 shows the circuit diagram for a certain lighting control system.

(i) State all four conditions obtained in operation of SPS and DPS and their effect on lamps L_1 , L_2 , and L_3 .

When SPS is ON and DPS is OFF, lamp L_1 lights while L_2 and L_3 remain OFF.

When SPS is OFF and DPS is ON, lamps L_2 and L_3 light while L_1 remains OFF.

When both SPS and DPS are ON, all lamps L_1 , L_2 , and L_3 light.

When both SPS and DPS are OFF, all lamps remain OFF.

(ii) Where do the SPS and DPS used for their normal operation?

SPS is normally used for controlling a single lighting point such as a room light.

DPS is used where two circuits or loads need to be controlled simultaneously, such as isolating both live and neutral in a circuit.

(iii) Give the current ratings of SPS and DPS.

SPS is commonly rated at 5 A or 6 A for lighting circuits.

DPS is commonly rated at 10 A or 15 A depending on the load.

14.(a) Why is it necessary to incorporate armouring in an underground cable?

Armouring is incorporated to provide mechanical protection to the cable against external damage caused by soil pressure, digging tools, stones, or accidental impact during installation and service life.

Armouring also protects the cable from rodent attacks and corrosion effects, especially when the cable is laid directly in the ground without ducts.

Another reason is that armouring improves the overall strength and durability of the cable, ensuring long service life under harsh underground conditions.

Armouring can also serve as an earth continuity conductor, providing a safe path for fault current and enhancing electrical safety.

(b) Underground system of an electric power transmission is better compared to overhead system. Justify the statement by giving six reasons.

Underground systems are safer because conductors are not exposed, reducing risks of electric shock, electrocution, and accidental contact.

They are more reliable since they are not affected by weather conditions such as storms, strong winds, lightning, or falling trees.

Underground transmission improves aesthetic appearance because cables are hidden from view, which is important in urban and residential areas.

Maintenance requirements are lower as faults due to environmental exposure are minimal compared to overhead lines.

They reduce power interruptions caused by external disturbances, leading to improved continuity of supply.

Underground systems occupy less surface land, avoiding right-of-way issues and interference with other activities.

(c) 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 mm². Calculate the:

(i) Voltage drop in the cable at load, ignoring the reactance of the cable.

$$\text{Power} = 18000 \text{ W}$$

$$\text{Voltage} = 240 \text{ V}$$

$$\text{Power factor} = 0.78$$

Current

$$I = P \div (V \times \text{power factor})$$

$$I = 18000 \div (240 \times 0.78)$$

$$I = 18000 \div 187.2$$

$$I = 96.15 \text{ A}$$

Resistivity of copper $\rho = 17.5$ micro ohm mm² per m

Resistance of one conductor

$$R = \rho L \div A$$

$$R = (17.5 \times 40) \div 35$$

$$R = 700 \div 35$$

$$R = 20 \text{ micro ohm}$$

Total resistance for two conductors

$$R_t = 2 \times 20 \text{ micro ohm}$$

$$R_t = 40 \text{ micro ohm}$$

$$R_t = 0.04 \text{ ohm}$$

Voltage drop

$$V_d = I \times R_t$$

$$V_d = 96.15 \times 0.04$$

$$V_d = 3.85 \text{ V}$$

(ii) Power lost in the cable.

Power loss

$$P_{\text{loss}} = I^2 \times R_t$$

$$P_{\text{loss}} = (96.15)^2 \times 0.04$$

$$P_{\text{loss}} = 9244.8 \times 0.04$$

$$P_{\text{loss}} = 369.8 \text{ W}$$

15.(a) With the aid of circuit diagram, explain how open circuit test is done in a transformer.

In the open circuit test, the secondary winding of the transformer is left open while the primary winding is connected to the rated supply voltage.

A voltmeter is connected across the primary to measure applied voltage, an ammeter is connected in series to measure no-load current, and a wattmeter is connected to measure input power.

When supply is switched on, the transformer draws a small no-load current which produces core flux, and the wattmeter reading represents the iron losses of the transformer.

This test is mainly used to determine iron losses, no-load current, and power factor of the transformer under no-load conditions.

(b) If no load test is done on a single phase transformer 220 V / 110 V, the following data is obtained: primary current is 0.5 A and power input is 30 W. Find:

(i) Turns ratio.

Turns ratio

$$= \text{Primary voltage} \div \text{Secondary voltage}$$

$$= 220 \div 110$$

$$= 2$$

(ii) Magnetizing current of no load.

Iron loss current

$$I_w = \text{Power} \div \text{Voltage}$$

$$I_w = 30 \div 220$$

$$I_w = 0.136 \text{ A}$$

Magnetizing current

$$I_m = \sqrt{I_o^2 - I_w^2}$$

$$I_m = \sqrt{0.5^2 - 0.136^2}$$

$$I_m = \sqrt{0.25 - 0.0185}$$

$$I_m = \sqrt{0.2315}$$

$$I_m = 0.48 \text{ A}$$

(iii) Primary copper losses if primary resistance is 0.6Ω .

Copper loss

$$= I_o^2 \times R$$

$$= (0.5)^2 \times 0.6$$

$$= 0.25 \times 0.6$$

$$= 0.15 \text{ W}$$

(iv) Iron losses if copper loss is neglected and if copper loss is not neglected.

If copper loss is neglected

Iron loss = Input power

$$\text{Iron loss} = 30 \text{ W}$$

If copper loss is not neglected

Iron loss = Input power – Copper loss

$$\text{Iron loss} = 30 - 0.15$$

$$\text{Iron loss} = 29.85 \text{ W}$$

