Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2013

ELECTRICAL TECHNOLOGY

MARKS: **200**

TIME: **3 hours**

This question paper consists of 11 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. Non-programmable calculators may be used.

6. A formula sheet is provided at the end of the question paper.

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

1.1 Define safety in a technology workshop. (2)

1.2 Give TWO unsafe acts that can take place in a workshop. (2)

1.3 FIGURE 1.3 shows the display of a sine wave on the screen of an oscilloscope. The setup is as follows:
Current flow through a resistor and the voltage across the same resistor. The scale setting is as follows:

Vertical: 5V/division
Horizontal: 2,5 µs/division

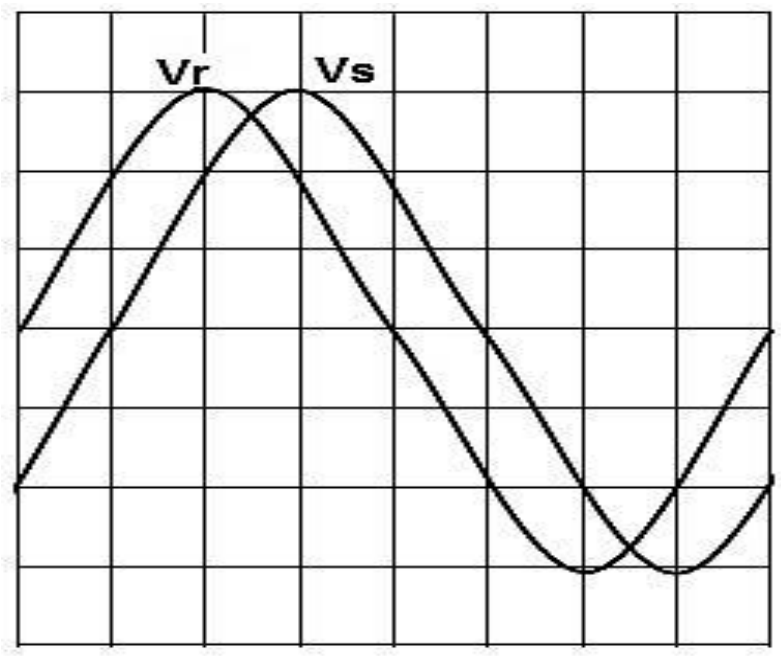

FIGURE 1.3: OSCILLSCOPE DISPLAY

1.3.1 Determine the frequency of the displayed waves. (3)

1.3.2 What does RMS value mean with reference to AC theory? (1)

1.3.3 Determine the RMS voltage of V_r. (2)
[10]

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

2.1 Describe what happens when a conductor loop is rotating through a two-pole magnetic field. (4)

2.2 Briefly explain how single-phase electricity is generated. Support your answer with neat diagrams. (7)

2.3 When is the maximum current induced in a loop rotating through a two-pole magnetic field? (2)

2.4 Which main factors determine the maximum current that can be induced during the generated period? Briefly explain the effect each one would have on the amount of current induced. (6)

2.5 A coil of 100 turns is rotated at 1 500 rpm through a magnetic field with a uniform density of 0,05 T. The mean area per turn is 40 cm^2. Calculate the following:

2.5.1 The frequency (3)

2.5.2 The period (3)

2.5.3 The maximum value of the generated EMF (3)

2.5.4 The value of generated EMF after the coil turned through 60° (3)

2.5.5 The RMS value of generated EMF (3)

2.6 Mr Manana, the shop owner living in a rural area needs to install electricity in the shop. The high voltage line passing next to the shop carries 11 000 volts. The appliances in the shop use 230 volts, which is the standard supply voltage. A single-phase transformer is needed to supply the shop with 230 volts from the 11 000 volt supply line. Assume the transformer is 100% efficient.

2.6.1 What is the purpose of transformers? (2)

2.6.2 Name TWO types of losses that occur in transformers and briefly explain the meaning of each. (2)

2.6.3 Calculate the number of secondary turns, if there are 3 600 turns on the primary side. (3)

2.6.4 Determine the primary current, if 60 A is drawn from the secondary side. (3)

2.6.5 Determine the kVA rating of the transformer. (3)

2.7 Name ONE disadvantage of an auto transformer. (1)

2.8 What is the purpose of a PT and a CT in high voltage circuitry? (2)

[50]

QUESTION 3: SINGLE-PHASE MOTORS AND PROTECTION DEVICES

3.1 Draw a neat fully labelled circuit diagram of a single-phase capacitor start squirrel cage induction motor. (4)

3.2 Explain the function of the centrifugal switch. (2)

3.3 What will happen to the motor if the capacitor is defective and it is an open circuit? (2)

3.4 Show by means of TWO sketches how the direction of rotation of this motor can be changed. (4)

3.5 What is the function of the two capacitors used in a single phase capacitor-start capacitor-run motor? (3)

3.6 Name THREE protection devices that we use in motor control circuits to protect the motor from damage during faulty operating conditions. Briefly explain how each one operates. (6)

3.7 Name ONE application of a split phase induction motor. (1)

3.8 Name the main disadvantages of the auxiliary winding. Give a reason. (2)

3.9 Draw a neat control circuit of a direct-on-line starter for a single-phase motor. (5)

3.10 What is the importance of the insulation test? (1)

[30]

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

4.1 How can we switch an SCR on and off? (4)

4.2 Explain the difference between the firing angle and conducting angle. (2)

4.3 The lamp dimming circuit in FIGURE 4.3 below is connected to a 240 V/50 Hz supply.

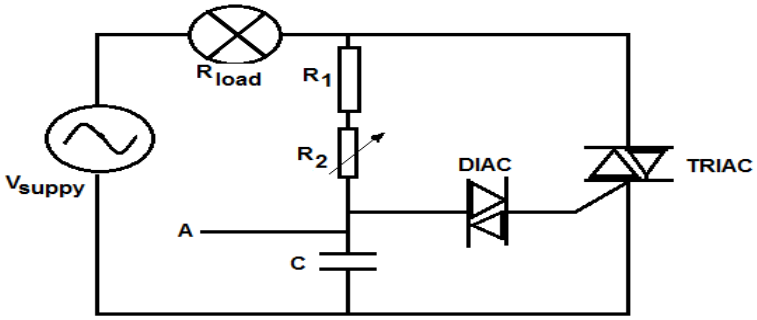

FIGURE 4.3: LAMP DIMMING CIRCUIT

4.3.1 If the angle is set to 60°, draw labelled wave forms of the voltage across the lamp and the supply on the same axes. Draw ONE full cycle. (4)

4.3.2 Explain what will happen to the brightness of the lamp if the value of R_2 is decreased. (3)

4.3.3 What is the function of R_1? (1)

4.4 TRIAC devices come in different sizes. What determines the physical size of a TRIAC? (2)

4.5 Draw a characteristic curve of an SCR. (4)

4.6 Power supply circuits are designed to provide an electronic circuit with a stable voltage and current source. FIGURE 4.6 shows a typical power supply block diagram.

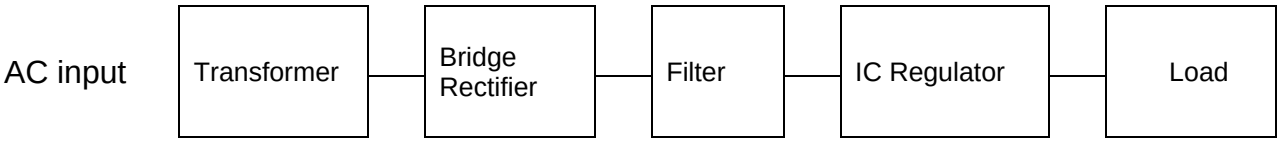

FIGURE 4.6: BLOCK DIAGRAM OF A POWER SUPPLY

4.6.1 Draw the wave form after the filter circuit. (2)

4.6.2 Describe the function of a capacitor in a power supply. (2)

4.7 Draw a circuit diagram of a centre-tap full wave rectifier. Also include a capacitor. (4)

4.8 Draw the output wave form if the capacitor should be removed from the circuit. (2)

4.9 In order for a transistor to be utilised as an amplifier, it needs to be biased in a certain manner. When biasing is applied correctly, a transistor will amplify a small input signal to create an enlarged output signal. Explain what is meant by *biasing*. (2)

4.10

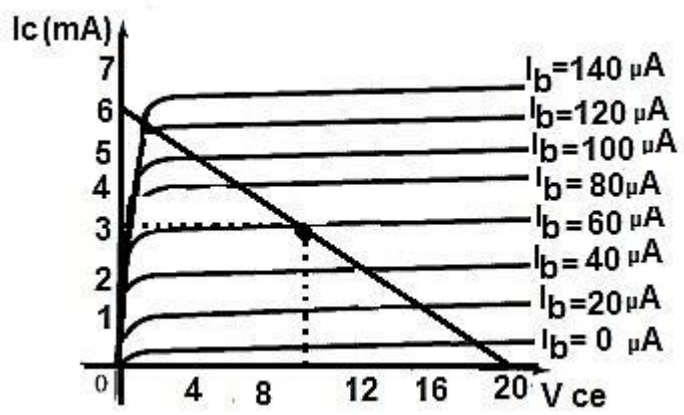

FIGURE 4.10: DC-LOAD LINE

4.10.1 Draw a circuit diagram of the potential divider base biasing common emitter voltage amplifier and label all the components. (8)

4.10.2 Refer to FIGURE 4.10 and determine the static current gain. (3)

4.11 State TWO configurations in which amplifiers are connected. (2)

4.12

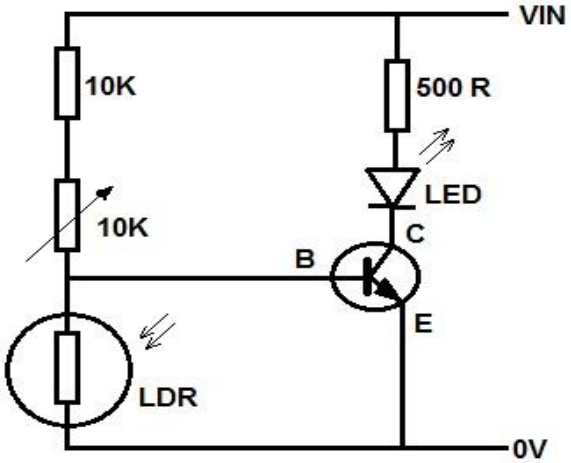

FIGURE 4.12: CIRCUIT USING LDR

Explain the night time operation of the circuit shown in FIGURE 4.12 above. (5)

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QUESTION 5: RLC SERIES CIRCUITS

5.1 The tuning circuit of a radio/TV consists of a 75 mH coil, 220 µf capacitor and a 22 Ω resistor, all connected in series across a 24 V, 50 Hz. Supply. Calculate the following:

5.1.1 The total impedance of the circuit (7)

5.1.2 The total current flow in the circuit (3)

5.1.3 The phase angle between the supply current and the voltage (3)

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

5.3 Explain the term *impedance* with reference to an RLC circuit. (2)

[20]

QUESTION 6: LOGIC

6.1 The logic circuit in FIGURE 6.1 shows six logic gates. Make use of your knowledge of logic circuits to determine the Boolean equation of output **X.**

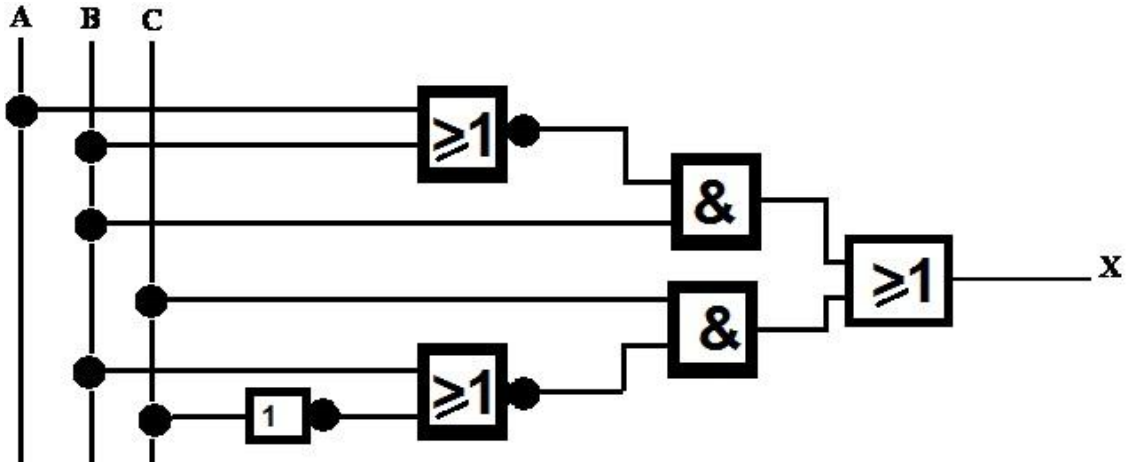

FIGURE 6.1: LOGIC CIRCUIT (3)

6.2 Design a logic circuit that will satisfy the following Boolean expression:

$$F = \overline{\overline{A+B}+B.C}$$ (3)

6.3 Use De Morgan's theorem to simplify the equation in QUESTION 6.2. (3)

6.4 Use the table below to answer the following questions:

X	Y	Z	Q
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

FIGURE 6.4: TRUTH TABLE

6.4.1 Write the Boolean expression for the truth table shown in FIGURE 6.4 in Sum of Product. (3)

6.4.2 Simplify the Boolean expression in QUESTION 6.4.1 above. (4)

6.4.3 Design a logic circuit that will be able to satisfy the truth table. (4)

[20]

QUESTION 7: COMMUNICATIONS

7.1 Draw and label the block diagram of a FM receiver. (5)

7.2 Give THREE applications of a repeater system. (3)

7.3 Explain the function of an antenna as a transmitter. (2)

7.4

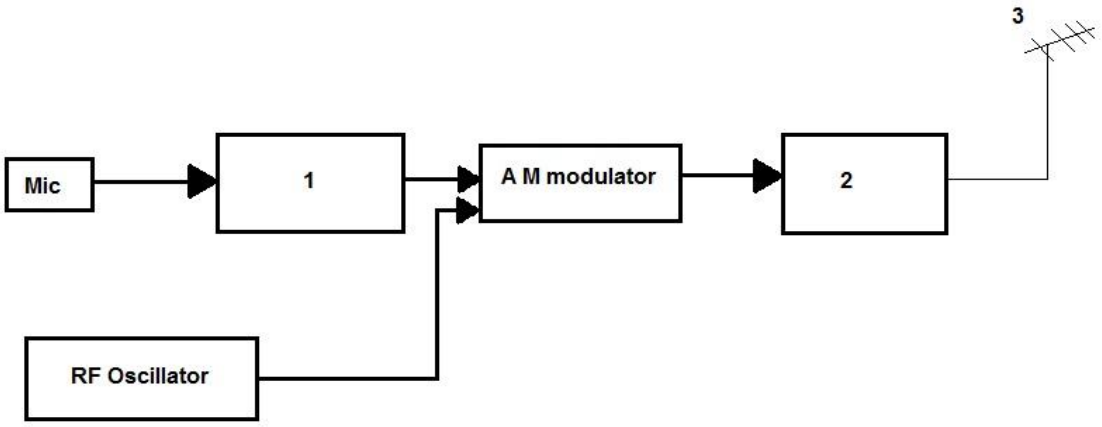

FIGURE 7.4: BLOCK DIAGRAM

7.4.1 Identify the above block diagram. (1)

7.4.2 Fill in the missing blocks labelled **1**, **2** and **3**. (3)

7.5 With reference to the electromagnetic spectrum, what is the relationship between the frequency and the wavelength? (2)

7.6 Name TWO main advantages of the cellular system compared to other communication systems. (2)

7.7 Give the main difference between a FM transmitter and an AM transmitter. (2)

[20]

TOTAL: 200

ELECTRICAL TECHNOLOGY GRADE 11

FORMULA SHEET

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + ...\frac{1}{Rn}$$

$$Rs = R1 + R2 + R3 + ...Rn$$

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

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

$$V = I \times R$$

$$P = V \times I$$

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

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

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

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

$$\tau = R \times C$$

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

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

Pf = Cos θ

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

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

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

Emf = 2πBAnNsin θ

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

θ = Cos^{-1}(R/Z)

FORMULEBLAD

$$e = EmSin\theta$$

$$\omega = 2\pi F$$

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

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

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

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

$$X_L = 2\pi FL$$

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

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

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

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

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

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

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

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

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

$$S = Vp \times Ip$$

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

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

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

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

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

$$P_S = VI$$

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

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

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