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: 2018**

Instructions

1. This paper consists of SIXTEEN questions.

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

1. (i) The following items are electronic accessories except
A luminaire
B lamp holder
C ceiling rose
D fuse
E socket-outlet

Answer: D fuse
Reason: A fuse is a protective device, not an accessory. Accessories are parts used for connecting and utilizing electrical supply like lamp holders and sockets.

(ii) Core laminations are generally made up of
A cast iron
B Carbon
C silicon steel
D stainless steel
E mica

Answer: C silicon steel
Reason: Silicon steel is used due to its low hysteresis loss and high magnetic permeability, ideal for laminated cores.

(iii) Why is it necessary to apply safety rules in a working place?
A To avoid burning
B To prevent accidents
C To put on workshop gear
D To take safety measure early
E To wear supportive garment

Answer: B To prevent accidents
Reason: The main aim of safety rules is to protect individuals from injury and prevent workplace accidents.

(iv) What is the value of the synchronous speed of a 4-pole 3-phase induction motor running from a 50 Hz power supply?
A 3600 rev/m
B 3000 rev/m
C 1800 rev/m
D 1500 rev/m
E 750 rev/m

Answer: D 1500 rev/m
Reason: Synchronous speed Ns = (120 × f) / P = (120 × 50) / 4 = 1500 rev/m

(v) Which of the following are considered as running costs of a power station?
A Fuel and generators
B Fuel and water
C Water and motors
D Generator and motors
E Taxes and insurance

Answer: B Fuel and water
Reason: Fuel and water are consumed continuously in operation and are part of running costs.

(vi) The practical application of low pressure mercury vapour is in
A road lighting
B flood lighting
C lighting of homes
D lighting industrial premises
E street lighting

Answer: E street lighting
Reason: Low pressure mercury vapour lamps are widely used in street lighting due to their efficiency and brightness.

(vii) The extension of voltmeter range can be achieved when
A a load is disconnected from the circuit.
B a resistor is connected in parallel to the voltmeter.
C an ammeter is connected parallel to the voltmeter.
D a multiplier resistor is connected in series to the voltmeter.
E two voltmeters are used in series.

Answer: D a multiplier resistor is connected in series to the voltmeter.
Reason: A series multiplier resistor increases the voltmeter range by limiting the current through the meter.

(viii) The electric system whereby the supply voltage is 240 V a.c. is known as
A live and neutral supply system
B domestic supply system
C single phase two wire
D single phase three wire
E two conductors supply system

Answer: C single phase two wire
Reason: A 240V supply system is typically a single-phase two-wire system with live and neutral.

(ix) Which of the following devices is necessarily required for automatic temperature control in a furnace?
A Thermocouple
B Thermostat
C Auto transformer
D Heating element
E Voltage regulator

Answer: B Thermostat
Reason: A thermostat senses temperature and switches the heating on or off to maintain desired temperature.

(x) The purpose of inspecting an installation is
A to identify small faults and rectify them before final test
B to identify leakage currents before connecting the circuit to power
C to know the number of accessories already installed
D to have communication between the contractor and the engineer
E to find time to assess the work

Answer: A to identify small faults and rectify them before final test
Reason: Inspection ensures safety and compliance before energizing the system.

2. (a) What does the term power distribution imply as far as electric power generation is concerned?
Power distribution refers to the process of delivering electric power from the transmission system to the end consumers. It involves stepping down the high voltage electricity from transmission lines to a lower voltage suitable for residential, commercial, and industrial use, and ensuring safe and reliable delivery to the final users.

(b) Differentiate between a feeder and a distributor as applied in transmission lines.
A feeder is a power line that carries electrical power from a substation to a distribution point without any tapping along its length. It handles large current loads and is designed for bulk power transfer.
A distributor is a power line that supplies electrical power to consumers with several tapping points along its length. It operates at lower voltage and handles the final stage of power delivery to homes and industries.

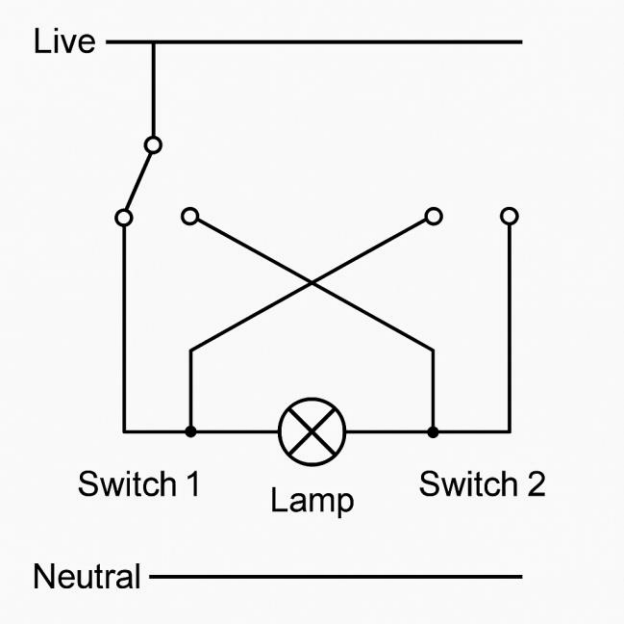
3. Give three necessity of fitting protective switchgear to consumer's installation.
Protective switchgear is necessary to:
- Protect equipment and appliances from damage due to overcurrent, short circuits, or fault conditions.
- Ensure safety of users by disconnecting faulty parts of the circuit to prevent electric shock or fire.
- Maintain continuity of supply by isolating only the faulty sections and allowing the rest of the system to operate.

4. (a) What is insulation?

Insulation is a non-conductive material used to cover electrical conductors to prevent leakage of current, avoid short circuits, and protect users from electric shocks. It ensures safe and efficient operation of electrical systems.

(b) A certain cable has an insulation resistance of 150 MΩ per meter length. Calculate the insulation value of 50 meter length of this cable.
Total insulation resistance = insulation per meter ÷ length
= 150 MΩ ÷ 50
= 3 MΩ

5. Draw a wiring diagram of a lamp controlled by two 2-way switches.



6. (a) Define the term 'resistance'.
Resistance is the property of a material or component that opposes the flow of electric current through it. It causes electrical energy to be converted into heat and is measured in ohms (Ω).

(b) (i) Why electrical devices are connected in parallel in a consumer's installation?
Devices are connected in parallel to ensure that each device receives the same voltage as the source, and the failure of one device does not affect the operation of others. It also allows independent control and operation of devices.

(ii) What will happen to the devices if they are connected in series?
If devices are connected in series, the same current flows through all of them, but the voltage is divided among the devices. If one device fails or is switched off, the entire circuit is broken and all other devices stop working.

7. (a) Give the meaning of the term 'appliance' as used in electrical engineering.

An appliance is an electrical device or equipment designed to perform a specific function such as heating, lighting, cooling, or cleaning, and which is connected to the electricity supply for operation.

(b) Differentiate lamp holder from ceiling roses basing on their uses.
A lamp holder is a device that holds the lamp (bulb) and provides electrical connection for it. It is used in portable lamps or fittings.
A ceiling rose is a fixed wiring accessory used at the ceiling to provide connection for lighting fixtures, often also serving as a junction point for light circuits.

8. (a) What electrical quantities identify the rate of electric lamps?
The rate of electric lamps is identified by voltage (V) and power rating (Wattage). The power rating indicates the amount of electrical energy consumed per unit time.

(b) Differentiate filament lamps from discharge lamps.
Filament lamps produce light by heating a tungsten filament until it glows, using incandescent principle. They are simple and inexpensive but less efficient.
Discharge lamps produce light by passing electric current through ionized gas or vapor inside the lamp, leading to emission of light. They are more energy efficient and have longer lifespan compared to filament lamps.

9. State three differences between heat and temperature.
Heat is a form of energy, while temperature is a measure of the average kinetic energy of particles.
Heat flows from a hotter body to a cooler one, while temperature does not flow.
Heat is measured in joules (J), while temperature is measured in degrees Celsius (°C), Fahrenheit (°F), or Kelvin (K).

10. Give three procedures to be followed while carrying out the insulation-resistance test of conductors to earth.
Ensure the circuit is de-energized and properly isolated.
Disconnect all sensitive equipment to prevent damage from test voltage.
Connect the insulation tester between the conductor and earth, then apply the specified voltage and record the resistance value.

11. (a) Which feature distinguish step down from step up transformer?
A step-down transformer has more turns in the primary coil and fewer turns in the secondary coil, resulting in a lower output voltage. Conversely, a step-up transformer has fewer turns in the primary and more turns in the secondary, increasing the voltage.

(b) If no-load secondary voltage of a transformer is 500V and its secondary terminal voltage under full load condition is 460V, find the percentage voltage regulation.
Percentage regulation = [(No-load voltage - Full-load voltage) / Full-load voltage] × 100

= [(500 - 460) / 460] × 100
= (40 / 460) × 100 = 8.70%

12. (a) What are the four applications of synchronous motors?
Used in power factor correction in industries.
Used in constant speed applications such as clocks and recorders.
Used in driving crushers and ball mills.
Used in textile and paper industries for uniform operation.

(b) Why the following motors are used in the particular applications indicated against them?
(i) D.C. shunt motors are used in lathes.
They provide constant speed under varying load, which is essential in lathe operations.

(ii) D.C. series motors are used in lifts and cranes.
They provide high starting torque which is needed in applications like lifts and cranes.

(iii) Cumulative compound motors are used for rolling mills.
They combine the advantages of shunt and series motors, offering good starting torque and speed regulation.

(iv) Three-phase induction motors are useful in industrial applications.
They are rugged, require low maintenance, and are economical for continuous industrial operation.

(c) A 440 V shunt motor has armature resistance of 0.8 Ω and field resistance of 200 Ω. Determine the back e.m.f when giving an output of 7.46 kW at 85 percent efficiency.
Output = 7.46 kW = 7460 W
Efficiency = 85%
Input Power = 7460 / 0.85 = 8776.47 W
Input Current I = Power / Voltage = 8776.47 / 440 = 19.94 A
Armature current = 19.94 A (approx., since field current is small)
Back e.m.f = V - Ia × Ra = 440 - (19.94 × 0.8) = 440 - 15.95 = 424.05 V

13. (a) A D.C motor fails to start when switched on. Briefly explain three possible causes for such failure and how each cause can be remedied.
Open circuit in armature winding – check and reconnect broken wires.
Brushes not properly in contact – clean commutator and adjust brushes.
No supply voltage – verify power source and fix fuse or breaker issues.

(b) A 240 V shunt motor having field and armature resistance of 50 Ω and 0.1 Ω respectively takes a total current of 80A and runs at 800 rpm. Find the:
(i) Back e.m.f
Armature current = Total current - Field current = 80 - (240 / 50) = 80 - 4.8 = 75.2 A
Back e.m.f = V - Ia × Ra = 240 - (75.2 × 0.1) = 240 - 7.52 = 232.48 V

(ii) Copper losses
Armature loss = $Ia^2 \times Ra = 75.2^2 \times 0.1 = 5653.44 \times 0.1 = 565.34$ W
Field loss = $If^2 \times Rf = 4.8^2 \times 50 = 23.04 \times 50 = 1152$ W
Total copper losses = 565.34 + 1152 = 1717.34 W

(iii) Armature torque
$T = (P \times 60) / (2\pi N) = (7460 \times 60) / (2\pi \times 800) = 447600 / 5026.55 = 89.01$ Nm

(iv) Output power = 7460 W (already given)

14. (a) (i) State the inverse square law of illumination.
Illumination is inversely proportional to the square of the distance from the source.
$E \propto 1 / d^2$

(ii) What are the five characteristics of a tungsten filament that make it mostly used in almost all modern incandescent lamps?
High melting point
Good ductility
High resistivity
Ability to emit white light when heated
Durability and long lifespan

(b) A workshop of 20 m by 25 m requires an illumination of 480 lux at the working bench level. If the mounting height of the lamps is 2 m above the bench level, the following alternatives are suggested:
(i) 120 W fluorescent lamp giving 2200 lumens
(ii) 240 W tungsten filament lamp giving 1000 lumens
Area = $20 \times 25 = 500$ m²
Required lumens = $480 \times 500 / (0.6 \times 0.8) = 240000 / 0.48 = 500000$ lumens

Number of lamps:
(i) Fluorescent: $500000 / 2200 = 227.27 \approx 228$ lamps
(ii) Tungsten: $500000 / 1000 = 500$ lamps

(c) An incandescent lamp with a luminous intensity of 60 cd in all direction provides an illumination of 26.7 lux at the surface of a table directly below the lamp.
(i) How far is the lamp above the table?
$E = I / d^2 \rightarrow d^2 = I / E = 60 / 26.7 = 2.247 \rightarrow d = \sqrt{2.247} = 1.5$ m

(ii) What illumination would be provided at the table by changing the lamp to 100 cd and reducing the height by 6.7 cm?
New height = 1.5 - 0.067 = 1.433 m
$E = I / d^2 = 100 / (1.433^2) = 100 / 2.053 = 48.72$ lux

15. (a) (i) Mention three types of D.C generators and give the application of each type.
Series generator – used in street lighting and arc welding.
Shunt generator – used for battery charging and lighting in vehicles.
Compound generator – used in industries requiring constant voltage.

(ii) Give three facts which differentiate lap winding from wave winding.
Lap winding has as many parallel paths as poles, while wave winding has only two parallel paths.
Lap winding is used for high current, low voltage machines; wave winding is for high voltage, low current machines.
Lap winding is more complex and occupies more space than wave winding.

(b) A D.C shunt generator supplies a current of 28A at 400 V. If the armature and field resistances are 0.5 Ω and 200 Ω respectively:

(ii) Calculate the armature current and the generated e.m.f.
Field current If = 400 / 200 = 2 A
Armature current Ia = IL + If = 28 + 2 = 30 A
Generated e.m.f = V + Ia × Ra = 400 + 30 × 0.5 = 400 + 15 = 415 V

16. (a) (i) What are the two differences between analogy instruments and digital instruments?
Analog instruments show readings using a pointer and scale, while digital instruments use numerical displays.
Analog instruments are less accurate and more affected by parallax error, while digital ones provide precise and direct readings.

(ii) Give four advantages of electronic instruments over electrical instruments basing on measurements.
Higher accuracy and precision
Faster response time
Compact and portable
Ability to store and transmit data

(b) Mention three advantages and three disadvantages of a moving iron instruments.
Advantages:
Can measure both AC and DC
Simple construction
Durable and cheap
Disadvantages:
Non-linear scale
Affected by stray magnetic fields
Low accuracy

(c) A moving coil instrument gives a full-scale deflection with a current of 60 mA and a voltage of 180 mV. With the help of a label sketch, calculate the value of a resistor to be connected in series with the instrument, so that it can be used to read up to 100 V.
Resistance needed = (100 - 0.18) / 0.06 = 99.82 / 0.06 = 1663.67 Ω
Required series resistor = 1663.67 Ω