higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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NOVEMBER 2010

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

(8080074)

16 November (X-Paper)
09:00 – 12:00

REQUIREMENTS: Graph paper

Calculators may be used.

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

1.2 A resistor of unknown value R is connected in parallel with a resistance of 20 ohms. This combination is connected in series with a resistance of 8 ohms. The circuit is then connected across a 36 V DC supply.

Calculate the following:

1.2.1 The value of the resistor R when a 1,8 A current is drawn from the supply

1.2.2 The power dissipated in the circuit (7)

1.3 What are the properties of hard and soft magnetic materials and where are they used? (4)
[20]

QUESTION 2

2.1 Two capacitors of 2,5 microfarads and 10 microfarads are connected in series across a 125 volt supply.

Calculate the following:

2.1.1 The total capacitance

2.1.2 The potential difference across each capacitor (6)

2.2 State Lenz's law. (3)

2.3 An aluminium conductor 20 m long is connected in parallel with a copper conductor, having the same length. When a current of 25 A passed through the combination, it is found that the current through the copper conductor is 15 A. The diameter of the aluminium conductor is 1,5 mm.

Calculate the following:

2.3.1 The diameter of the copper conductor if the resistivity of copper is 0,017 micro ohm metres and that of the aluminium is 0,028 micro ohm metres

2.3.2 The voltage drop across the conductors (8)

2.4 The resistance of a coil of wire increases from 100 ohms at 35 °C while the temperature coefficient of the conductor is 0,004 per degree Celsius at 35 °C. Find the increase in the resistance if the temperature is 75 °C. (3)
[20]

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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NATIONAL CERTIFICATE
ELECTROTECHNICS N6
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers correctly 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 75 V and 45 V and an internal resistance of 0,4 ohm and 1,2 ohms respectively, are to be charged by a generator having an EMF of 90 V and an internal resistance of 0,2 ohm.

Use Kirchhoff's laws to determine the following:

1.1.1 The value of the current supplied by the generator
1.1.2 The value of the current through the battery A
1.1.3 The value of the current through the battery B (9)

QUESTION 3

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

EMF (V)	4	8	13	15,5	16	16,5
Field current (A)	0,2	0,4	0,9	1,7	2,0	2,4

Plot a graph and determine the following:

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 (10)

3.2 A short shunt compound generator supplies a load current of 100 A. It has a shunt field resistance of 40 ohms, an armature resistance of 0,2 ohms and a field resistance of 0,5 ohms.

Calculate the armature EMF if the terminal voltage is 150 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 5 550/555 V, 50 Hz transformer has a net area of 50 cm^2 and a maximum flux density of 0,5 Tesla. Estimate the number of turns in each winding. (6)

4.2 A sinusoidal AC supply has a maximum value of 339,463 V and a frequency of 50 Hz.

Calculate the following:

4.2.1 The RMS value of the voltage

4.2.2 The periodic time in milliseconds (2)

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

$$i_1 = 30Sin(wt - \frac{\pi}{6})A$$

$$i_2 = 60Sin(wt + \frac{\pi}{3})A$$

$$i_3 = 60Sin(wt + \frac{\pi}{4})A$$

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

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

4.3.2 Represent these currents by drawing a phasor diagram. (7)

4.4 An impedance of 9 + j6 ohms and an impedance of -6 - j3 ohms are connected in series across a 424,30 V 50 Hz supply.

Calculate the following:

4.4.1 The current flowing in the circuit

4.4.2 The power factor of the circuit (5)
[20]

QUESTION 5

5.1 A 480 V DC supply is connected across a circuit of a 120 ohms resistor in series with a resistor of unknown value. A voltmeter having a resistance of 150 ohms is connected across the 120 ohms resistor and shows a reading of 30 volt. Calculate the value of the unknown resistor. (5)

5.2 What is the function of 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)

5.6 An ideal 10 kVA transformer has 800 primary turns and 40 secondary turns.

The primary windings are connected to a 1 kV, 50 Hz supply.

Calculate the following:

5.6.1 Secondary voltage
5.6.2 Value of the secondary current and primary currents on full load
5.6.3 Maximum core flux (5)
[20]

TOTAL: 100

ELECTROTECHNICS N4

FORMULA SHEET

Any applicable formula may also be used.

1. *Principles of electricity*

$$E = V + Ir$$

$$V = IR$$

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

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

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

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

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

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

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

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

$$F = B\ell I$$

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

$$E = B\ell v$$

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

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

$$Q = VC$$

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

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

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

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

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*

$$E_m = 2\pi BANn$$

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

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

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

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

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

$$\omega = 2\pi f$$

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

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

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

$$S = VI$$

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

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

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*

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

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