Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2022

ELECTRICAL TECHNOLOGY: DIGITAL ELECTRONICS (EXEMPLAR)

MARKS: **200**

TIME: **3 hours**

This question paper consists of 14 pages, including a formula sheet.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of EIGHT questions.
2. Sketches and diagrams must be large, neat and fully labelled.
3. Show ALL calculations and round off answer correctly to TWO decimal places. Show the units for ALL answers of 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: MULTIPLE-CHOICE QUESTIONS

Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.15) in the ANSWER BOOK, for example 1.16 D.

1.1 Ergonomics can be defined as …

A economically providing earthing to an installation.
B the science of fitting tasks, equipment and the surroundings to the end user to make them more comfortable.
C providing signs in a workshop.
D keeping the floors clean and clear of rubbish, rags and dirt. (1)

1.2 The purpose of a function generator is to …

A generate different types of waveforms as its output across a range of frequencies.
B check the functionality of generators.
C serve as a power supply for oscilloscopes.
D generate electricity for power stations. (1)

1.3 It is the distance between the beginning and end of one complete sequence of waveform including one peak and one trough, measured in seconds:

A Peak-to-peak value
B Wave length
C Cycle
D Ramp wave (1)

1.4 The ratio of DC voltage relative to the given AC voltage is known as …

A effective value.
B RMS value.
C form factor.
D average value. (1)

1.5 One the following is NOT a type of filter:

A Capacitor filter
B Inductor filter
C LC filter
D Transformer filter (1)

1.6 An electronic device or circuit that increases the voltage, current or power of a signal is known as a/an ...

A transistor.
B covalent bond.
C voltage divider biasing.
D amplifier. (1)

1.7 For the normal operation of a transistor, the … always needs to be reverse biased.

A emitter-base junction
B collector-base junction
C unbiased junction
D P-N junction (1)

1.8 The advantages of using negative feedback in an amplifier:

A Improved stability against changes of temperature.
B Increase distortion of the amplified signal.
C Simple construction and robustness.
D Provided a combination of both voltage amplification and current implication. (1)

1.9 All phasors rotate in a/an … direction.

A anticlockwise
B clockwise
C linear
D haphazard (1)

1.10 In a capacitive RLC circuit the …

A voltage leads the current.
B voltage and current are in phase.
C current lags the voltage.
D current leads the voltage. (1)

1.11 The main features of the common base transistor connection is …

A high current gain, no voltage gain and medium power gain.
B medium current gain and high-power gain.
C no current gain, high voltage gain and medium power gain.
D no voltage gain, no current gain and high-power gain. (1)

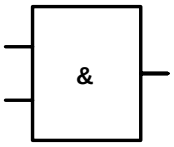
1.12 The device that detects or senses and reacts to and measures physical quantities is known as a …

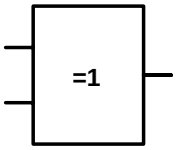
A transducer.
B sensor.
C thermistor.
D piezo-electric effect. (1)

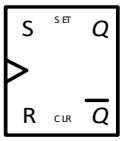
1.12 Which ONE of the following sensors is NOT a type of humidity sensor?

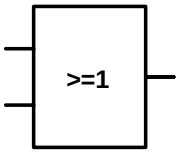
A Capacitive sensor
B Silicon controlled rectifier sensor
C Resistive sensor
D Thermal sensor (1)

1.13 Which ONE of the following symbols is NOT a logic gate?

A 

B 

C 

D 

1.14 The NOR gate is a combination of the …

A AND gate combined with a NOT gate.
B XOR gate combined with a NOT gate.
C OR gate combined with a NOT gate.
D XNOR gate combined with a NOT gate. (1)

1.15 An advantage of logic probes:

A It provides an accurate voltage reading
B Low cost
C Easy to use
D B and C (1)

[15]

QUESTION 2: OCCUPATIONAL HEALTH AND SAFETY

2.1 State ONE example of each of the following categories of ergonomics in the workplace:

2.1.1 Working factors (1)

2.1.2 Environmental factors (1)

2.2 Describe how inadequate lighting is considered as an unsafe condition. (2)

2.3 Write down why it is necessary to wear personal protective clothing in the workplace. (2)

2.4 Explain the purpose of yellow, triangular safety signs. (2)

2.5 Explain why regulations are necessary in the workplace. (2)

[10]

QUESTION 3: TOOLS AND MEASURING INSTRUMENTS

3.1 State the care and maintenance required for a function generator. (3)

3.2 FIGURE 3.2 below represents an oscilloscope which shows two full cycles of a sine wave. The vertical volts per division is set to 5 V/div and the horizontal time per division is set to 2 ms/div.

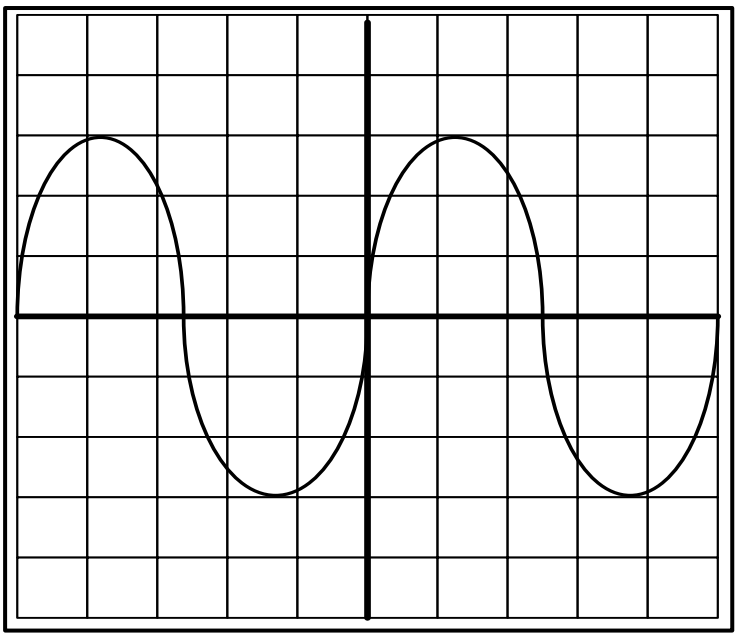


FIGURE 3.2

Given: V/div = 5 V
T/div = 2 ms

Calculate:

3.2.1 The maximum voltage of the waveform (3)

3.2.2 The frequency of the waveform (4)

[10]

QUESTION 4: LOGICS

4.1 Draw the logic diagram of a NAND gate using only FOUR NOR gates. (4)

4.2 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.

4.2.1 Write down the truth table. (4)

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

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

4.2.4 Draw the gate network. (2)

4.3 Prove the following:

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

4.4 Explain the difference between the sum of product and the *product of sum* notation. Give ONE example of each. (4)

4.5 Refer to the following Boolean expression and answer the questions that follow.

F = AB + $\overline{B}$C + C$\overline{D}$

4.5.1 Convert the expression to a NAND gates only expression. (2)

4.5.2 Draw the NAND gates only logic circuit. (4)

4.6 Use a Karnaugh map to simplify the following expression:

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

4.7 Draw a fully labelled truth table of a Half Adder. (6)

4.8 Name the FOUR states that can be indicated by a logic probe. (4)

4.9 Explain the shortcut to remembering De Morgan's Theorems. (3)

[50]

QUESTION 5: WAVEFORMS

5.1 Name the TWO fields that combine to form a radio wave. (2)

5.2 Draw and label TWO digital pulses, one positive-going, the other negative-going. (4)

5.3 Refer to waveforms and explain the following terms:

5.3.1 Rise time (2)

5.3.2 Mark-space ratio (2)

5.3.3 Clock pulse (2)

5.4 Refer to wave shaping circuits and draw the following:

5.4.1 The circuit of a positive biased parallel clipping circuit using a 3 V biasing battery (4)

5.4.2 The output waveform when the peak sinusoidal voltage of 4 V is applied (4)

5.5 An AC supply has a RMS voltage of 12,8 V. Determine its peak voltage. (3)

5.6 Determine the periodic time of a wave with a frequency of 2 750 Hz. (3)

5.7 Determine the form factor of a sine wave if the peak voltage is 12,8 V. (4)

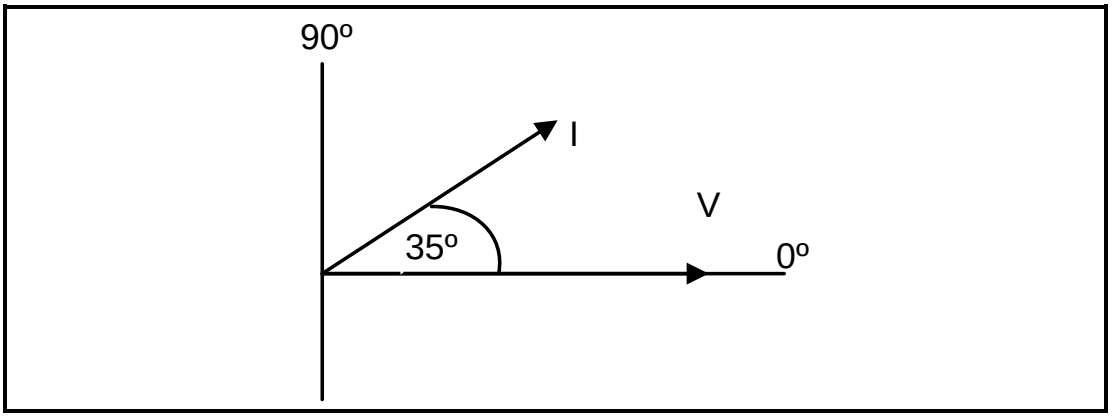
[30]

QUESTION 6: RLC CIRCUITS

6.1 State the relationship between the current and the voltage in an AC circuit, when the capacitive reactance is larger than the inductive reactance. (1)

6.2 Explain how an increase in frequency will affect the inductive reactance of a circuit. (1)

6.3 Draw the waveforms which will represent the phasor diagram below.



(2)

6.4 Define the term *power factor*. (2)

6.5 Explain how an increase in frequency will affect the current flow in a RC circuit if the supply voltage remains constant. (3)

6.6 A series RLC circuit has an apparent power of 5 VA and a power factor of 0,75. Determine the true power of the circuit.

Given: $S = 5$ VA
$\cos\theta = 0{,}75$ (3)

6.7 Refer to the circuit diagram in FIGURE 6.7 and answer the questions that follow.

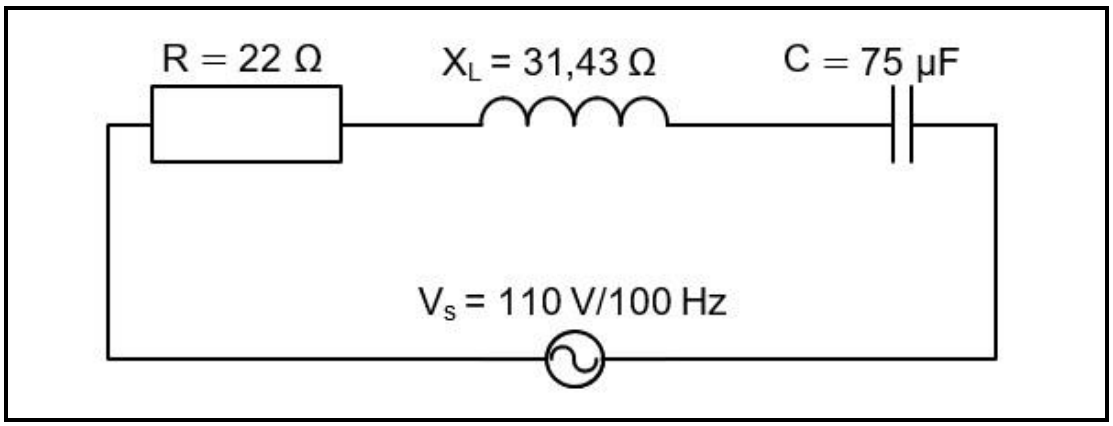


FIGURE 6.7

Given: R = 22 Ω
X_L = 31,43 Ω
C = 75 µF
V_S = 110 V
f = 100 Hz

Calculate:

6.7.1 The capacitive reactance (3)

6.7.2 The impedance of the circuit (3)

6.7.3 The current flowing through the circuit (3)

6.7.4 The apparent power (3)

6.7.5 The value of the inductor in the circuit (3)

6.7.6 The power factor if the real power is 40 W (3)
[30]

QUESTION 7: SEMICONDUCTOR DEVICES

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

7.2 Give ONE application where zener diodes are used. (1)

7.3 With reference to FIGURE 7.3 below, explain the operation of a SCR by using the two-transistor analogy. (6)

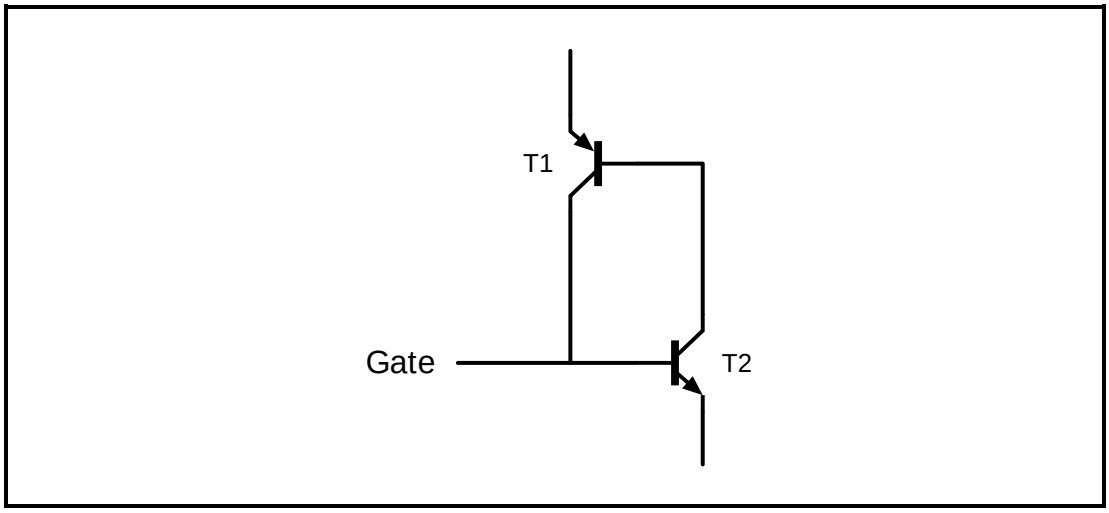


FIGURE 7.3

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

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

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

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

7.8 Draw a characteristic curve of a zener diode. (4)

7.9 Draw a symbol of a PNP transistor, indicating conventional current flow direction through the transistor. (4)

7.10 A circuit consists of a 12,8 V supply, connected in series with a silicon diode with a known forward voltage of 0,8 V. The load has an impedance of 75 Ω. Answer the following questions.

7.10.1 Draw the IV characteristic curve of this circuit. (3)

7.10.2 Draw the load line of the diode. (5)

[40]

QUESTION 8: SENSORS AND TRANSDUCERS

8.1 Define the term *piezo electric effect.* (2)

8.2 Explain the difference between a *sensor* and a *transducer*. (4)

8.3 Explain the principal of operation of a Light Dependent Resistor (LDR). (2)

8.4 Explain the term *opto-coupler.* (2)

8.5 Draw the circuit symbol of a phototransistor. (3)

8.6 With reference to thermistors, explain the term *Negative Temperature Coefficient (NTC)*. (2)

[15]

TOTAL: 200

FORMULA SHEET

MEASURING INSTRUMENTS

V_{max} = V/div x no. of divisions

$T = \frac{T}{div} \times$ no. of divisions

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

RLC-CIRCUITS

$X_L = 2\pi fL$

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

$I_T = I_R = I_L = I_C$

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

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

$\cos\theta = \frac{R}{Z}$ and $\cos\theta = \frac{P}{S}$

WAVE FORMS

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

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

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

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