Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2015

ELECTRICAL TECHNOLOGY

MARKS: **200**

TIME: **3 hours**

IELTTE

This question paper consists of 10 pages including a formula sheet.

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Sketches and diagrams must be large, neat and fully labelled.
3. ALL calculations must be shown and correct to TWO decimal places.
4. Answers must be numbered correctly according to the numbering system used in this question paper.
5. A non-programmable calculator may be used.
6. A formula sheet is provided at the end of the question paper.

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QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY, TOOLS AND MEASURING INSTRUMENTS

1.1 An employee is responsible for working according to the safety rules and regulations in an electrical workshop. Give THREE examples of these rules and regulations that the employee must obey, in order to meet his responsibility. (3)

1.2 Oscilloscopes are normally used to measure AC and DC voltages and to examine waveforms. Discuss the procedure that can be used to measure the phase angle between two waveforms. (5)

1.3 Why is it necessary to use an insulation tester when measuring insulation resistance? (2)

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QUESTION 2: SINGLE-PHASE AC GENERATION SINGLE-PHASE TRANSFORMERS

2.1 What is meant by *instantaneous current*? (2)

2.2.1 Discuss the term RMS value with reference to a sine wave. (2)

2.2.2 What is the relationship between radians and degrees? (1)

2.2.3 What is meant by *magnetic flux* (φ), and how is it calculated? (3)

2.3 A coil with 200 turns has an area of 0,03 m^2 and is rotated at 2 400 rpm about an axis through the centre and parallel with two sides in a uniform magnetic field of 0,6 T. If the frequency is 40 Hz and the period is 0,025 seconds, calculate:

2.3.1 The maximum value of the generated EMF (3)

2.3.2 The RMS value of the generated EMF (3)

2.3.3 The instantaneous value of the generated EMF when the coil is at a position 60 degrees after passing its maximum induced voltage. (3)

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

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

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

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

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2.5 How are transformers rated? (1)

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

2.7 If the frequency applied to the primary of a transformer is 50 Hz, what will the secondary frequency be? Explain your answer. (2)

2.8 Give ONE reason why a transformer would overheat. (1)

2.9 A 220/24 Volt transformer can deliver 2 ampere. Calculate:

2.9.1 The transformation ratio of the transformer (3)

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

2.9.3 The primary current (3)

2.10 What is an *autotransforme*r? (2)

2.11 Name TWO types of losses that occur in transformers. (2)

2.12 Where are instrument transformers used? (2)

2.13 Describe how voltage and current (PT's and CT's) transformers are used. (4)

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QUESTION 3: SINGLE-PHASE MOTORS AND PROTECTION DEVICES

3.1 Are the following statements TRUE or FALSE?

3.1.1 Induction motors consist of a rotor, stator and stator windings. (1)

3.1.2 Induction motors are self-starting. (1)

3.1.3 In all single-phase induction motors the rotors are of the squirrel-cage type. (1)

3.1.4 Universal motors can run off AC or DC supplies. (1)

3.2 Describe in detail the operation of a single-phase induction motor. (8)

3.3 Describe the operation of the centrifugal switch in an induction motor. (5)

3.4 What is the purpose of the hold-in contacts in the starter control circuit of a single-phase induction motor? (3)

3.5 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 of two tests.

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

3.5.2 Name the TWO tests involved in the insulation test. (2)

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

3.5.4 What readings are acceptable? (1)

3.6 Name TWO applications where universal motors are used. (2)

3.7 Explain how to change the direction of rotation of a capacitor start inductive run induction motor. (3)

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QUESTION 4: SEMI-CONDUCTOR DEVICES, POWER SUPPLIES AND AMPLIFIERS

4.1 Describe what is meant by the depletion region with reference to diodes. (4)

4.2 Give ONE application where Zener diodes are used. (1)

4.3 Describe with the aid of a circuit diagram, the operation of a SCR. Use the two transistor analogy. (6)

4.4 State TWO ways that an SCR can be switched off. (2)

4.5 In a lamp dimming circuit, what is the purpose of the resistor that is in series with the variable resistor? (2)

4.6 Draw a labelled block diagram of a regulated DC power supply. (4)

4.7 Draw a fully labelled circuit diagram of a shunt regulator that uses a transistor. (4)

4.8 What is the advantage of a bridge rectifier over against using two diodes and a centre-tap transformer? (2)

4.9 4.9.1 With reference to the transistor load line, what is meant by the Q-point? (3)

4.9.2 How is the output of a transistor influenced, when biased in class A? (2)

4.9.3 Name TWO applications where Class B amplifiers are used. (2)

4.10 Transistor amplifier circuits are configured in one of three ways. Name the THREE configurations. (3)

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4.11

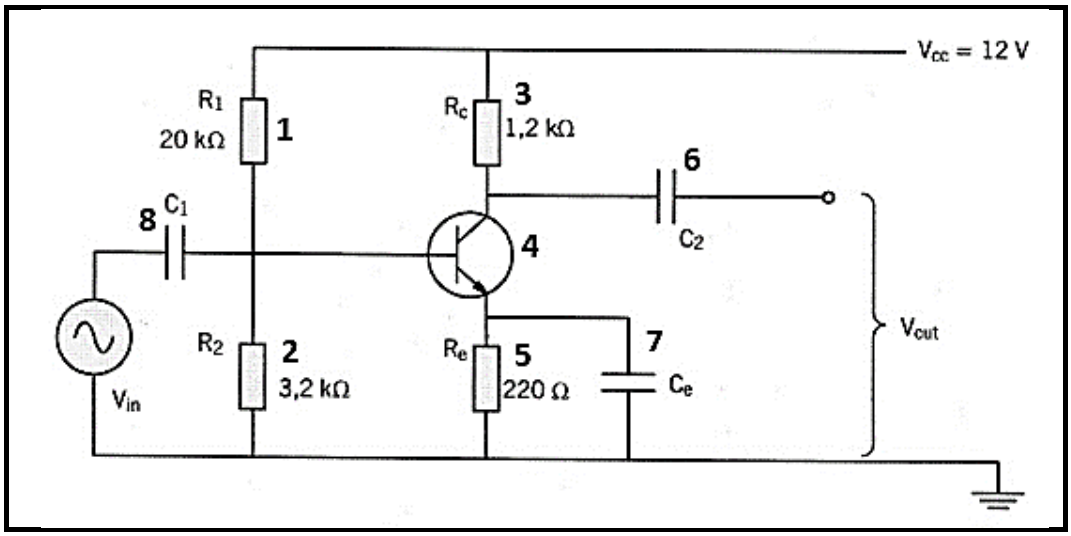

FIGURE 4.10

What is the purpose of each of the components numbered 1–8 in the diagram in FIGURE 4.10? (8)

4.12 Give THREE advantages of negative feedback. (3)

4.13.1 With reference to common emitter transistor amplifiers, what is meant by "*thermal runaway*"? (2)

4.13.2 How can thermal runaway be prevented? (2)

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QUESTION 5: RLC SERIES CIRCUITS

5.1 5.1.1 How is the reactance of a capacitor influenced by an increase in frequency? (1)

5.1.2 How is the reactance of an inductor influenced by an increase in frequency? (1)

5.1.3 What is meant by the term *power factor*? (2)

5.1.4 State TWO characteristics of an RLC circuit at resonance. (2)

5.2 A series AC circuit consists of an 24 Ω resistor, a 10 mH inductor, and a 470 µF capacitor. The circuit is connected across a 110 V, 60 Hz supply. Calculate:

5.2.1 The impedance of the circuit (9)

5.2.2 Will this circuit have a leading, or lagging power factor? (1)

5.2.3 At what frequency will this circuit resonate? (4)

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QUESTION 6: LOGIC

6.1 Create a NAND gate using NOR gates. Make use of your knowledge of logic circuits and Boolean expressions. (5)

6.2 The owner of a spaza shop in your area asks you to design a simple alarm for his shop. The shop has one window and one door. You must design an alarm that will sound if either the window or the door is opened.

6.2.1 Write down the truth table. (3)

6.2.2 From the truth table derive the sum-of-products expression. (3)

6.2.3 Simplify the sum-of-products expression. (2)

6.2.4 Draw the gate network. (2)

6.3 Prove $\bar{A}.B.\bar{C} + \bar{A}.B.C + \bar{A}.\bar{B}.C = \bar{A}.B + \bar{A}.C$ (5)

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QUESTION 7: COMMUNICATIONS

7.1 State whether the following statements are TRUE or FALSE.

7.1.1 A single repeater system requires one frequency. (1)

7.1.2 The receiver of a repeater is tuned to the transmit frequency of the mobile radios. (1)

7.1.3 The transmitter of a repeater transmits on the receive frequency of the mobile radios. (1)

7.1.4 The wavelength of an electromagnetic signal is the speed of light, multiplied by the frequency of the signal. (1)

7.1.5 The gain of an antenna is determined by the radiation of the antenna. (1)

7.1.6 Radio propagation is a term used to explain how radio waves behave when they transmit. (1)

7.2 Name THREE agencies or services that use repeater systems. (3)

7.3 7.3.1 Explain the difference between AM and FM. (4)

7.3.2 Describe the advantage that FM has over AM. (1)

7.3.3 State TWO advantages that cellular systems have over alternative systems. (2)

7.4 An AM receiver uses a detector. An FM receiver uses a discriminator. Compare the two forms of demodulation. (4)

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TOTAL: 200

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ELECTRICAL TECHNOLOGY GRADE 11

FORMULA SHEET

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_n}$$

$$Rs = R1 + R2 + R3 + \ldots\ldots Rn$$

$$= \frac{V}{R}$$

$$R = \frac{V}{I}$$

$$R = I \times R$$

$$P = V \times I$$

$$P = I^2 \times R$$

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

$$R_t = R_o\,(1 + \infty_o\, t)$$

$$\boldsymbol{R = \frac{\rho l}{a}}$$

$$\tau = \boldsymbol{R \times C}$$

$$\tau = \frac{\boldsymbol{R}}{\boldsymbol{L}}$$

$$\boldsymbol{a = \frac{\pi d^2}{4}}$$

$$Pf = Cos\,\theta$$

$$V_{RB} = Vcc - V_B$$

$$F = \frac{No.of\ div}{Time/div}$$

$$F = \frac{rev}{sec}$$

$$Emf = 2\pi BAnNsin$$

$$Current\ gain = \frac{\Delta Ic}{\Delta Ib}$$

$$\theta = Cos^{-1}(\mathrm{R/Z})$$

$$e = EmSin\theta$$

$$\omega = 2\pi F$$

$$E_{rms} = Em \times 0.707$$

$$E_{ave} = Em \times 0{,}637$$

$$E_{wgk} = Em \times 0{,}707$$

$$E_{gem} = Em\times),637$$

$$X_L = 2\pi FL$$

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

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$I_Z = \sqrt{I_R{}^2 + (I_{XL} - I_{XC})^2}$$

$$V_Z = \sqrt{V_R{}^2 + (V_{XL} - V_{XC})^2}$$

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

$$Gain = \frac{Vout}{Vin}$$

$$Wins = \frac{Vuit}{Vin}$$

$$Ic = \frac{Vcc}{Rc}$$

$$\frac{Ns}{Np} = \frac{Vs}{Vp} = \frac{Ip}{Is}$$

$$S = Vp \times Ip$$

$$\overline{A.B} = \overline{A} + \overline{B}$$

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

$$V = {}^{V}\!/_{Div} \times Div$$

$$Iz = \frac{Vz}{Z}$$

$$P = V.I.Cos\theta$$

$$P_S = VI$$

$$V_O = V_{Zener} - V_{basis}$$

$$V_{CE} = V_I - V_O$$

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