T530**(E)**(N15)T

NATIONAL CERTIFICATE

ELECTROTECHNICS N4

(8080074)

15 November 2018 (X-Paper)
09:00–12:00

Calculators may be used.

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

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.   Questions may be answered in any order but subsections of questions must
        be kept together.

5.   Write neatly and legibly.

QUESTION 1

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (1.1–1.10) in the ANSWER BOOK.

1.1   The ampere is that current which, if maintained in two straight pependicular conductors of infinite length of negligible cross-sectional area, and placed 1 metre apart in a vacuum, would produce between the conductors a force of 2×10^{-15} newtons per metre of length.

1.2   Electromotive force is that force which tends to produce an electric current in a circuit.

1.3   A unit of resistance is that resistance in which a current of 1 ampere flowing for 1 second generates 1 joule of thermal energy, and the unit in which it is measured is the ohm.

1.4   Primary and secondary cells are the principal sources of emf.

1.5   The resistance of material is always inversely proportional to the type of material, inversely proportional to its cross-sectional area, and proportional to the length of the material.

1.6   Materials such as paper and cotton become brittle if their temperature is allowed to exceed 100 ºC.

1.7   The third law of electromagnetism is known as Faraday's law.

1.8   The emf in terms of inductance and the rate of change of current may be expressed as $E_{ave} = \dfrac{-L\Delta I}{\Delta t} volts$.

1.9   Fleming's left-hand rule states that if the thumb, index and middle finger are held at right angles to one another with the index finger pointing in the direction of the current and the middle finger in the direction of the force, the thumb will indicate the direction of the flux.

1.10   The voltage is that amount of magnetic flux which, when cut at a uniform rate by a conductor in 1 second, generates an emf of 1 volt.

(10 × 1)   **[10]**

QUESTION 2

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

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

2.3   Distinguish between a *positive* and a *negative* temperature coefficient of
      resistance.   (4)

2.4   Briefly explain what is understood by Kirchoff's first law.   (2)

2.5   Define *temperature coefficient of resistance* at 0 ºC.   (2)

2.6   A coil with 550 turns of a conductor with a cross-sectional area of 0,3 mm²
      and a mean length per turn of 150 mm has an inductance of 0,5 henry.

      Calculate the following:

      2.6.1   Resistance of the windings if the specific resistance of the
              conductor is 0,02 micro-ohm metres.   (3)

      2.6.2   Average value of the emf induced in the coil when a current of 5 A
              is reversed in 0,4 seconds.   (2)
                                                                                                  [18]

QUESTION 3

3.1   State Lenz's law.   (3)

3.2   Define *Farad*.   (2)

3.3   What is meant by each of the following terms?

      3.3.1   High permeability

      3.3.2   Low permeability

                                                                                       (2 × 1)   (2)

3.4   Define *ampere.*   (3)

3.5   What is the function of a pole core in a DC machine?   (2)

3.6   Three capacitors of values 30, 90 and 180 microfarads are placed in series
      across a DC supply of 180 V.

      Determine the charge and voltage across each capacitor.   (6)
                                                                                                  [18]

QUESTION 4

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

4.2   What is the chief purpose of a DC motor starter?   (2)

4.3   Briefly explain the Barkhausen effect.   (3)

4.4   Name THREE types of capacitors.   (3)

4.5   Give the type of winding used for each of the following:

     4.5.1   High-voltage, low-current DC machine

     4.5.2   High-current, low-voltage DC machine

                                          (2 × 1)   (2)

4.6   A short-shunt compound generator supplies a load current of 200 A. It has a shunt field resistance of 59 ohms, an armature resistance of 0,1 ohm and a field resistance of 0,08 ohms.

     Calculate the armature emf if the terminal voltage is 220 V.   (5)
[18]

QUESTION 5

5.1   Why are the rotor bars of a motor skewed?   (2)

5.2   A sinusoidal AC supply has a maximum value of 311,174 V and a frequency of 50 Hz.

     Calculate the following:

     5.2.1   RMS value of the voltage

     5.2.2   Period in milliseconds

                                          (2 × 1)   (2)

5.3   An impedance of 6 + j4 ohms and an impedance of 4–j2 ohms are connected in series across a 220 V, 50 Hz supply.

     Calculate the following:

     5.3.1   Current flowing in the circuit   (4)

     5.3.2   Power factor of the circuit   (2)

5.4   A coil with a resistance of 20 ohms and an inductance of 45 mH is connected in series with a 330 microfarad capacitor. This circuit is connected across a 250 V, 50 Hz supply.

Calculate the voltage drop across each of the following:

5.4.1   Coil   (7)

5.4.2   Capacitor   (1)
                                                                                                         [18]

QUESTION 6

6.1   Name FIVE types of power stations.   (5)

6.2   Name the system in which failure of one interconnecting feeder does not interrupt the supply to any of the substations.   (1)

6.3   In the radial system failure of a feeder interrupts the supply to a substation.

Show, by means of a fully labelled sketch, how radial feeders run from the grid substation to distributors.   (12)
                                                                                                         [18]

                                                                            TOTAL: **100**

ELECTROTECHNICS N4

FORMULA SHEET

Any other applicable formula may also be used.

1. Principles of electricity

$E = V + Ir$

$V = IR$

$R_{se} = R_1 + R_2 + ... R_n$

$R_p = \dfrac{1}{\dfrac{1}{R_1} + \dfrac{1}{R_2} + ... \dfrac{1}{R_n}}$

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

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

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

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

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

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

$F = B\ell I$

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

$E = B\ell v$

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

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

$Q = VC$

$Q_{se} = Q_t = Q_1 = Q_2 ... = Q_n$

$C_{se} = \dfrac{1}{\dfrac{1}{C_1} + \dfrac{1}{C_2} + ... \dfrac{1}{C_n}}$

$Q_p = Q_1 + Q_2 + ... Q_n$

$C_p = C_1 + C_2 + ... C_n$

2. Direct-current machines

$E = \dfrac{2Z}{c} . \dfrac{Np}{60} . \Phi$

$c = 2a$

$E_{gen} = V + I_a R_a$

$E_{mot} = V - I_a R_a$

$R_{start} = \dfrac{(V - E)}{I_a} - R_a$

3. Alternating-current machines

$E_m = 2\pi BANn$

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

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

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

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

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

$$\omega = 2\pi f$$

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

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

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

$$S = VI$$

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

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

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*

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

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