higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

ELECTRONIC CONTROL AND DIGITAL ELECTRONICS
NQF LEVEL 3

(12041023)

17 November 2023 (X-paper)
09:00–12:00

This question paper consists of 8 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)
ELECTRONIC CONTROL AND DIGITAL ELECTRONICS
NQF LEVEL 3
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer all the questions.
2. Read all the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Use only a black or blue pen.
5. Write neatly and legibly.

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QUESTION 1: FUNDAMENTALS OF ELECTRONICS

1.1 Measuring instruments:

Use FIGURE 1 (below) of an oscilloscope screen to calculate the following values:

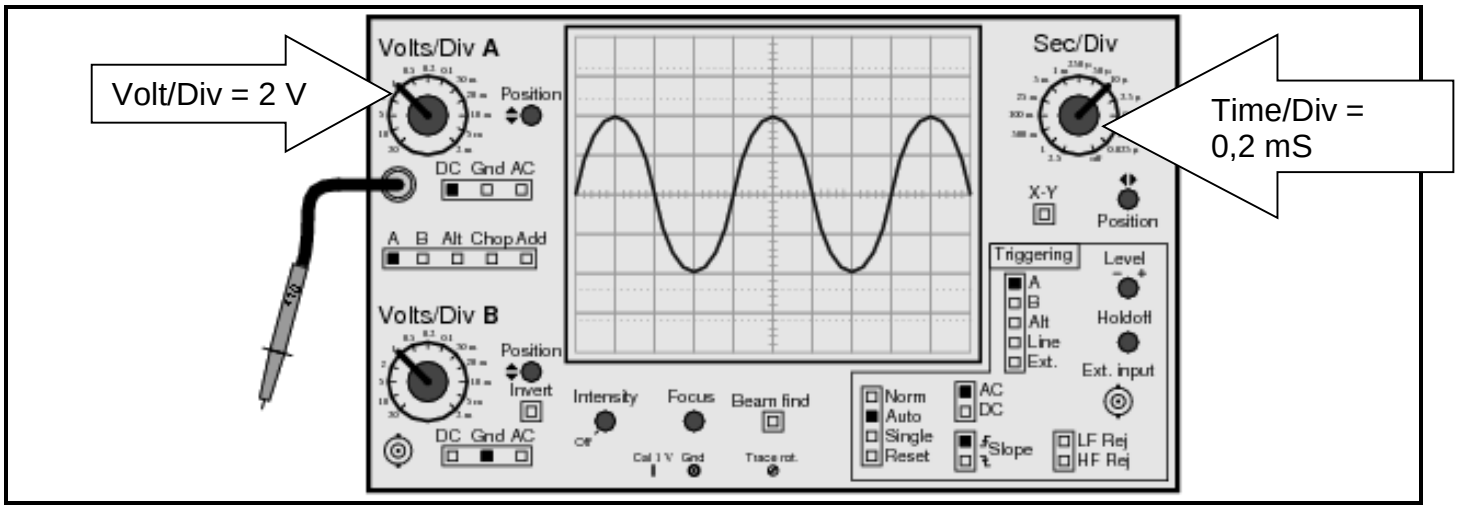

FIGURE 1

1.1.1 The amplitude of the sine wave (3)

1.1.2 The period of the sine wave (3)

1.1.3 The frequency of the sine wave (2)

1.2 Atomic theory:

1.2.1 Explain why the element silicon or germanium is used to create a semiconductor material. (2)

1.2.2 What type of bonding occurs to form the crystal lattice structure of a semiconductor material? (1)

1.2.3 Explain why a semiconductor material remains neutral even after doping. (2)

1.3 Semiconductor diodes:

1.3.1 Compare how heat affects the reverse currents of a typical PN junction diode. (2)

1.3.2 List TWO uses of LCD units. (2)

1.3.3 How many segments of a seven-segment LCD display will be used to create the number 2? (1)

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1.4 Bipolar junction transistors:

Selecting the correct transistor is important. Decide from the datasheet table (FIGURE 2) below why you would select the transistor.

Tipe	PNP/ NPN	VCE maks (V)	IC maks (mA)	P maks (mW)	hfe	hfe bias (mA)
BC107	NPN	45	100	300	>110	2
BC108	NPN	20	100	300	>110	2
BC109	NPN	20	100	300	>110	2
BC140	NPN	40	1000	3700	>40	100
BC141	NPN	60	1000	3700	>40	100
BC160	PNP	40	1000	3700	>40	100
BC161	PNP	60	1000	3700	>40	100

FIGURE 2

1.4.1 Why would you select a BC141 instead of a BC107 to switch a 500-mA circuit on and off?

1.4.2 Why would you select a BC109 instead of a BC160 for a low-power consumption circuit?

1.4.3 Why would you select a BC161 instead of a BC141 to handle negative-going voltages and currents?

1.4.4 Which transistor would you select to build a high-gain common emitter amplifier circuit: a BC108 or a BC140?

1.4.5 If the BC160 transistor in a circuit was faulty, which transistor would you select as a replacement transistor?

(5 × 1) (5)

1.5 Power supplies:

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (1.5.1–1.5.5) in the ANSWER BOOK.

1.5.1 Bridge rectifier circuits make use of two diodes.

1.5.2 Non-filtered power supplies produce pulsating DC.

1.5.3 A half-wave rectifier circuit is more efficient than a full-wave circuit.

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1.5.4 LC filter components remove ripple from the output DC supply.

1.5.5 Shunt Zener diodes are used in series to the output load.

(5 × 1) (5)

1.6 Field effect transistors (FET):

1.6.1 Describe the construction of a P-channel JFET. (3)

1.6.2 The P-channel allows hole flow through the channel.

Explain how the depletion-type P-channel MOSFET operates. (3)

1.7 Operational amplifiers:

Complete the following sentences by writing only the missing word or words next to the question number (1.7.1–1.7.5) in the ANSWER BOOK.

1.7.1 The output of the … op-amp circuit is 180° out of phase to its input.

1.7.2 A … op-amp circuit does not have any gain.

1.7.3 Integrator op-amp circuits use a … for feedback.

1.7.4 The … circuit has 0° output phase shift.

1.7.5 Multiple input resistors form part of the … circuit.

(5 × 1) (5)

1.8 Op-amp ICs can be configured as a differentiator circuit.

What is the use or application of this circuit? (1)

[40]

QUESTION 2: DIGITAL ELECTRONICS

2.1 Number systems – conversions:

2.1.1 Convert 36_8 to binary.

2.1.2 Convert 11000110_2 to hexadecimal.

2.1.3 Convert 209_{10} to octal.

(3 × 3) (9)

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2.2 Binary arithmetic:

2.2.1 Add $1011_2 + 1111_2 + 1001_2$. (4)

2.2.2 Multiply $1110_2 \times 10_2$. (3)

2.2.3 Divide $11101_2 \div 110_2$. (4)

2.3 Binary counters:

2.3.1 Describe the operation of a synchronous four-bit binary upcounter. (4)

2.3.2 What will be the final binary count of a decade counter before it resets? (1)

[25]

QUESTION 3: PERSONAL COMPUTERS

3.1 What are the FOUR main components or hardware of any personal computer? (4)

3.2 How does the tower indicate to the user that there are faults with attached components or peripherals? (2)

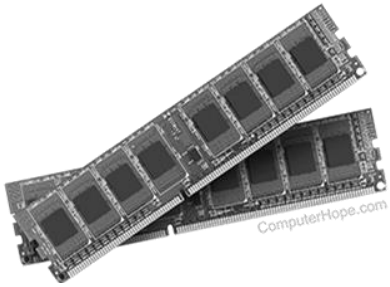
3.3 Explain what the term *POST* means in terms of a computer start-up process and how it affects the proper start-up process. (3)

3.4 Identify the following internal components of a computer and indicate their use in a personal computer:

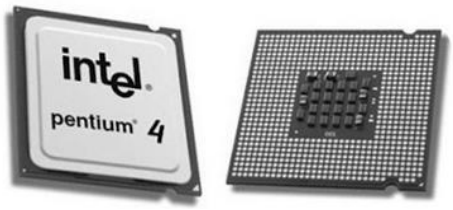
3.4.1



3.4.2



3.4.3



(3 × 2) (6)
[15]

QUESTION 4: TRANSDUCERS

4.1 What transducer devices or components can be used to measure the following?

4.1.1 Pressure

4.1.2 Movement

4.1.3 Velocity or speed

4.1.4 Heat

(4 × 1) (4)

4.2 Describe how you would use a strain gauge connected to a Wheatstone bridge to measure force applied to it. (4)

4.3 What is the purpose of an electrical transducer? (2)
[10]

QUESTION 5: PROGRAMMABLE LOGIC CONTROLLERS (PLCs)

5.1 Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–F) next to the question number (5.1.1–5.1.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
5.1.1	Allows programs to be read off a PLC	A	microprocessor
5.1.2	Used as an input device	B	AND configuration
5.1.3	Contacts are in series	C	OR configuration
5.1.4	Controls the operation of a PLC	D	ROM memory
5.1.5	Stores operation instructions of a PLC	E	laptop computer
		F	heat sensor

(5 × 1) (5)

5.2 Design a labelled ladder diagram to solve the following problem:

A heating element can be switched on only if a sensor detects a metal pot above it. The element continues to heat until the operator switches it off. (5)

[10]

TOTAL: 100

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