higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T470**(E)**(A12)T

APRIL EXAMINATION

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

(8080074)

12 April 2016 (X-Paper)
13:00–16:00

REQUIREMENTS: **Graph paper**

Calculators may be used.

This question paper consists of 6 pages and 1 formula sheet of 2 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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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.

Tec

QUESTION 1

1.1 Two capacitors of 12 microfarads and 6 microfarads respectively are connected in series across a 20-volt supply.

Calculate the following:

1.1.1 The total capacitance. (2)

1.1.2 The pd across each capacitor. (4)

1.2 Why are certain currents that circulate in transformer cores undesirable and what are they called? (3)

1.3 An aluminium conductor, 1,5 km long, is connected in parallel with a copper conductor of the same length. When a current of 300 A passes through the combination it is found that the current through the copper conductor is 100 A. The diameter of the aluminium conductor is 5 mm.

Calculate the following:

1.3.1 The diameter of the copper conductor if the resistivity of copper is 0,018 micro-ohm metres and that of the aluminium is 0,028 micro-ohm metres. (6)

1.3.2 The voltage drop across the conductors. (2)

1.4 The field coil of a motor has a resistance of 500 ohm at 40 °C.

By how much will the resistance increase if the motor reaches a temperature of 60 °C when running? Take the temperature coefficient of resistance as 0,004 per °C at 40 °C. (3)
[20]

QUESTION 2

2.1 A DC-generator with an EMF 150 V and internal resistance of 0,25 ohms is connected in parallel with a battery with an EMF of 80 V and internal resistance of 0,6 ohms. The combination is used to supply a load with a resistance of 5 ohms.

Draw the circuit and use Kirchhoff's laws to calculate:

2.1.1 The value of the current supplied by the generator (5)

2.1.2 The value of the current through the battery (2)

2.1.3 The terminal voltage across the load (2)

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2.2 A resistance of 9 ohms is connected in parallel with a resistance of 9 ohms, which is then connected in series with a third resistance. The circuit is connected across a 100 V DC supply and draws a current of 20 A.

Calculate:

2.2.1 The voltage across the resistors (5)

2.2.2 The currents through the parallel resistors (2)

2.3 Define the term *ampere*. (3)

2.4 What is the reason why certain alloys are used in the manufacturing of standard resistors for use in measuring instruments? (1)
[20]

QUESTION 3

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

Terminal voltage (V)	20	40	50	60	77,5	80	82,5
Field current (A)	1	2	3	4	8	10	12

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 (5 x 2) (10)

3.2 A short shunt compound generator supplies a load current of 40 A. It has a shunt field resistance of 30 ohms, an armature resistance of 0,4 ohms and a field resistance of 0, 25 ohms.

Calculate the armature EMF if the terminal voltage is 290 V. (5)

3.3 Name THREE methods that can be used to overcome the effects of armature reaction. (3)

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

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QUESTION 4

4.1 A single-phase 1110/111 -V, 50 Hz transformer has a net area of 10 cm² and 200 turns on the primary windings.

Calculate the following:

4.1.1 The maximum flux density in Tesla (3)

4.1.2 The number of turns on the secondary windings (2)

4.2 A sinusoidal AC-supply has a RMS value of 424,2 V and a periodic time of 25 milliseconds.

Calculate the following:

4.2.1 The maximum value of the voltage

4.2.2 The frequency of the supply (2 x 1) (2)

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

$$i_1 = 6,708Sin(wt + \frac{p}{6})A$$

$$i_2 = 6,708Sin(wt - \frac{p}{6})A$$

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

$$i = I_{max} Sin\,(wt + \theta)$$ (4)

4.4 An impedance of 15 + j10 ohms and an impedance of 15 – j10 are connected in series across a 270,825 V 50 Hz supply.

Calculate the following:

4.4.1 The total impedance of the circuit (4)

4.4.2 The total current flowing in the circuit (1)

4.4.3 The current in each branch (2)

4.4.4 The total power (1)

4.4.5 The power factor of the circuit (1)

[20]

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QUESTION 5

5.1 A single-phase transformer has 20 secondary turns and 40 primary turns. The secondary winding is connected to a 200 volt supply.

Calculate the following:

5.1.1 The primary voltage (2)

5.1.2 The value of the primary current when the secondary current is 20 A (2)

5.1.3 The primary power if the load has a power factor of 0,6 (1)

5.2 Name THREE types of capacitors. (3)

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

5.4 Name TWO of the most common methods of cooling transformers. (2)

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

5.6 A 400 V DC-supply is connected across a circuit of a 200 ohms resistor in series with a resistor of unknown value. A voltmeter with a resistance of 800 ohms is connected across the 200 ohms resistor and shows a reading of 200 volt.

Calculate the value of the unknown resistor. (5)
[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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