education

Department:
Education
REPUBLIC OF SOUTH AFRICA

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APRIL 2010

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

(8080074)

7 April (X-Paper)
09:00 – 12:00

REQUIREMENTS: Graph paper

Calculators may be used.

This question paper consists of 5 pages and a 2-page formula sheet.

DEPARTMENT OF EDUCATION
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 correctly according to the numbering system used in this question paper.
4. Write neatly and legibly.

QUESTION 1

1.1 A coil having 1 000 turns of conductor with a cross-sectional area of 50 mm² and a mean length per turn of 100 mm, has an inductance of 10 henry.

Calculate the following:

1.1.1 The resistance of the winding if the specific resistance of the conductor is 50 micro-ohm metres

1.1.2 The average value of the EMF induced in the coil when a current of 10 A is reversed in 10 seconds (5)

1.2 A resistor of unknown value R is connected in parallel with a resistance of 25 ohms. This combination is connected in series with a resistance of 20 ohms.

The circuit is then connected across a 200 V DC supply.

Calculate the following:

1.2.1 The value of the resistor R when a 5 A current is drawn from the supply

1.2.2 The power dissipated in the circuit (6)

1.3 Distinguish between a positive and a negative temperature coefficient of resistance. (3)

1.4 The field coil of a motor has a resistance of 300 ohms at 30 °C. By how much will the resistance increase if the motor attains a temperature of 80 °C when running? Take the temperature coefficient of resistance as 0,004 per degree Celsius at 30 °C. (4)

1.5 What does Kirchhoff's first law mean? (2)
[20]

QUESTION 2

2.1 Calculate the magnetomotive force required to produce a flux of 10 mWb in a magnetic circuit having a reluctance of 30 000 A/Wb. (2)

2.2 Two batteries of EMF 20 V and 60 V and internal resistance of 0,8 ohms and 0,4 ohms respectively, are connected in parallel to supply a load resistance of 0,4 ohms.

Use Kirchhoff 's laws to determine the voltage across the load and the current supplied by each battery. (9)

2.3 Define the *farad*. (3)

2.4 Two capacitors connected in series have respective volt readings of 60 V and 15 V. If the total charge equals 600 µC, determine the following:

2.4.1 The total capacitance

2.4.2 The value of each capacitor (6)
[20]

QUESTION 3

3.1 The open-circuit characteristics of a shunt-excited DC machine are as follow:

Terminal voltage (V)	100	200	250	290	305	310
Field current (A)	10	20	30	50	65	75

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 5 ohms

3.1.2 The critical resistance (10)

3.2 A long-shunt compound-wound DC machine has an armature resistance of 0,2 ohms, a series field resistance of 0,1 ohms and a shunt field resistance of 30 ohms. The machine draws a current of 110 A from a 300 V DC supply when run as a motor.

Calculate the EMF generated in the armature. (5)

3.3 What is the purpose of a pole shoe in a DC machine? (2)

3.4 Make a neat sketch to illustrate magnetic fringing, leakage flux and useful flux. (3)
[20]

QUESTION 4

4.1 What can be done to improve the power factor? (2)

4.2 A 50 Hz sinusoidal voltage has an RMS value of 424,2 V. If the initial instantaneous voltage is zero and rising positively, find the time for the voltage to reach a value of 300 V from zero for the first time.

Draw a phasor diagram and show the waveform of this voltage. (6)

4.3 A coil with a resistance of 387,3 ohms and an inductance of 0,63662 henry is connected in series with a 10,6103 microfarad capacitor. This circuit is connected across a 400 V, 50 Hz supply.

Calculate the voltage drop across:

4.3.1 The coil

4.3.2 The capacitor (8)

Draw the phasor diagram to represent the distribution of the voltage and the current in the circuit. (4)
[20]

QUESTION 5

5.1 The value of a resistor is measured by the voltmeter-ammeter method. The internal resistance of the voltmeter is 400 ohms. When the voltmeter is connected directly across the resistance to be measured, then the ammeter reads 5 A and the voltmeter 300 V.

Calculate the value of the resistor:

5.1.1 Approximately

5.1.2 Accurately

5.1.3 The percentage error in the value of the resistance (6)

5.2 The no-load current of a 8 880/400 V single-phase transformer is 10 A at a power factor of 0,1. The primary winding has 40 turns and the supply frequency is 50 Hz.

Calculate the following:

5.2.1 The maximum value of the flux in the core

5.2.2 The power loss on no-load

5.2.3 The value of the magnetising current (6)

5.3 Which device is used on a transformer that serves as a protection system and what does it also activate? (2)

5.4 Why are the rotor bars of an induction motor skewed? (2)

5.5 State any FOUR disadvantages of a single-phase motor compared to a three-phase motor. (4)
[20]

TOTAL: 100

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

$$\omega = 2\pi f$$

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

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

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

$$S = VI$$

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

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

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

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

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