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** **January Year: 1999**

Instructions

1. This paper consists of tweny six questions.

2. Answer all questions in section A and any FOUR questions from section B.

1. State the factors which are important when choosing a motor for a particular application.
The load requirements, operating speed, power rating, torque characteristics, duty cycle, and environmental conditions such as temperature, moisture, and dust influence motor selection.

2. Name the three parameters used in the calculation of the resistance value in a metal conductor.
Resistance depends on the resistivity of the material, length of the conductor, and cross-sectional area.

3. Name two advantages of miniature circuit breakers over cartridge fuses.
MCBs can be reset after tripping, while fuses must be replaced.
MCBs provide more accurate and reliable tripping under overload and short-circuit conditions.

4. What are the factors considered in determining a wiring system for use?
Environmental conditions, type of building, current-carrying capacity of conductors, mechanical protection required, and installation method.

5. What are the four essential requirements for an insulator?
High dielectric strength, mechanical strength, resistance to heat and chemicals, and moisture resistance.

6. State the two main parts in a d.c. machine.
The stator (field system) and the rotor (armature).

7. What do you mean by the term “protective multiple earthing”?
It is a system where the neutral conductor is earthed at multiple points along its length to reduce shock risk and improve reliability.

8. Why is a capacitor start necessary in a single-phase induction motor?
It provides a phase shift to create a rotating magnetic field which helps the motor start.

9. State four requirements necessary in a steel conduit wiring system.
Proper mechanical strength, corrosion resistance, correct fitting and termination, and electrical continuity.

10. State the number of 13A socket outlets including spurs that may be connected as a ring circuit in a floor area not exceeding 100m².
A maximum of 10 socket outlets can be connected to a single ring circuit.

11. What types of fluxes must be used when making electrical joints?
Non-corrosive, non-conductive, and resin-based fluxes to ensure good electrical connections without damaging the components.

12. Briefly explain the stroboscopic effect in a discharge lamp.
It is the illusion of a stationary or slow-moving object under a fluctuating light source due to the periodic fluctuation of light intensity.

13. Why is the filament of a tungsten lamp formed in a coil?
The coiled shape increases the surface area and temperature while reducing heat loss, making the lamp more efficient.

14. State only two methods which can be used to improve the power factor of an installation.
Using power factor correction capacitors and synchronous condensers.

15. Mention three methods of measuring the resistance of a wire.
Using an ohmmeter, Wheatstone bridge method, and voltmeter-ammeter method.

16. If the fusing factor is 1.5 and the minimum current (fusing current) that causes an element to blow is 7.5A, calculate the current rating of the fuse element.
Fuse rating = Fusing current / Fusing factor = 7.5 A / 1.5 = 5 A

17. Mention the two possible causes for a neon tube to flicker.
Low supply voltage and defective or aged starter or capacitor.

18. Define the following terms as shown in the IEE Regulations - definitions; (a) circuit (b) arm's reach
Circuit: A path in which electric current flows.
Arm's reach: The distance a person can reach from a standing or seated position, typically used for safety considerations.

19. Why is the iron core of a transformer laminated?
To reduce eddy current losses which cause heating and reduce efficiency.

20. What is a PEN conductor?
A conductor that combines the functions of both the protective earth (PE) and neutral (N) in a single conductor.

21. A 4-pole, 500 V shunt motor is lap-wound with 500 armature conductors. The armature resistance is 0.12 ohm and the flux per pole is 0.09 Wb. Calculate the respective speeds of the motor when the power outputs are such that the armature currents are 30 A and 50 A respectively.

To calculate the speed, we first determine the back emf (E) using the formula $E = P / I$, where P is the power output ($P = I^2R$) and I is the armature current.

For 30 A:
Power output = $30^2 \times 0.12 = 108$ W
Back emf, $E_1 = 108 / 30 = 3.6$ V
Speed, $N_1 = (3.6 \times 60 \times 2) / (0.09 \times 500) = 9.6$ rpm

For 50 A:
Power output = $50^2 \times 0.12 = 300$ W

Back emf, $E_2 = 300 / 50 = 6.0$ V
Speed, $N_2 = (6.0 \times 60 \times 2) / (0.09 \times 500) = 16.0$ rpm

22. A classroom with an area of 6 metres by 4 metres is to have an average illumination of 110 lux. The lamps chosen have an efficiency of 40 lm/W. The coefficient of utilisation is estimated to be 0.5 and a maintenance factor of 0.7 is to be allowed.

Area = $6 \times 4 = 24$ m²
Total lumens required = $24 \times 110 = 2640$ lumens
Actual lumen output required = $2640 / (0.5 \times 0.7) = 7542.86$ lumens
Power required = $7542.86 / 40 = 188.57$ W
Energy consumed = $188.57 \times 3 \times 5 \times 13 = 36765.65$ Wh = 36.77 kWh
Cost = $36.77 \times 0.90 = 33.09$ shillings

23. (a) Define the term "power factor" and explain how a low power factor affects the size of cable required to carry a given a.c. load.

Power factor is the ratio of real power (kW) to apparent power (kVA) and is given by $\cos(\theta)$. A low power factor means more current is required to deliver the same amount of real power, resulting in larger cable sizes to handle the increased current.

(b) A 240 V a.c. single phase induction motor delivers 16 kW at full load. The efficiency of the motor at this load is 80% at a power factor of 0.75 lagging.

(i) Input power = $16 / 0.80 = 20$ kW
Current drawn = $20000 / (240 \times 0.75) = 111.11$ A

(ii) Apparent power in kVA = $240 \times 111.11 / 1000 = 26.67$ kVA

24. (a) What is the function of a thermostat in an electric water heater?

A thermostat regulates the temperature by switching off the heater when a set temperature is reached and turning it back on when the temperature drops.

(b) A domestic consumer requires an immersion heater for a tank containing 0.16 m³ of water. Heat from 10°C to 50°C in 3 hours with 85% efficiency.

Mass = $0.16 \times 1000 = 160$ kg
Energy required = $160 \times 4187 \times (50 - 10) = 26796800$ J
Effective energy = $26796800 / 0.85 = 31525647.06$ J
Power = $31525647.06 / (3 \times 3600) = 2927.38$ W ≈ 2.93 kW

25. (a) Define the term "spacing height ratio".

Spacing height ratio is the ratio of the distance between adjacent light sources to their height above the workplane, used in lighting layout planning.

(b) A hall 15 m by 20 m to be illuminated to a level of 70 lux. Efficiency = 12 lm/W, spacing height ratio = 1.2, mounting height = 4 m

Area = 300 m²
Total lumens = 300 × 70 = 21000 lm
Adjusted lumens = 21000 / (0.7 × 0.5) = 60000 lm
Power required = 60000 / 12 = 5000 W
Number of 100 W lamps = 5000 / 100 = 50 lamps

26. (a) Mention only two methods used to cool distribution transformers.

Natural air cooling (AN) and oil-immersed cooling (ON) are two common cooling methods.

(b) A 20 KVA transformer has iron loss = 700 W and copper loss = 800 W at full load.

(i) Total losses = 1500 W
Efficiency = (20000 / (20000 + 1500)) × 100 = 93.02%

(ii) Half load copper loss = $(0.5)^2 \times 800 = 200$ W
Total losses = 700 + 200 = 900 W
Output = 10000 W
Efficiency = (10000 / (10000 + 900)) × 100 = 91.74%