higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T550(**E**)(M28)T

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

(8080074)

28 March 2017 (X-Paper)
09:00–12:00

REQUIREMENTS: Graph paper

Calculators and drawing instruments may be used.

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

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.

QUESTION 1

1.1 A coil having 1 000 turns of conducting wire with a cross-sectional area of 100 mm² and a mean length per turn of 100 mm, has an inductance of 2 henry.

Determine the following:

1.1.1 The resistance of the winding if the specific resistance of the conductor is 2 micro-ohm metres. (3)

1.1.2 The average value of the EMF induced in the coil when a current of 5 A is reversed in 10 seconds. (2)

1.2 A resistor of unknown value R is connected in parallel with a resistor of 15 ohms. This combination is connected in series with a resistance of 30 ohms. The circuit is then connected across a 160 V DC-supply.

Determine the following:

1.2.1 The value of the resistor R when a 4 A current is drawn from the supply.

1.2.2 The power dissipated in the circuit.

(2 × 3) (6)

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

1.4 The field coils of a motor have a resistance of 125 ohms at 50 °C. By how much will the resistance increase if the motor attains a temperature of 150 °C when running?

Take the temperature coefficient of resistance as 0,004 per degree Celsius at 50 °C. (4)

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

[20]

QUESTION 2

2.1 What magnetomotive force is required to produce a flux of 5 mWb in a magnetic circuit having a reluctance of 50 000 A/Wb? (2)

2.2 Two batteries with an EMF of 45 V and 90 V, and an internal resistance of 0,3 ohms and 0,3 ohms respectively, are connected in parallel to supply a load resistance of 1,2 ohms.

Use Kirchhoff's laws to determine:

2.2.1 The voltage across the load (5)

2.2.2 The current supplied by each battery (4)

2.3 Define the term *farad.* (3)

2.4 Two capacitors connected in series have respective volt readings of 18 V and 6 V.

If the total charge equals 1 800 μC, determine the following:

2.4.1 The total capacitance (4)

2.4.2 The value of each capacitor (2)

[20]

QUESTION 3

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

Terminal voltage (V)	20	40	50	58	61	62
Field current (A)	2	4	6	10	13	15

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 ohm.

3.1.2 The critical resistance.

(10)

3.2 A long-shunt compound-wound DC-machine has a armature resistance of 0,4 ohms, a series field resistance of 0,2 ohms, and a shunt field resistance of 40 ohms. The machine draws a current of 50 A from a 400 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 Name the THREE main components of an induction motor. (3)
[20]

QUESTION 4

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

4.2 A 50 Hz sinusoidal voltage has a RMS value of 282,8 V.

Determine the following:

4.2.1 The time for the voltage to reach a value of 200 V from zero for the first time (5)

4.2.2 Draw a phasor diagram and show the waveform of this voltage. (1)

4.3 A coil with a resistance of 200 ohms and an inductance of 0,79578 henry is connected in series with a 7,957 microfarad capacitor. This circuit is connected across a 250 V, 50 Hz supply.

Calculate the voltage drop across the following:

4.3.1 The coil (6)

4.3.2 The capacitor (2)

4.3.3 Draw a 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 300 ohms. When the voltmeter is connected directly across the resistance to be measured, then the ammeter reads 3 A and the voltmeter 150 V.

Calculate the value of the unknown resistor:

5.1.1 Approximately

5.1.2 Accurately

5.1.3 Determine the percentage error in the value of the resistance.

(3 × 2) (6)

5.2 The no-load current of a 2 000/250 V single-phase transformer is 10 A at a power factor of 0,3. The primary winding has 200 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

(3 × 2) (6)

5.3 What 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 Name any FOUR disadvantages of a single-phase motor compared to a three-phase motor. (4)

[20]

TOTAL: 100

ELECTROTECHNICS N4

FORMULA SHEET

Any applicable formula may also be used.

1. Principles of electricity

$$E = V + Ir$$

$$V = IR$$

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

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

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

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

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

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

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

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

$$F = B\ell I$$

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

$$E = B\ell v$$

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

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

$$Q = VC$$

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

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

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

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

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

$$E_m = 2\pi BANn$$

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

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

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

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

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

$$\omega = 2\pi f$$

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

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

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

$S = VI$

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

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

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

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

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