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: 2016**

Instructions

1. This paper consists of SIXTEEN questions.

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

(i) What is the recommended current rating of the main switch found in a domestic consumer control unit?
A 30 A
B 60 A
C 20 A
D 40 A
E 100 A

Answer: B 60 A
Reason: The standard current rating for domestic main switches is 60 A, which suits average household load demand.

(ii) What is the supply voltage recommended for three phase induction motors in Tanzania?
A 415 V
B 380 V
C 250 V
D 240 V
E 460 V

Answer: A 415 V
Reason: The standard three-phase supply voltage in Tanzania for industrial motors is 415 V.

(iii) What is a luminaire?
A It is a source of light.
B It is anything that emits solar energy.
C It is a lighting fitting.
D It is the unit of light intensity.
E It is a lamp with less than 50 candelas.

Answer: C It is a lighting fitting.
Reason: A luminaire is the complete lighting unit, including the lamp and the fitting that holds it.

(iv) The best power supply suitable for both lighting circuits and industrial loads is
A Single phase supply system
B Three phase supply system
C Two phase supply system
D Delta connected three phase system
E Star connected three phase system

Answer: B Three phase supply system
Reason: A three-phase system supports both heavy machinery and lighting circuits efficiently.

(v) Which one of the following is the main disadvantage of the plastic conduit wiring system?

A It is liable to corrosion.
B It provides earth return path.
C It is more expensive compared to metallic conduit wiring system.
D It requires a separate earth wire inside the conduit.
E It needs extra mechanical support.

Answer: D It requires a separate earth wire inside the conduit.
Reason: Plastic is non-conductive, so it can't act as an earth return path, thus requiring a separate earth wire.

(vi) Why a reasonable tariff to each type of consumer should include fixed and unit charges?
A To cover running costs and interest on capital cost per unit.
B To cover depreciation costs and standing cost per unit.
C To cover standing costs and running costs per unit.
D To cover taxes and running costs.
E To cover standing costs and interest on capital cost per unit.

Answer: C To cover standing costs and running costs per unit.
Reason: Tariffs must cover both fixed infrastructure costs and variable costs depending on usage.

(vii) The first safety precaution to be taken in an electrical workshop is
A to switch 'on' all lighting points in workshop.
B to operate the workshop fire extinguisher.
C to clean the workshop.
D to switch 'off' all lighting points in workshop.
E to undertake the class installation works given by an instructor.

Answer: A to switch 'on' all lighting points in workshop.
Reason: Adequate lighting is critical to safely see and work with electrical tools and materials.

(viii) What type of wiring system is recommended for a petrol filling station?
A PVC sheathed cable
B PVC insulated and sheathed armoured cable
C Paper insulated and impregnated cable
D M.I.C.S with overall PVC sheath cable
E Rubber insulated cable

Answer: D M.I.C.S with overall PVC sheath cable
Reason: Mineral Insulated Cable with PVC sheath offers superior fire resistance, essential for hazardous areas like fuel stations.

(ix) Why copper conductors are tinned?
A To make the conductors appear white.

B To improve the flexibility of the cables.
C To prevent copper from reacting with sulphur from the rubber insulation.
D To change the appearance when the conductor is joined with aluminium conductor.
E To meet IEE regulations concerning flexible cables.
Answer: C To prevent copper from reacting with sulphur from the rubber insulation.
Reason: Tinning protects copper from corrosive chemical reactions with insulation materials.

(x) Which one of the following is not true about power transformers?
A They are used to step up or down the power of a transmission line.
B Their cores are made of silicon steel laminations.
C They need constant cooling when they are in operation.
D They are more efficient than other ac machines.
E They are made in different sizes depending on voltage and power levels.

Answer: A They are used to step up or down the power of a transmission line.
Reason: Transformers step up or down voltage, not power. Power remains nearly constant aside from losses.
2. (a) Define the temperature coefficient of resistance of a material.
The temperature coefficient of resistance is the rate at which the resistance of a material changes with temperature. It is defined as the change in resistance per degree Celsius rise in temperature, relative to its resistance at a reference temperature (usually 0°C).

(b) Briefly explain the effect of heat on:
(i) The resistance of pure conductor
As temperature increases, the resistance of pure conductors increases. This is due to increased vibrations of atoms which obstruct the flow of electrons.

(ii) The resistance of semiconductor
In semiconductors, resistance decreases with increase in temperature. Higher temperature generates more charge carriers, thus increasing conductivity.

3. Compute the rotor speed (in r.p.m) for a 4-pole turbo alternator if the frequency of the induced e.m.f is 50 Hz.
$Ns = (120 \times f) / P = (120 \times 50) / 4 = 6000 / 4 = 1500$ rpm
Rotor speed = 1500 rpm

4. (a) Briefly describe the following types of d.c generators:
(i) Separately-excited generators
These generators have their field windings supplied by an external independent power source, not connected to the generator's output.

(ii) Self-excited generators

In these, the field winding is energized by the generator's own output. They are more compact and cost-effective than separately-excited types.

(b) Name two types of self-excited generators.
- Series generator
- Shunt generator

5. Briefly explain the function of the following tools which are used by an electrician in performing electrical installation works:
(a) Pliers
Used for gripping, twisting, bending, and cutting wires during installation and repair work.

(b) Mallet
Used to gently drive conduit fittings and accessories without damaging them.

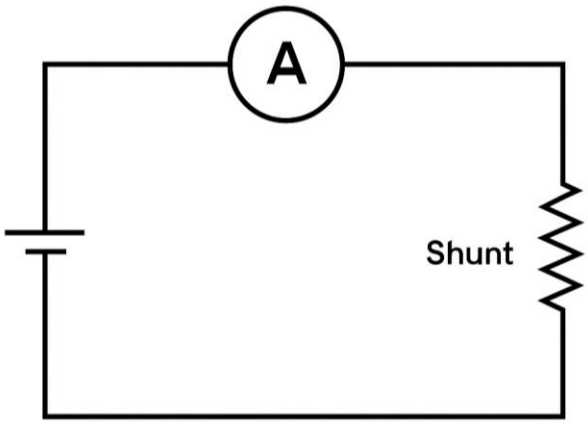
(c) Spirit level
Used to ensure electrical fittings and trunkings are installed level and aligned properly.

6. (a) Mention two types of fuses.
- Cartridge fuse
- Rewireable fuse

(b) Explain the operational difference between a fuse and a circuit breaker.
A fuse is a single-use protective device that melts and breaks the circuit when excessive current flows. A circuit breaker is a reusable switch that automatically trips and disconnects power when there is a fault or overload.

7. Briefly explain three types of indicator elements used in electric signaling systems.
- Pilot lamps: Indicate the presence or absence of voltage.
- Buzzers: Provide audible signals for alarms or alerts.
- Neon indicators: Used for phase indication and presence of voltage in circuits.

8. With the aid of a diagram, explain how the range of an ammeter can be extended.
The range of an ammeter is extended by connecting a low resistance called a shunt in parallel with it. Most of the current bypasses the meter through the shunt, allowing it to measure higher currents.



9. (a) Mention one type of lamp which can be used for both d.c and a.c circuit.
Incandescent lamp

(b) Explain the function of the following parts of a fluorescent lamp:
(i) Choke
It limits the current and provides a high voltage spike to initiate the discharge in the lamp.

(ii) Capacitor
Improves the power factor of the circuit and reduces flickering.

10. Draw a diagram showing how the TANESCO power supply is connected to a domestic consumer premises and the unit which records the consumed electrical energy.
Diagram should include: Service line, energy meter, main switch, distribution board, and wiring to final circuits.

11. Explain three advantages of 3-phase induction motors over the single phase induction motors.
- They are self-starting, unlike single phase motors which need auxiliary means.
- They are more efficient and have higher power factor.
- They deliver more power and are suitable for industrial applications.

12. (a) A lighting circuit is to be designed using two 2-way switches S1 and S2 and two bulbs L1 & L2. The circuit should operate as follows:
S1 down, S2 up – light off
S1 up, S2 down – L1 ON (medium light)
S1 up, S2 up – L1 and L2 in parallel (bright light)
S1 down, S2 down – L1 and L2 in series (dim light)

(i) Draw a schematic diagram for the circuit.
(ii) Draw a wiring diagram for the circuit.
[Diagrams to be provided separately.]

13. (a) Explain the use of the following as used in domestic wiring system:
(i) Ducting – Provides a pathway for routing multiple wires in a neat and protected way.
(ii) Trunking – Used to house and protect electrical cables along walls and ceilings.
(iii) Conduit – Protects single or multiple conductors from mechanical damage and moisture.
(iv) Catenary wire – Provides support for suspended cable installations over long spans.

(b) Give six advantages which differentiate lead-sheathed wiring system from conduit wiring system.
- Better moisture resistance
- Flexible and easier to install
- Less susceptible to corrosion
- Better insulation properties
- Quicker installation time
- More suitable for embedding in walls and floors

(c) (i) Briefly explain how a running coupler is used to join two pieces of steel conduits.
It is slid over the ends of two steel conduits and tightened using screws or threading to securely join and align them.

(ii) Briefly explain seven points which should be kept in mind for installation of metal-sheathed wiring.
- Proper earthing must be ensured.
- Bends should not damage the sheath.
- Use of proper clips and fasteners for secure mounting.
- Avoid sharp edges to prevent insulation damage.
- Ensure proper sealing at joints to avoid moisture ingress.
- Maintain correct spacing and route planning.
- Test continuity and insulation resistance after installation.

14. (a) Briefly explain two methods used to reduce power loss of a transformer.
- Use of low resistance conductors: Using materials like copper with low resistivity reduces I^2R losses.
- Laminating the core: Using laminated silicon steel cores minimizes eddy current losses.

(b) Compare an auto-transformer to double wound transformer.
An auto-transformer has a single winding tapped at various points to supply different voltages, making it lighter and more efficient but less safe.
A double wound transformer has separate primary and secondary windings, offering electrical isolation and safer operation.

(c) Show how the windings of a transformer can be connected in:
(i) Star connection

Each winding is connected with one end to a common neutral point and the other end to a phase line.
(ii) Delta connection
Each winding connects end-to-end forming a closed loop, with three nodes connecting to phase lines.

(d) A 50 kVA single phase transformer has a primary voltage of 6600 V and a secondary voltage of 250 V. It has 52 secondary turns. Neglecting losses, find:
(i) The number of primary turns
Vp/Vs = Np/Ns
6600 / 250 = Np / 52
Np = (6600 × 52) / 250 = 1372.8 ≈ 1373 turns

(ii) The primary current
I = P / V = 50000 / 6600 = 7.58 A

(iii) The secondary current
I = P / V = 50000 / 250 = 200 A

15. (a) With the help of a simple labeled circuit diagram, show how you can test the insulation resistance of a load resistor (R_l) using an appropriate measuring instrument.
[Diagram includes a megger connected between the resistor terminal and ground; measure resistance in mega ohms]

(b) Explain four tests which should be done to a new installation before connecting it to the power supply.
- Continuity test: Checks if conductors are properly connected.
- Insulation resistance test: Ensures there's no leakage current.
- Earth continuity test: Confirms proper earthing.
- Polarity test: Checks that the live and neutral wires are not reversed.

(c) (i) Differentiate “inspection” from “testing” of an electrical installation.
Inspection is a visual examination to check compliance with standards, while testing involves measurements and use of instruments to verify functionality and safety.

(ii) The most vulnerable part of any electrical system is a cable. Give three basic steps to be followed in locating a fault in a cable.
- Visual inspection for damage.
- Continuity testing with a multimeter.
- Use of cable fault locator or insulation tester.

16. (a) Briefly explain standing costs and running costs of electricity. Give four examples in each case.
Standing costs are fixed and do not change with usage, e.g., rent, salaries, equipment depreciation, and insurance.
Running costs vary with electricity generation or consumption, e.g., fuel, water, lubricants, and maintenance.

(b) Briefly explain the following tariffs:
(i) Flat rate tariffs
A single charge per unit of electricity consumed, regardless of the time or usage amount.

(ii) Two part tariffs
Charges split into fixed charges (standing charges) and variable charges based on consumption (per unit used).

(c) A factory is loaded daily as follows: 250 kVA for 2 hours, 180 kVA for 8 hours and 75 kVA for 6 hours per day. The charge for the energy is made on a basis of TZS 10,000 per kVA of maximum demand plus TZS 500 per unit. Assuming a 5-day week, 50-week year and a unit power factor, calculate the cost per year of the energy supplied.

Maximum demand = 250 kVA
MD charges per year = 250 × 10000 = 2,500,000 TZS

Energy per day = (250 × 2) + (180 × 8) + (75 × 6) = 500 + 1440 + 450 = 2390 kWh/day
Annual energy = 2390 × 5 × 50 = 597500 kWh
Energy charge = 597500 × 500 = 298,750,000 TZS

Total cost per year = 2,500,000 + 298,750,000 = 301,250,000 TZS