higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

**NATIONAL CERTIFICATE (VOCATIONAL)**

# ELECTRONICS AND DIGITAL CONCEPTS FOR ROBOTICS

(First paper)
**NQF LEVEL 3**

(10041043)

**13 November 2024 (X-paper)**
**09:00–12:00**

**This question paper consists of 8 pages and formula sheet of 2 pages.**

131Q1N2413

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# DEPARTMENT OF HIGHER EDUCATION AND TRAINING
# REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)
ELECTRONICS AND DIGITAL CONCEPTS FOR ROBOTICS
(First paper)
NQF LEVEL 3
TIME: 3 HOURS
MARKS: 100

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**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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## SECTION A

## QUESTION 1

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 number (1.1–1.10) in the ANSWER BOOK.

1.1 A ... is a type of diode which is a heavily doped p-n junction diode in which the electric current decreases as the voltage increases.

A Tunnel diode
B Zener diode
C Varactor diode
D LED

1.2 Which electromagnetic induction law states that the induced emf in a coil is equal to the rate of change of flux linkage.

A Faraday's first law
B Ampere's Law
C Lenz's Law
D Faraday's second law

1.3 An example of how a three-phase transformer can be connected.

A Dry type
B Oil-immersed
C Air-core
D Delta-Delta

1.4 A … consist of coil wire, which generates a magnetic field when current flows through it.

A Capacitor
B Solenoids
C Flux density
D Magnetic density

1.5 Which operational amplifier configuration produces an output signal that is identical to the input signal?

A Differentiator
B Integrator
C Voltage follower
D Inverting amplifier

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1.6 Which type of transducer is best to make a microphone.?

A Resistive
B Crystal
C Inductive
D Photosensitive

1.7 There are three components that work together to maintain the proper oil level of the transformer. Identify one of these components.

A Conservator
B Electromagnet
C Star-Star
D Magnetic field

1.8 Which Boolean expression represent the AND gate?

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

1.9 Witch one of the following is a functional unit found in a PLC.

A Conservator
B Relay
C Star-Star
D CPU

1.10 Which electronic instrument is used to analyse the output signal waveform from a rotary encoder?

A Oscilloscope
B Function generator
C Multi-meter
D Clamp meter

(10 × 1) **[10]**

## QUESTION 2

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (2.1–2.10) in the ANSWER BOOK.

2.1 Seven segment display is a component that displays decimal numbers from 0 to 9 by means of switching on different combinations of bar-type LEDs.

2.2 Operational amplifiers are devices with a low gain.

2.3 Silicon diodes are made of a semiconductor junction and exhibit a low forward voltage drop of around 0,65 volts.

2.4 Magnetic flux is a measure of strength of a magnetic field at a specific point by taking into consideration the number of flux lines per unit area.

2.5 When the secondary voltage is less than the primary voltage, the transformer is called a step-down transformer.

2.6 Current drain refers to the reduction in voltage that occurs when current flows through a component or conductor in an electrical circuit.

2.7 Solar panels are photovoltaic panels that convert sunlight into electricity.

2.8 The function of a generator is to convert electrical energy into mechanical energy, which is used to perform mechanical work.

2.9 In a DC machine, the armature windings are located on the rotor.

2.10 Kirchoff's voltage law states that all the voltages in series will add up to the total voltage.

(1 ×10) **[10]**

## QUESTION 3

Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–M) next to the question number (3.1–3.10) in the ANSWER BOOK.

| COLUMN A | | COLUMN B | |
|---|---|---|---|
| 3.1 | Opposition to the flow of the current | A | coulomb |
| 3.2 | North pole and south pole | B | auto-transformer |
| 3.3 | To find the direction of the force | C | function block diagram |
| 3.4 | The number of electrons that pass a given point in a circuit | D | amplitude |
| 3.5 | Lead-acid batteries | E | barrier potential |
| 3.6 | An example of a PLC programming language | F | base |
| 3.7 | Signal's peak voltage | G | Fleming's left-hand rule. |
| 3.8 | One example of the three basic components of a transistor | H | metallic bonding |
| 3.9 | Electrons jump depletion region | I | magnetic poles |
| 3.10 | Uses a common winding | J | NPN |
| | | K | resistance |
| | | L | secondary cells |
| | | M | primary cells |

(10 × 1) **[10]**

**TOTAL SECTION A: 30**

## SECTION B

## QUESTION 4

4.1 A conductor of 1,25 m in length is moved perpendicular to a uniform magnetic field of 0,36 T at a rate of 12 m/s.

Calculate the induced emf in the conductor. (3)

4.2 An electromagnet has a coil length of 250 mm.

Calculate the magnetic field strength of the electromagnet if the coil produces a magnetomotive force of 200,9 A. (3)

4.3 A single-phase transformer with a turns ratio of 50:2 is connected to a 240-V AC supply. A 2 kΩ load is connected to the secondary side.

Determine:

4.3.1 The secondary voltage.

4.3.2 The value of the secondary current.

4.3.3 The primary current.

(3 × 3) (9)

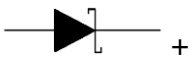
4.4 Draw a schematic diagram to show how controlling the armature voltage can be used to control the speed of a DC shunt motor. (6)

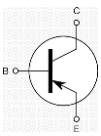
**[21]**

## QUESTION 5

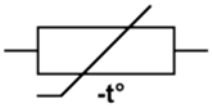
5.1 Identify the following component symbols by labelling it next to the question number (5.1.1–5.1.5) in the ANSWER BOOK:

5.1.1 

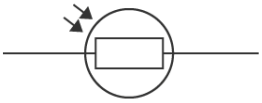
5.1.2 


5.1.3 

5.1.4




5.1.5



(5 × 1) (5)

5.2 List TEN advantages of digital multi-meters. (10)
**[15]**

**QUESTION 6**

6.1 Discuss TEN guidelines that will assist in taking good care of measuring instruments. (10)

6.2 List any SIX main characteristics of an operational amplifier. (6)

6.3 You are given a 12 V battery, a 2Ω, 4Ω and 6Ω carbon film resistors.

Draw the series circuit diagram using the given components. (5)
**[21]**

**QUESTION 7**

7.1 Draw a ladder diagram that performs a logic OR function of two input contacts A and B that control an output relay M, and include a stop contact C. (5)

7.2 Draw a switching equivalent circuit of a 3-input AND logic gate. (5)

7.3 List any THREE advantages that PLCs have over the older relay system. (3)
**[13]**

**TOTAL SECTION B: 70**
**GRAND TOTAL: 100**

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**FORMULA SHEET**

**ELECTRONICS AND DIGITAL CONCEPT FOR ROBOTIC L3**

Emf = Blv

mmf = N x I
H= mmf/I

emf, $E_m$ = 2(BLv)

$I_aR_a = E - V$ or $V = I_aR_a - E$
$I_L = I_A + I_F$

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

F = BLI sin Θ, F= qE + qv x B

$V_p/V_s = I_s/I_p = N_p/N_s$

η = Output power/Input power

$V_{phase} = V_{line}$ , $I_{phase} = I_{line}/\sqrt{3}$

$V_{phase} = V_{line}/\sqrt{3}$ , $I_{phase} = I_{line}$

$N_p/N_s = \sqrt{3} \times V_{pri\ phase}/V_{sec\ phase}$
$N_p/ N_s = V_{pri\ phase}/ \sqrt{3} \times V_{sec}$

$\eta = P_{out}/P_{in} = P_{in} - losses/P_{in}$

f = PN/120

$Pe = KB_m{}^2f^2t^2V$

$PBD = V_{BD}\, I_a$

$N \propto Eb/\varnothing$

N = K(V-IR)/ ∅

Ah = I x t

RT = R1 + R2 + R3 + R4
1/Rt = 1/R1 + 1/R2 + 1/R3 + 1/R4

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$\Sigma$V rise/drops = 0, $\Sigma$rise = $\Sigma$drops

$\Sigma$I Entering/Leaving = 0, $\Sigma$I Entering = $\Sigma$I Leaving

R= p x L/A

Rt = R0[1+ $\propto$0(t-0)]

1/CT= 1/C1 + 1/C2 +1/C3 or CT = $(1/C_1 + 1/C_2 + 1/C_3)^{-1}$

$1/L_{total}$ = 1/L1 + 1/L2 +1/L3 …….+ 1/Ln

$I = V_{battery}/R_1 + R_2 + R_3$

$R_T = R_1 + R_2 + R_3$

$I_T = V_T/I_T$

$I_E = I_C + I_B$

Gain = Output amplitude/Input amplitude

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