higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T410**(E)**(N30)T

NOVEMBER EXAMINATION

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

(8080074)

30 November 2016 (X-Paper)
09:00–12:00

REQUIREMENTS: Graph paper

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. Write neatly and legibly.

QUESTION 1

1.1 Two batteries having an EMF of 60 V and 50 V and an internal resistance of 0, 3 ohm and 1, 5 ohms respectively are to be charged by a DC-generator having an EMF of 80 V and internal resistance of 0, 2 ohm.

Use Kirchhoff's laws to determine:

1.1.1 The value of the current supplied by the generator (4)

1.1.2 The value of the current through the battery A (2)

1.1.3 The value of the current through the battery B (2)

1.2 Calculate the value of an unknown resistor that is connected across a rheostat. The rheostat is connected in series with a heater element of 1 000 W. The value of the rheostat is 15 ohms and the heater draws 10 A when the whole circuit is connected across a 190 V supply. (7)

1.3 On what does the magnitude of the hysteresis loss depend? (3)

1.4 What is the reason that certain alloys are used in the manufacturing of standard resistors for the use in measuring instruments? (2)

[20]

QUESTION 2

2.1 Two capacitors of 8 microfarads and 10 microfarads respectively are connected in parallel across a 20-volt supply.

Determine the following:

2.1.1 The total capacitance

2.2.2 The potential difference across each capacitor

(2 × 3) (6)

2.2 Name any THREE types of capacitor. (3)

2.3 An aluminium conductor 500 m long is connected in parallel with a copper conductor, having the same length. When a current of 350 A passes through the combination it is found that the current through the copper conductor is 150 A. The diameter of the aluminium conductor is 20 mm.

Calculate the following:

2.3.1 The diameter of the copper conductor if the resistivity of copper is 0,017 micro-ohm metre and that of the aluminium is 0,028 micro-ohm metre. (6)

2.3.2 The voltage drop across the conductors (2)

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2.4 The resistance of a coil of wire increases from 200 ohms at 60 °C to 232 ohms at 100 °C.

Calculate the temperature coefficient of the conductor. (3)
[20]

QUESTION 3

3.1 The open-circuit characteristics of a separately excited DC-generator are as follows:

Terminal voltage (V)	80	160	260	310	320	330
Field current (A)	4	8	18	34	40	48

Plot a graph and determine:

3.1.1 The voltage to which the machine will excite on no-load when shunt connected if the total field resistance is 8 ohms

3.1.2 The value of the critical resistance.

(2 × 5) (10)

3.2 A short-shunt compound generator supplies a load current of 50 A. It has a shunt-field resistance of 10 ohms, an armature resistance of 0, 2 ohm and a field resistance of 0,8 ohm.

Calculate the armature EMF if the terminal voltage is 360 V. (5)

3.3 How can the field coils of DC-machines be connected with self-excitation? (3)

3.4 What is the chief purpose of a DC-motor starter? (2)
[20]

QUESTION 4

4.1 A single-phase 888 0/888 -V, 50 Hz transformer has a net area of 200 cm² and a maximum flux density of 1 Tesla.

Estimate the number of turns in each winding. (6)

4.2 A sinusoidal AC-supply has a RMS value of 360 V and a frequency of 50 Hz.

Determine the following:

4.2.1 The maximum value of the voltage

4.2.2 The periodic time in milliseconds

(2 × 1) (2)

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4.3 4.3.1 In a certain circuit of three parallel branches, the instantaneous branch currents are represented by:

$$i_1 = 60Sin(wt - \frac{\pi}{4})A$$

$$i_2 = 30Sin(wt + \frac{\pi}{6})A$$

Calculate the magnitude of the supply current and write it in the form:

$$i = I_{max}Sin(wt + \theta)$$

(5)

4.3.2 Represent these currents by drawing a phasor diagram. (2)

4.4 An impedance of 9 + j9 ohms and an impedance of 3–j3 ohms are connected in series across a 268,3282 V 50 Hz supply.

Calculate the following:

4.4.1 The current flowing in the circuit (3)

4.4.2 The power factor of the circuit (2)

[20]

QUESTION 5

5.1 A 360 V-DC supply is connected across a circuit of a 400 ohms resistor in series with a resistor of unknown value. A voltmeter having a resistance of 600 ohms is connected across the 400 ohms resistor and shows a reading of 120 volts.

Calculate the value of the unknown resistor. (5)

5.2 What is the function of a Buchholz device on a transformer? (2)

5.3 What is the purpose of the capacitor in a single-phase capacitor motor? (3)

5.4 What crystals are commonly used in the breather of a transformer and what purpose do they serve? (2)

5.5 5.5.1 Name two types of feeders used in transmission systems. (2)

5.5.2 In which system does failure of one interconnecting feeder interrupt the supply to any of the other substations? (1)

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5.6 An ideal 30–kVA transformer has 3 000 primary turns and 300 secondary turns. The primary windings are connected to a 6–kV, 60 Hz supply.

Calculate the following:

5.6.1 The secondary voltage (1)

5.6.2 The value of the secondary and the primary currents on full load (2)

5.6.3 The maximum core flux (2)

[20]

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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