Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2020

ELECTRICAL TECHNOLOGY: DIGITAL ELECTRONICS (EXEMPLAR)

MARKS: **200**

TIME: **3 hours**

This question paper consists of 11 pages, including a 1-page formula sheet.

INSTRUCTIONS AND INFORMATION

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

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY

1.1 Name TWO instances where the user is not required to supply an earth to roofs, gutters, downpipes and wastepipes, on a premises to which electrical energy is supplied. (2)

1.2 Explain how the following environmental factors could impact negatively on a worker in the workshop:

1.2.1 Lack of space (1)

1.2.2 Lighting (1)

1.3 Describe the term *anthropometrics*. (2)
[6]

QUESTION 2: TOOLS AND MEASURING INSTRUMENTS

2.1 What is the purpose of a crimping lug? (1)

2.2 Explain the advantage of a clamp meter over a digital multimeter when measuring current. (2)

2.3 Why is it important to stand aside to allow the grinder wheel to run up to full speed before using it? (2)

2.4 Explain the purpose of a time-base generator in an oscilloscope. (1)
[6]

QUESTION 3: LOGICS

3.1 Refer to FIGURE 3.1 below and answer the questions that follow.

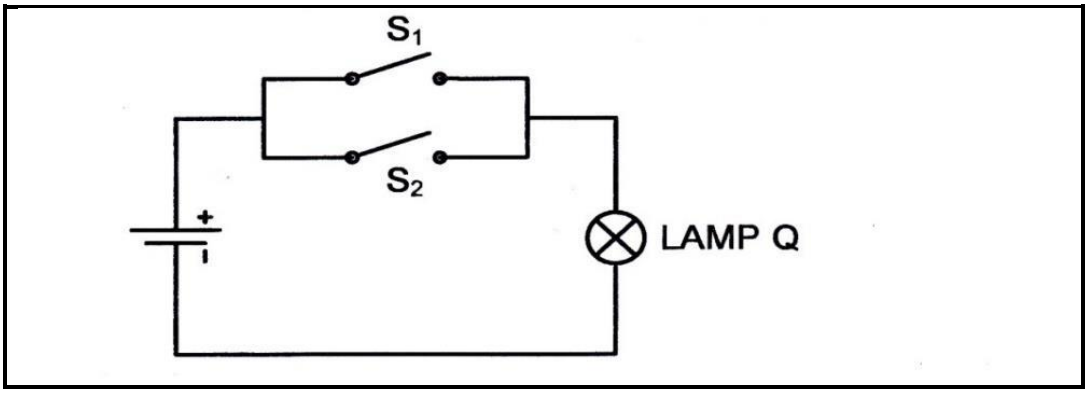


FIGURE 3.1

3.1.1 Identify the logic function of the circuit. (1)

3.1.2 Draw the logic symbol that is represented by the circuit. (2)

3.1.3 Draw the truth table of the gate. (4)

3.1.4 Write the Boolean expression for FIGURE 3.1. (2)

3.2 Using Boolean algebra, simplify the expression below:

Q = $\overline{A}B\overline{C} + AB\overline{C} + A\overline{B}\,\overline{C} + \overline{A}\overline{B}\,\overline{C}$ (7)

3.3 Use a Karnaugh map to simplify the expression below:

Q = $\overline{A}B\overline{C} + AB\overline{C} + A\overline{B}\,\overline{C} + \overline{A}\overline{B}\,\overline{C}$ (7)

3.4 Name TWO different states a logic probe can operate in. (2)

3.5 State TWO disadvantages of TTL. (2)

3.6 State TWO disadvantages of CMOS. (2)

3.7 Refer to FIGURE 3.7 below and answer the questions that follow.

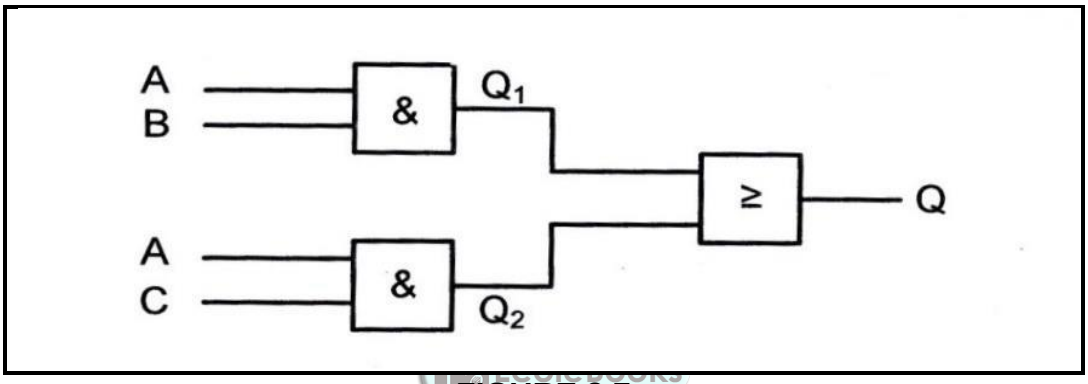


FIGURE 3.7

Give the Boolean expression at the following points:

3.7.1 Q_1 (2)

3.7.2 Q_2 (2)

3.7.3 Q (3)

3.8 Draw the truth table for a Half Adder. (4)

[40]

QUESTION 4: COMMUNICATION SYSTEMS

4.1 Explain the term *resonance*. (2)

4.2 Name THREE types of oscillators (3)

4.3 Explain the purpose of the Wien bridge oscillator. (6)

4.4 Explain the purpose of a variable frequency oscillator. (3)

4.5 Name the applications of a continuous wave transmitter. (2)

4.6 Explain the term *modulation*. (2)

4.7 Draw a block diagram of an AM receiver. (6)

4.8 Describe the purpose of frequency shift keying. (2)

[26]

QUESTION 5: RLC-CIRCUITS

5.1 Mention ONE factor that directly affects the capacitive reactance of an AC circuit with RC components. (1)

5.2 Draw a neatly labelled graph showing the relationship between the inductive reactance and the frequency in an RLC series circuit. (3)

5.3 Study FIGURE 5.3 below and answer the questions that follow.

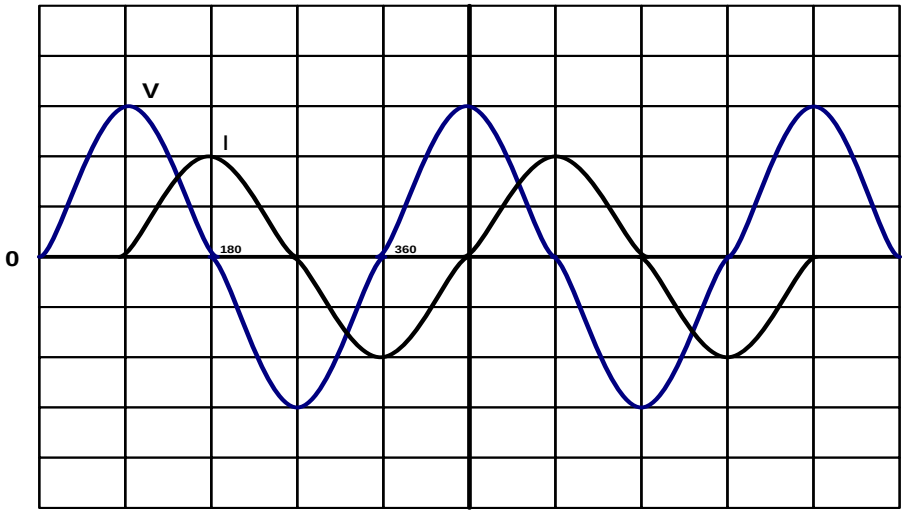


FIGURE 5.3: RL CIRCUIT WAVEFORMS

5.3.1 Describe the relationship between the voltage and current waveforms. (1)

5.3.2 Explain how an increase in frequency would affect the current waveform. (3)

5.4 Refer to the circuit diagram in FIGURE 5.4 and answer the questions that follow.

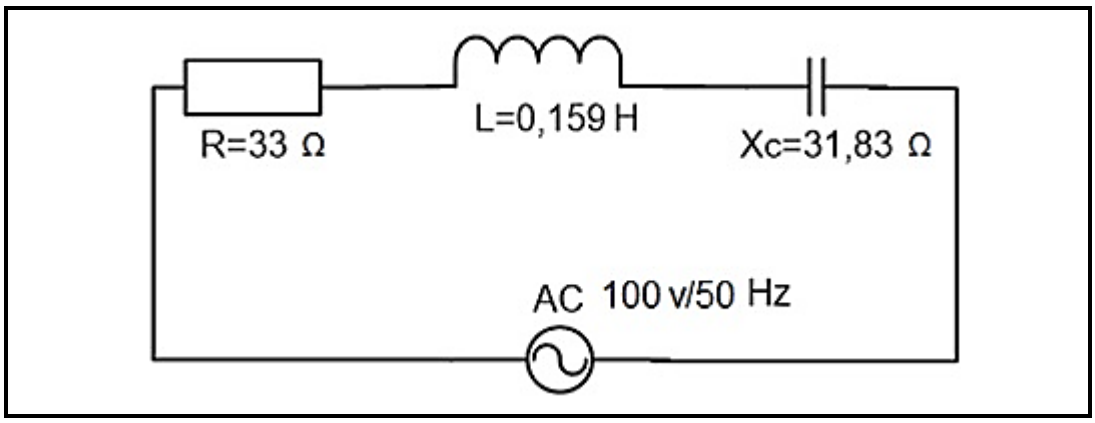


FIGURE 5.4

Given: $R = 33\ \Omega$
$L = 0{,}159\ H$
$X_C = 31{,}83\ \Omega$
$V = 100\ V$
$f = 50\ Hz$

Calculate:

5.4.1 The inductive reactance of the coil (3)

5.4.2 The total impedance of the circuit (3)

5.4.3 The current flowing through the circuit (3)

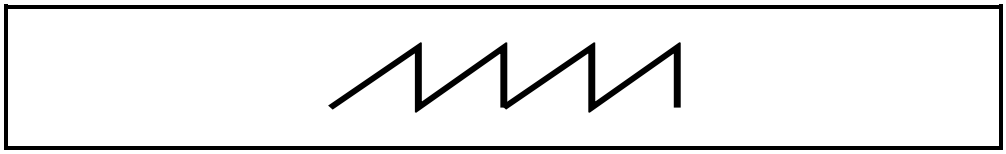
5.4.4 The value of the capacitor in the circuit (3)

5.5 Given a series circuit with a 600 Ω resistor, an inductive reactance of 37,7 Ω and a capacitive reactance of 665 Ω. Describe what occurs to the impedance of a series circuit when it reaches the point of resonance. (4)
[24]

QUESTION 6: WAVEFORMS

6.1 Identify the following waveforms as shown in FIGURES 6.1.1 to 6.1.4.

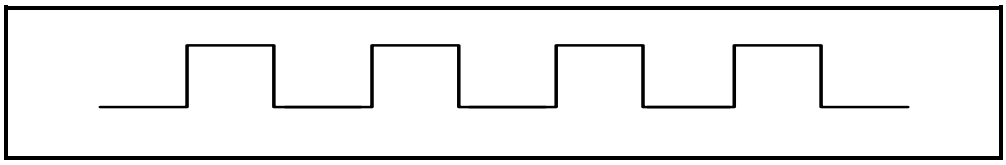
6.1.1



(1)

FIGURE 6.1.1

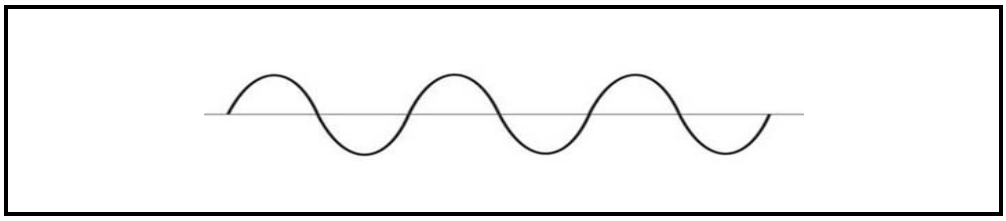
6.1.2



(1)

FIGURE 6.1.2

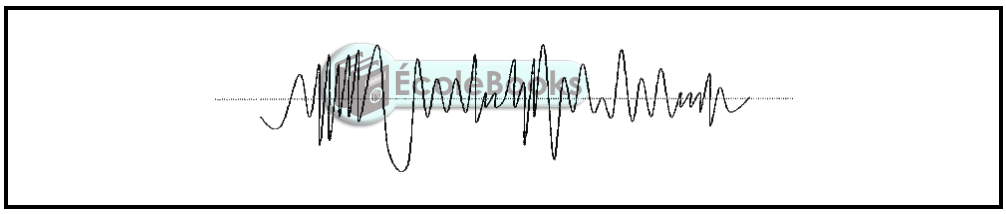
6.1.3



(1)

FIGURE 6.1.3

6.1.4



(1)

FIGURE 6.1.4

6.2 Define the term *period* with reference to a wave form. (3)

6.3 For a digital pulse waveform, explain the following terms:

6.3.1 Pulse width (3)

6.3.2 Fall time (3)

6.4 An AC supply has an rms voltage of 9 V. Determine its peak voltage. (3)

6.5 Determine the periodic time of a wave with a frequency of 500 Hz. (3)

6.6 Describe the concept of *clamping* in electronics. (4)

6.7 Mention THREE applications of a radio wave. (3)

[26]

QUESTION 7: POWER SUPPLIES

7.1 Draw the block diagram of the series voltage regulator. (3)

7.2 Refer to the circuit diagram in FIGURE 7.2 below and answer the questions that follow.

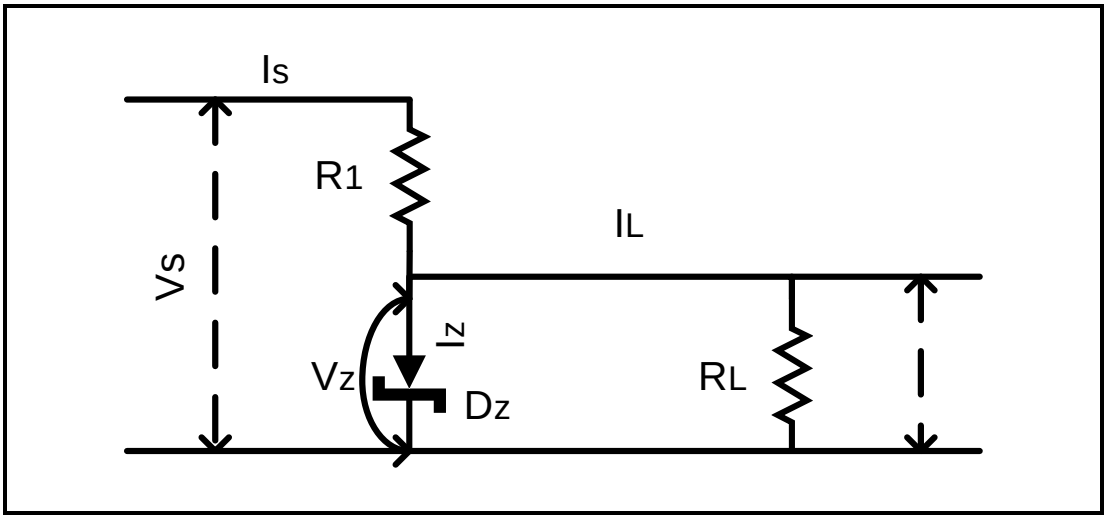


FIGURE 7.2

Given:

Pz = 2 W
Vs = 12 V
Vz = 5 V
RL = 1 kΩ

Calculate:

7.2.1 The maximum current flowing through the Zener diode (I_Z). (3)

7.2.2 The minimum value of the series resistor, R_S. (3)

7.2.3 The load current IL if a load resistor of 1 kΩ is connected across the Zener diode. (3)
[12]

QUESTION 8: SEMICONDUCTOR DEVICES

8.1 Describe the term *semiconductor*. (3)

8.2 What is the Q-point of a diode? (3)

8.3 Briefly explain the term majority carriers in a P-type silicon semiconductor. (2)

8.4 Draw a fully labelled characteristic curve of a TRIAC. (4)

8.5 Semiconductors are mass produced and are often small in physical size. Manufacturers supply component data sheets. Answer the following questions with reference to component data sheets.

8.5.1 State ONE source where such data sheets may be found. (1)

8.5.2 Working temperature may be displayed on the sheet. Explain why this information is important. (3)

8.5.3 Other than working temperature, state TWO types of information given on data sheets. (2)

8.6 Draw fully labelled circuit symbols of the following:

8.6.1 SCR (3)

8.6.2 TRIAC (3)

8.7 Explain the difference between *conventional* current flow and *electron* flow. (4)

8.8 Describe the term *solid state*, with reference to semiconductors. (2)

8.9 Describe how N-type material is formed. (5)

8.10 Explain how a Zener diode differs from other diodes. (3)

8.11 For the normal operation of a transistor as a switch, which junction should always be:

8.11.1 Forward biased? (2)

8.11.2 Reverse biased? (2)

8.12 Briefly explain TWO ways of switching on the SCR. (4)

8.13 Name any TWO impurities which are added to pure silicon to create P-type material. (2)

[48]

QUESTION 9: SENSORS AND TRANSDUCERS

9.1 Define the term '*sensor*' with reference to sensors and transducers. (2)

9.2 Describe the basic operation of a dynamic microphone. (4)

9.3 List TWO types of humidity sensors. (2)

9.4 Explain the principle of operation of a Light Dependant Resistor (LDR). (4)
[12]

TOTAL: 200

FORMULA SHEET

WAVE FORMS

Frequency

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

Maximum value

$$V_{MAX=}\ V_{RMS}\ \times 1{,}414\ (V)$$

RMS Value

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

Average value

$$V_{ave}\ =\ V_{max}\ \times 0{,}637$$

POWER SUPPLIES

$$Vave = Vpk - \frac{1}{2}\ V_{RIP\ P-P}$$

$$V_{OUT}\ = V_Z$$

$$Vo = V_Z - V_{BE}$$

$$I_L\ = I_E\ (\beta\ + 1) I_B$$

RLC CIRCUITS

Inductive reactance

$$X_L\ = 2\pi Fl$$

Capacitive reactance

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

Impendence

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

Power factor

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

$$COS\ \theta\ =\ \frac{VR}{VZ}$$

AMPLIFIERS

$$V_{CE\ max} = V_{VCC}$$

$$V_{CC} = V_{CE}\ +\ I_C\ R_C$$

$$I_C\ =\ \beta I_B$$

$$A_V\ = \frac{Output\ voltage}{input\ voltage}$$

$$A_I = \frac{output\ current}{input\ current}$$