Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2016

ELECTRICAL TECHNOLOGY

MARKS: **200**

TIME: **3 hours**

* I E L T T E *

This question paper consists of 9 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.

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

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

1.2 Unsafe acts are the cause of many accidents. Name TWO unsafe acts that could cause accidents in electrical technology workshop. (2)

1.3 State ONE unsafe condition that you may observe in an electrical technology workshop. (1)

1.4 Give THREE examples where measurements are taken by an oscilloscope. (3)

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

[10]

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

2.1 Distinguish between *alternating current* and *direct current*. (2)

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

2.3 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)

2.4 Determine the average value of a waveform that measured 16 V_P. (3)

2.5 A 30 cm long conductor moves perpendicularly through a magnetic field with a flux density of 0,08 T at a speed of 50 m/s. Determine the EMF induced. (3)

2.6 Determine the peak value of a waveform having an RMS value of 240 V_{RMS}. (3)

2.7 Describe the main difference between a *RMS voltage* and an *average voltage*. (3)

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

2.9 Explain why the iron core of transformers needs to be laminated. (2)

2.10 Determine the frequency of a four pole generator if its rotor has a speed of 3 600 rpm. (3)

2.11 Discuss the basic operation of a transformer. (6)

2.12 Draw a current transformer connected in a circuit. Show all safety features. (5)

2.13 Refer to the circuit below to answer the questions that follow.

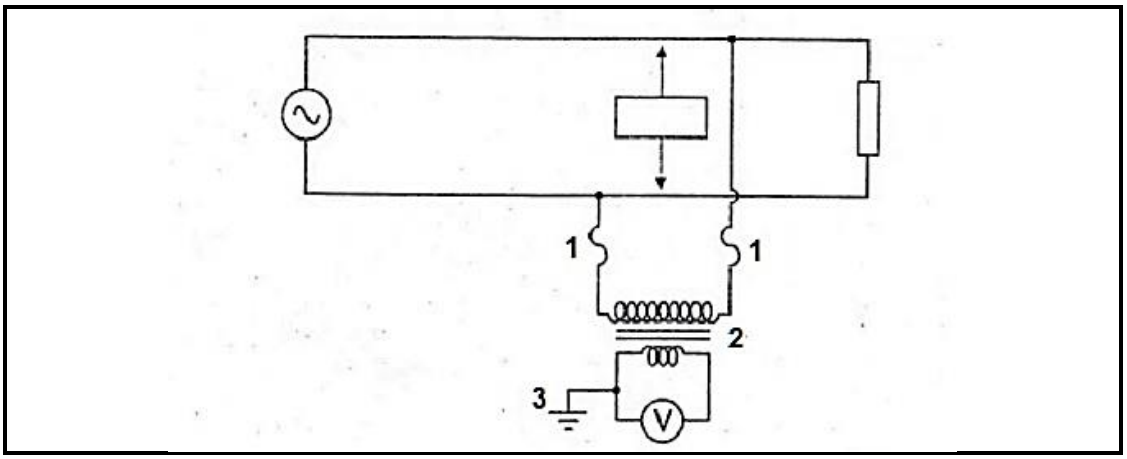


FIGURE 2.14

Label numbers **1**–**3**. (3)

2.14 Name THREE losses that occur in transformers. (3)

2.15 Write down THREE applications of transformers. (3)

[50]

QUESTION 3: SINGLE-PHASE MOTORS AND PROTECTION DEVICES

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

3.2 Give THREE types of overload protection used in motor starters. (3)

3.3 State the purpose of a zero-volt coil. (2)

3.4 Briefly explain how the bimetal strip overload relay works. (4)

3.5 Draw a neat labelled control circuit for a direct on line starter. (4)

3.6 Name any TWO types of induction motors. (2)

3.7 Explain the importance of the earth insulation resistance test performed on motors. (2)

3.8 Draw a neat, labelled circuit diagram of a capacitor start capacitor run motor. (5)

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

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

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

[30]

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

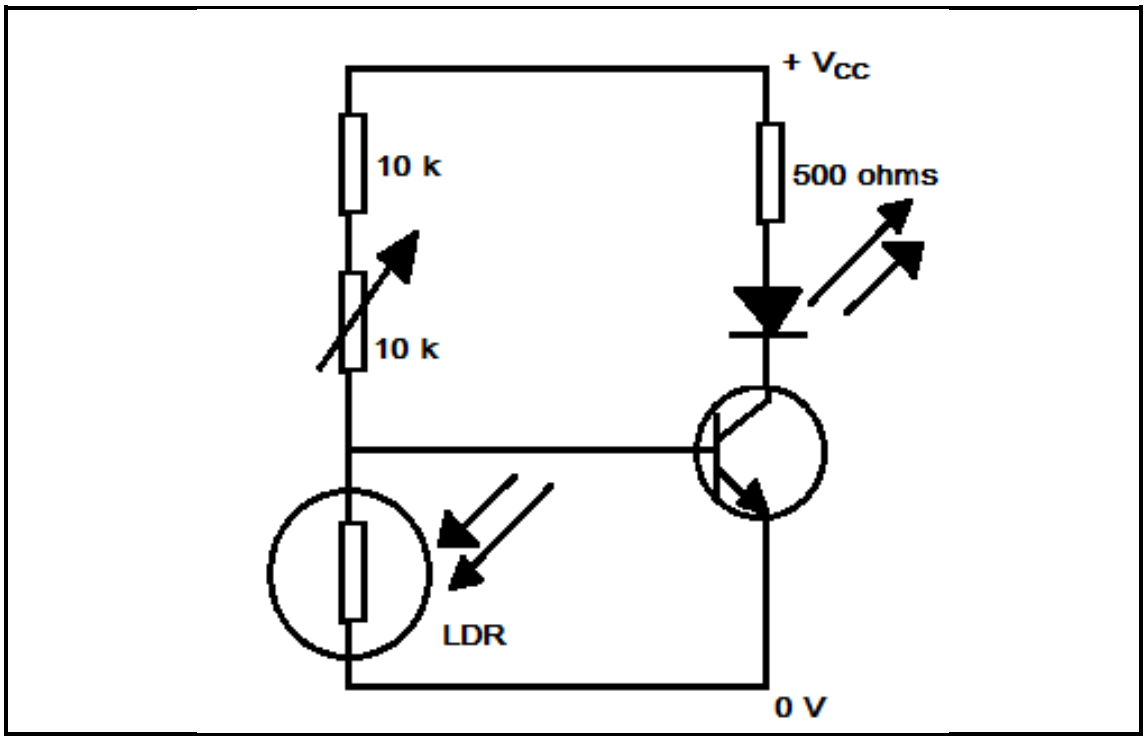
4.1 Explain how a diode connected in a circuit can be tested using a multi-meter? (2)

4.2 State the THREE regions of operation for a transistor. (3)

4.3 With the aid of sketch, briefly explain the difference between a *firing angle* and a *conducting angle* of a thyristor. (5)

4.4 Draw a characteristic curve of a Zener diode. (4)

4.5 Explain the operation of the circuit shown below during the night time.



(6)

FIGURE 4.5

4.6 Explain why a transformer can only work when connected to an AC supply and NOT when connected to a DC supply. (2)

4.7 Draw a neat circuit diagram of a bridge rectifier and smoothing capacitor of a DC power supply circuit. Also show the waveform after the smoothing capacitor. (8)

4.8 Study FIGURE 4.8 below then answer the questions that follow.

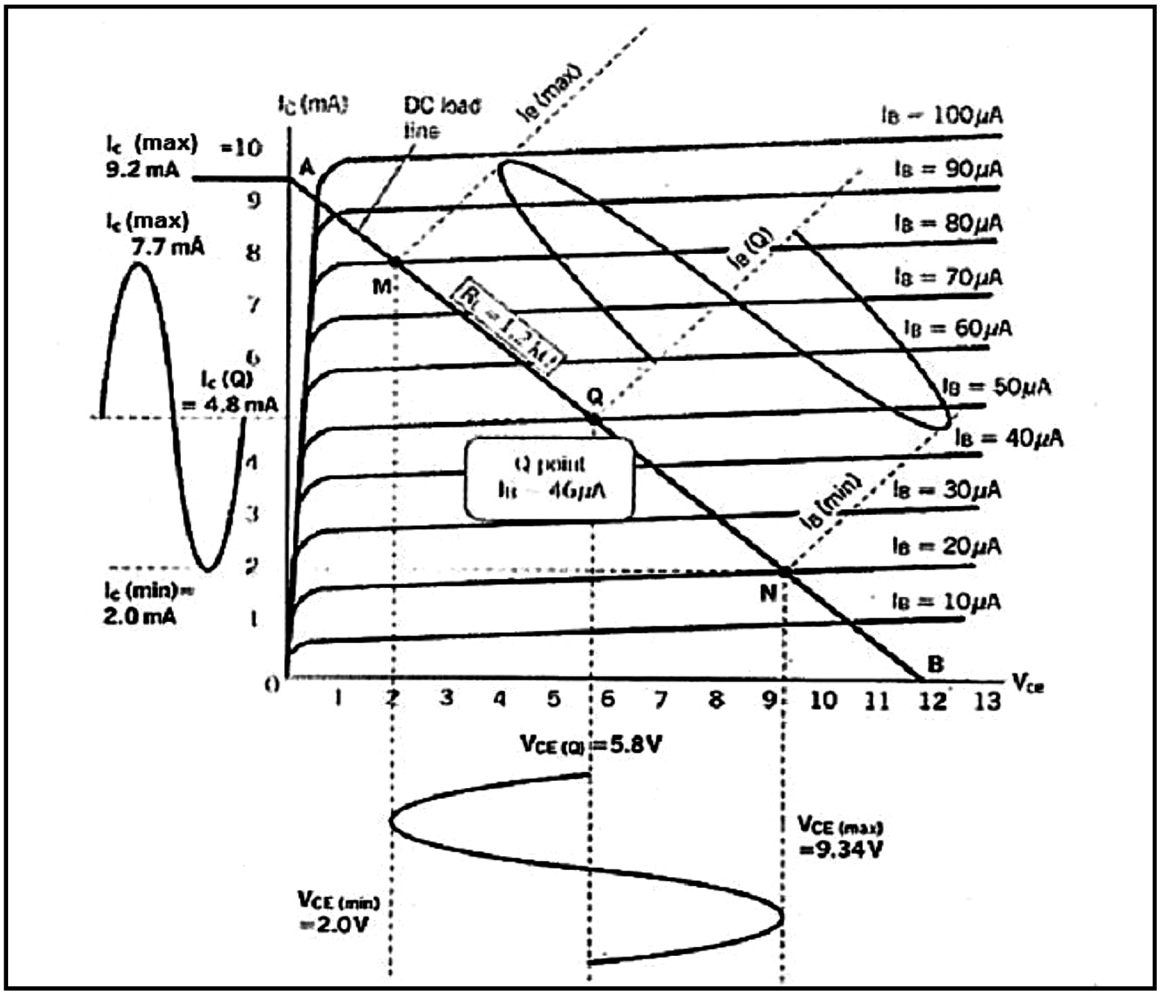


FIGURE 4.8

4.8.1 Give the supply voltage. (1)

4.8.2 Determine the maximum collector current. (1)

4.8.3 Calculate the current gain of the transistor. (3)

4.8.4 Determine the maximum base current. (1)

4.9 Name the THREE main configurations in which amplifiers are connected. (3)

4.10 Explain what is meant by *negative feedback*. (2)

4.11 Give THREE advantages of negative feedback. (3)

4.12 Name THREE classes of amplification and explain the differences in amplification between these classes. (6)

[50]

QUESTION 5: RLC SERIES CIRCUITS

5.1 Name any TWO characteristics of a series RLC circuit at resonant frequency. (2)

5.2 Define the term *impedance* with reference to an RLC circuit. (2)

5.3 A series circuit consists of a pure resistor of 15 Ω, an inductance of 0,0637 H and a variable capacitor connected across a 220 V/50 Hz supply. Calculate:

5.3.1 The capacitive reactance to produce resonance (3)

5.3.2 What will the impedance be at resonance? (1)

5.4 The tuning circuit of a radio consist of a 75 mH coil, 220 µF capacitor and a 22 Ω resistor, all connected in series across a 240 V/50 Hz supply. Calculate the following:

5.4.1 The reactances (4)

5.4.2 The phase angle between the supply voltage and the current and state whether is leading or lagging (3)

5.4.3 Draw a neatly labelled phasor diagram, not necessarily to scale, representing all the calculated resistance values of the circuit. (5)

[20]

QUESTION 6: LOGIC

6.1 Explain the difference between the *Sum of Product* and the *Product of Sum* notation. Give ONE example of each. (4)

6.2 In the factory control room, three motors are monitored. If two or more of the motors develop a fault, an indicator lamp must go off in the control room, notifying the person in the control room. Design a logic circuit that will be able to perform this function. (10)

6.3 Convert the following Boolean expression to NAND gate only; also draw the NAND gate logic circuit.

$$A.B + \overline{B}.C + C.\overline{D}$$

(6)

[20]

QUESTION 7: COMMUNICATIONS

7.1

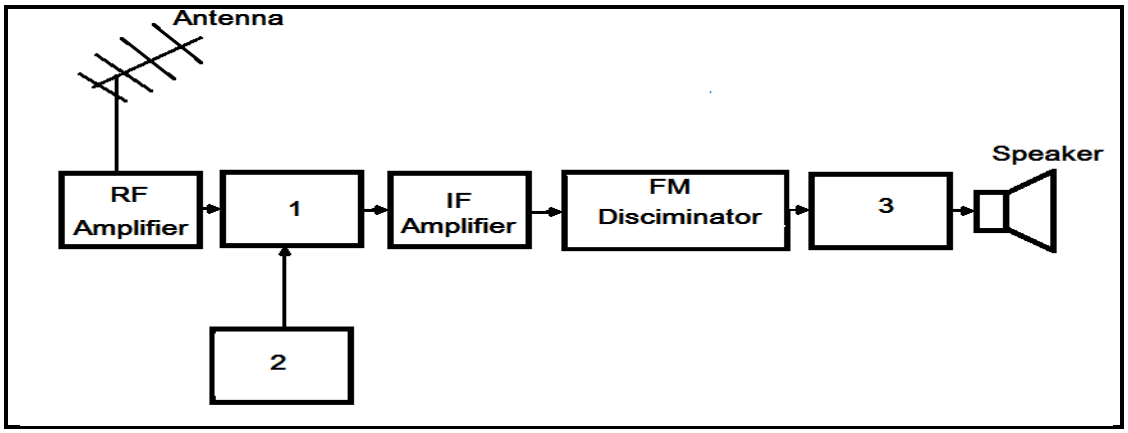


FIGURE 7.1

7.1.1 Label numbers **1**–**3**. (3)

7.1.2 Identify the above circuit. (1)

7.2 Draw a labelled block diagram of an AM transmitter. (5)

7.3 Briefly explain the working principle of a Foster-Seeley discriminator. (4)

7.4 What is the main function of an antenna? (2)

7.5 Write down TWO main advantages of amplitude modulation (AM). (2)

7.6 Give THREE types of modulations used to transmit intelligence. (3)
[20]

TOTAL: 200

FORMULA SHEET

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

$$R_S = R_1 + R_2 + \cdots R_n$$

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

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

$$V = IR$$

$$P = VI$$

$$P = I^2R$$

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

$$R_t = R_O(1 + \infty_O t)$$

$$R = \frac{\rho l}{\alpha}$$

$$\tau = RC$$

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

$$\alpha = \frac{\pi d^2}{4}$$

$$Pf = Cos\,\theta$$

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

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

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

$$F = \frac{pn}{60}$$

$$Emf = 2\pi BAnNsin\theta$$

$$Current\ gain = \frac{\Delta I_C}{\Delta I_b}$$

$$\theta = Cos^{-1}\frac{R}{Z}$$

$$\theta = BA$$

$$e = E_m Sin\theta$$

$$\omega = 2\pi F$$

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

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

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

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

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

$$E_{gem} = E_m \times 0{,}637$$

$$X_L = 2\pi FL$$

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

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

$$Z = \frac{V}{I_T}$$

$$I_t = \sqrt{I_R^2 + (I_L - I_C)^2}$$

$$I_T = \frac{V_S}{Z}$$

$$V_S = \sqrt{V_R^2 + (V_L - V_C)^2}$$

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

$$Gain = \frac{V_{out}}{V_{in}}$$

$$Wins = \frac{V_{uit}}{V_{in}}$$

$$I_C = \frac{V_{CC}}{R_C}$$

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

$$S = V_P \times I_P$$

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

$$V = {}^{V}/_{Div} \times No.of\ Div$$

$$P_S = V\,I$$

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

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