Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2018

ELECTRICAL TECHNOLOGY: POWER SYSTEMS

MARKS: **200**

TIME: **3 hours**

* I E L T T E 1 *

This question paper consists of 11 pages, including a formula sheet.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of NINE questions.
2. Answer ALL the questions.
3. Sketches and diagrams must be large, neat and fully labelled.
4. ALL calculations must be shown, and correctly rounded off to TWO decimal places.
5. Answers must be numbered correctly according to the numbering system used in this question paper.
6. You may use a non-programmable calculator.
7. A formula sheet is provided at the end of the question paper.
8. Write neatly and legibly.

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY

1.1 State ONE unsafe condition that may cause injury in an electrical technology workshop. (1)

1.2 Explain the importance of having good housekeeping in place. (2)

1.3 Explain the term *nip point* and mention ONE method used to protect workers from injury against *nip points*. (3)
[6]

QUESTION 2: TOOLS AND MEASURING INSTRUMENTS

2.1 Briefly explain what a *dry joint* is when soldering. (2)

2.2 Give any TWO examples where measurements are taken by an oscilloscope. (2)

2.3 In your own words explain why we would use an insulation resistance tester instead of a digital multi-meter when testing insulation resistance. (2)
[6]

QUESTION 3: DC MACHINES

3.1 Name THREE types of losses that occur in DC machines. (3)

3.2 Briefly explain the reason behind the construction of the armature in a DC machine. (2)

3.3 Explain in your own words how you will change the direction of rotation of a capacitor start induction motor. (2)

3.4 A 250 kW, eight pole machine has 768 armature conductors. Calculate the number of conductors per parallel path if it is:

3.4.1 Lap wound (4)

3.4.2 Wave wound (3)

3.5 Name and explain the greatest advantage that DC machines have. (3)

3.6 Mention any TWO tests performed on a single-phase motor before connecting it to the supply. (2)

3.7 Describe by means of a characteristic curve the different types of DC machines. (5)

3.8 Name TWO methods used to reduce commutation. (2)

[26]

QUESTION 4: SINGLE-PHASE AC GENERATION

4.1 Explain what is meant by the term *Root-Mean-Square value* of an AC waveform. (2)

4.2 Differentiate between *alternating current* and *direct current*. (2)

4.3 Briefly explain with the aid of neat diagrams, how single-phase electricity is generated. (7)

4.4 A bar magnet with a cross-sectional area of 9 cm^2 has a flux density of 3 Wb/m^2. Calculate the flux at each pole. (3)

4.5 With reference to AC generators, answer the following questions.

4.5.1 How does the number of windings of the coil affect the generated EMF? (2)

4.5.2 How does increasing the number of pole pairs affect the frequency of the generated EMF? (2)

4.5.3 Why is it necessary to laminate the core used in generators? (2)

4.6 An AC signal has a peak value of 75 V. Calculate the RMS and average values for this signal. (6)

[26]

QUESTION 5: SINGLE-PHASE TRANSFORMERS

5.1 How are transformers rated? (1)

5.2 Name THREE types of losses that occur in transformers. (3)

5.3 What is the purpose of a potential transformer and a current transformer in high voltage circuitry? (2)

5.4 Explain the function of an isolation transformer. (2)

5.5 A 220/24 Volt transformer can deliver 2 amperes. Calculate:

5.5.1 The transformation ratio of the transformer (3)

5.5.2 The resistive value of the load so that not more than 2 amperes is drawn from the transformer (3)

5.5.3 The primary current (3)

5.6 Draw a labelled diagram of a voltage instrument transformer connected in a circuit. (5)

5.7 Explain the principle of operation of a transformer. (4)

[26]

QUESTION 6: RLC-CIRCUITS

6.1 6.1.1 How is the reactance of a capacitor influenced by a decrease in frequency? (1)

6.1.2 How is the reactance of an inductor influenced by a decrease in frequency? (1)

6.2 A circuit with a resistor of 4 Ω, an inductor with an inductive reactance of 157 Ω and a variable capacitor set to 120 µF are connected in series to a 100 V/50 Hz supply.

Calculate:

6.2.1 The value of the capacitance that will result in resonance at 50 Hz (3)

6.2.2 The Q-factor of the circuit at resonance (3)

6.3 FIGURE 6.3 shows the relationship between the inductive reactance and the capacitive reactance against frequency in an RLC series circuit. Study FIGURE 6.3 and answer the questions that follow.

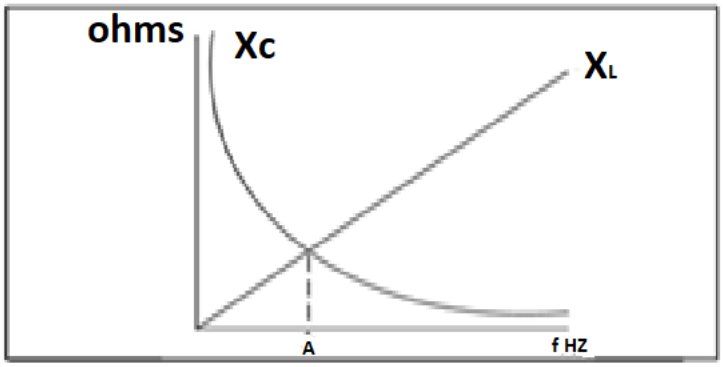

FIGURE 6.3

6.3.1 Explain the effect of frequency on the impedance of the circuit at point **A**. (2)

6.3.2 Calculate the frequency at point **A** if the circuit included a 50 µF capacitor and a 0,1 H inductor.
Given: C = 50 µF
L = 0,1 H (3)

6.4 A series circuit consists of a capacitor with a capacitive reactance of 20 Ω, an inductor withan inductive reactance of 40 Ω and a resistor with a resistance of 30 Ω connected across a 240 V/50 HZ supply.

Calculate the:

6.4.1 Impedance of the circuit (3)

6.4.2 Phase angle of the circuit and state if it is leading or lagging (4)

[20]

QUESTION 7: CONTROL DEVICES

7.1 Name the parts of a circuit breaker that determines its capacity. (2)

7.2 Differentiate between *hardware* and *software* as components of PLC. (4)

7.3 Draw the complete zero- volt coil/ no- volt coil wiring diagram, connected to a transformer, used for bigger motors. (6)

7.4 Briefly describe the condition under which the zero volt /no-volt coil circuit will operate. (2)

7.5 Name THREE causes of over-current situations. (3)

7.6 Briefly describe the conditions under which a PTC operates. (3)

7.7 The circuit in FIGURE 7.7 below represents a logic function.

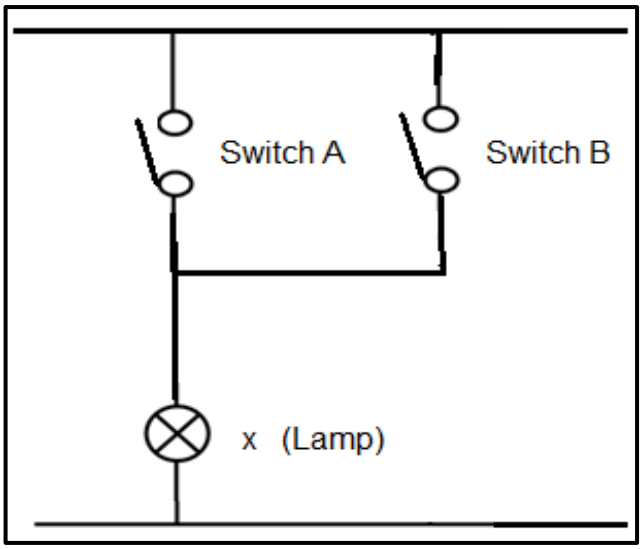

FIGURE 7.7

7.7.1 Name the logic function this circuit represents. (1)

7.7.2 Draw the equivalent logic symbol for this circuit. (2)

7.7.3 Draw the truth table of the logic function. (2)

7.7.4 Draw the ladder logic diagram of this circuit. (5)

7.8 Name TWO input terms of latching. (2)

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QUESTION 8: SINGLE-PHASE MOTORS

8.1 State the purpose of overload protection in motors. (2)

8.2 Name the THREE main parts of a single-phase induction motor. (3)

8.3 Draw a neat, labelled circuit diagram of a capacitor start motor. (9)

8.4 Mention any TWO tests performed on a single-phase motor before connecting it to the supply. (2)

8.5 Give TWO advantages of a capacitor-start, capacitor run motor system. (2)

8.6 Explain in your own words how you would change the direction of rotation of a capacitor start induction motor. (2)

8.7 Explain what a *synchronous motor* is. (3)

8.8 Before a single-phase motor is put into service, various electrical tests need to be done. A continuity test and insulation test. The insulation test comprises two operations.

8.8.1 What is the purpose of the continuity test? (1)

8.8.2 Name the TWO insulation resistance tests performed on the motor. (2)

8.8.3 State which test instrument must be used for the insulation test. (1)

8.8.4 What readings are acceptable for the insulation tests? (1)

8.9 Explain how a universal motor is able to operate on an AC voltage supply. (2)

8.10 Write down any TWO applications of a split-phase motor. (2)

[32]

QUESTION 9: POWER SUPPLIES

9.1 Draw and label TWO output waveforms to illustrate the difference between full wave and half wave rectification. (2)

9.2 List the FOUR stages of a DC power supply. (4)

9.3 Draw a block diagram showing the four stages of a power supply circuit with each stage clearly labelled and the voltage wave shape produced by each. (8)

9.4 A half wave circuit is connected to a step-down transformer which produces a secondary AC voltage of 23 V and a silicon diode with a junction voltage of 0,6 V.

Calculate:

9.4.1 The peak secondary voltage (3)

9.4.2 The peak load voltage (3)

9.4.3 The average load voltage (3)

9.5 Explain how the filtering capacitor circuit is able to filter the voltage ripple. (3)

[26]

TOTAL: 200

ELECTRICAL TECHNOLOGY/ELEKTRIESE TEGNOLOGIE

FORMULA SHEET/FORMULEBLAD

DC MACHINES

PARALLEL PATHS

LAPWOUND =2p

WAVE WOUND = 2

$$conductors\ per\ path = \frac{Z}{p}$$

SINGLE-PHASE AC GENERATION

$$\emptyset = \beta . A$$

$$V_{RMS} = V_{MAX} \times 0{,}707$$

$$V_{AVE} = V_{MAX} \times 0{,}637$$

SINGLE-PHASE TRANSFORMERS

TRANSFORMATION RATIO

$$\frac{N_P}{N_S} = \frac{V_P}{V_S} = \frac{I_S}{I_P}$$

$$P = VIcos\theta$$

$$S = V . I$$

$$Q = VIsin\theta$$

POWER SUPPLIES

$$E_{RMS} = E_{PK} \times 0{,}707$$

$$V_{PK} = E_{PK} - V_D$$

$$V_{AVE} = V_{DC} = 0{,}318 \times V_{PK}$$

RLC-CIRCUITS

$$X_L = 2\pi fL$$

$$X_C = \frac{1}{2\pi fC}$$

$$Q = \frac{X_L}{R}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$cos\theta = \frac{R}{Z}$$