higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T530**(E)**(J26)T

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

(8080074)

26 July 2019 (X-Paper)
09:00–12:00

Calculators may be used.

This question paper consists of 6 pages and a formula sheet of 2 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ELECTROTECHNICS N4
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Questions may be answered in any order but subsections of questions must NOT be separated.
5. Write neatly and legibly.

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QUESTION 1

Choose the correct option from the words given in brackets in the following sentences. Write only the correct option next to the question number (1.1–1.10) in the ANSWER BOOK.

1.1 In the centre of an atom is the (nucleus/electrons) consisting of protons and neutrons bound together by extremely powerful nuclear forces.

1.2 The residual flux density on hysteresis can be reduced to zero by applying (negative/positive) magnetic field strength.

1.3 When the magnet is pulled out of the coil, the meter registers a momentary current in the (same/opposite) direction. No current is registered while the magnet is at rest.

1.4 The third law of electromagnetism is known as (Lenz's law/Ohm's law).

1.5 The capacitance of a capacitor is (inversely proportional/directly proportional) to the area of the plates and inversely proportional to the distance between them.

1.6 The main frame for the general construction of a four-pole DC generator or motor is referred to as the (yoke/flux) and is made up of magnetic material.

1.7 Principles of a generator and a motor state that, if the conductor is moved (downwards/upwards), the EMF is in such a direction that the current produced sets up an upward force.

1.8 Lap windings can be compared to cells connected in (parallel/series), while wave windings can be compared to cells connected vice versa of the lap winding.

1.9 A series-connected machine has its field coils connected in (series/parallel) with the armature and, therefore, both carry the same amount of current.

1.10 Commutation is the reversal of the EMF and current in the (open-circuited/short-circuited) coil during its transfer from one commutator segment to the next.

(10 × 1) **[10]**

QUESTION 2

2.1 Briefly explain what is meant be Kirchhoff's second law. (2)

2.2 On what does the magnitude of the hysteresis loss depend? (2)

2.3 Name and describe the following laws of electromagnetism:

2.3.1 TWO principal laws (3)

2.3.2 ONE-third law (2)

2.4 A straight conductor, 30 cm long, is moved at right angles to a magnetic field with a flux density of 0,15 Wb/m² and a velocity of 5 m/s.

Calculate the following:

2.4.1 A magnitude of the EMF induced in the conductor

2.4.2 The force required to produce this movement if the ends of this conductor were connected to a circuit drawing 400 mA.

(2 × 2) (4)

2.5 A copper conductor and an aluminium conductor are connected in parallel and carry a combined current of 200 A. The diameter of the copper conductor is 10 mm and it carries 50 A. The length of each conductor is 2 km and the resistivity of copper and aluminium may be taken as 0,017 and 0,028 micro-ohm metres respectively.

Given the formula $R = \frac{\rho}{a}\ell$, manipulate and make 'd' the subject of the formula. Show all necessary steps, without calculating. (5)

[18]

QUESTION 3

3.1 Explain how the change of flux can be produced by including the EMF during electromagnetic induction as follows:

3.1.1 Dynamically

3.1.2 Statically

(2 × 1) (2)

3.2 What are the FOUR types of brushes normally used on DC machines? (4)

3.3 Why is one of the two DC machine types called separately-excited machines? (1)

3.4 Name the THREE types into which self-excited machines are subdivided. (3)

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3.5 An aluminium conductor, 3 km long, is connected in parallel with a copper conductor of the same length. When a current of 200 A passes through the combination, it is found that the current through the copper conductor is 50 A. The diameter of the aluminium conductor is 2 mm.

Calculate the following:

3.5.1 The diameter of the copper conductor if the specific resistivity of copper is 0,018 micro-ohm metres and that of the aluminium is 0,0028 micro-ohm metres. (7)

3.5.2 The voltage drop across the conductors (1)

[18]

QUESTION 4

4.1 Give THREE reasons why the voltage of a shunt generator may fail to excite. (3)

4.2 Show, by means of fully labelled load characteristics, how to represent three different types of DC motors. (5)

4.3 Induction motors are playing a very special role in increasing and fast tracking production for companies such as Acerlor Mittal, Hillside Alluminium, Mondi Paper, Eskom Generation, etc.

State FIVE advantages of a three-phase induction motor compared to a single-phase induction motor. (5 × 2) (10)

[18]

QUESTION 5

5.1 The construction of transformers is the simplest of all the AC machines.

What are THREE advantages of transformers? (3)

5.2 Transformers are constructed of different types of elements.

Name FIVE principal elements of transformers. (5)

5.3 Name THREE practical applications of capacitor-start, split-phase motors. (3)

5.4 Briefly explain how to reverse direction of rotation of a single-phase, split-phase induction motor. (2)

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5.5 A moving-coil instrument has a resistance of 10 ohms and gives a full-scale deflection when 25 mA flows through it.

Calculate the value of the additional circuit component required to enable the instrument to be used as:

5.5.1 An ammeter, reading 0 – 20 A (3)

5.5.2 A voltmeter, reading 0 – 110 V (2)

[18]

QUESTION 6

6.1 When measuring the value of a resistance by means of the voltmeter-ammeter method, the errors owing to the resistance of the meters must also be taken into account. There are two methods of connection used in an attempt to reduce these errors.

Name the TWO methods of connection. (2)

6.2 Why is water an important consideration for the location of a power station? (1)

6.3 Name the THREE measuring instruments to be considered when connecting instruments in an AC circuit using instrument transformers. (3)

6.4 In the ring system, failure of one interconnecting feeder does not interrupt the supply to any of the substations.

Show by means of a fully labelled sketch, how ring feeders run from the grid substation to the distributors. (12)

[18]

TOTAL: 100

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ELECTROTECHNICS N4

FORMULA SHEET

Any applicable formula may also be used.

1. Principles of electricity

$$E = V + Ir$$

$$V = IR$$

$$R_{se} = R_1 + R_2 + \ldots R_n$$

$$R_p = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \ldots \frac{1}{R_n}}$$

$$R = \rho \frac{\ell}{a}$$

$$\frac{R_1}{R_2} = \frac{1 + \alpha_o T_1}{1 + \alpha_o T_2}$$

$$R_t = R_\theta \left[1 + \alpha_\theta \left(t - \theta\right)\right]$$

$$P = VI = I^2 R = \frac{V^2}{R}$$

$$\Phi = \frac{mmf}{S} = \frac{IN}{S}$$

$$H = \frac{IN}{\ell}$$

$$F = B\ell I$$

$$E = \frac{\Delta\Phi}{\Delta t} . N$$

$$E = B\ell v$$

$$E = \frac{L\Delta I}{\Delta t}$$

$$L = \frac{\Delta\Phi}{\Delta I} . N$$

$$Q = VC$$

$$Q_{se} = Q_t = Q_1 = Q_2 \ldots = Q_n$$

$$C_{se} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \ldots \frac{1}{C_n}}$$

$$Q_p = Q_1 + Q_2 + \ldots Q_n$$

$$C_p = C_1 + C_2 + \ldots C_n$$

2. Direct-current machines

$$E = \frac{2Z}{c} . \frac{Np}{60} . \Phi$$

$$c = 2a$$

$$E_{gen} = V + I_a \ R_a$$

$$E_{mot} = V - I_a \ R_a$$

$$R_{start} = \frac{(V - E)}{I_a} - R_a$$

3. Alternating-current machines

$$E_m = 2\pi BANn$$

$$e = E_m \sin\left(2\pi f . \ t \times 57{,}3\right)°$$

$$E_{ave} = 0{,}637 \ E_m$$

$$E_{rms} = 0{,}707 \ E_m$$

$$T = \frac{1}{f}$$

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$$f = \frac{Np}{60}$$

$$\omega = 2\pi f$$

$$Z_L = R + j\omega L$$

$$Z_c = R - j\frac{1}{\omega C}$$

$$pf = \cos\phi = \frac{R}{Z}$$

$$S = VI$$

$$P = V.I\cos\phi = I^2R$$

$$Q = V.I\sin\phi$$

4. Transformers

$$E = 4{,}44\ f\ \Phi_m\ N$$

$$k_t = \frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1}$$

5. Measuring instruments

$$R_{SH} = \frac{i_m\ R_m}{I_{sh}}$$

$$R_{se} = \frac{V}{i_m} - R_m$$

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