



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

**NATIONAL CERTIFICATE
INDUSTRIAL ELECTRONICS N4**

(8080164)

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

Drawing instruments and nonprogrammable calculators may be used.

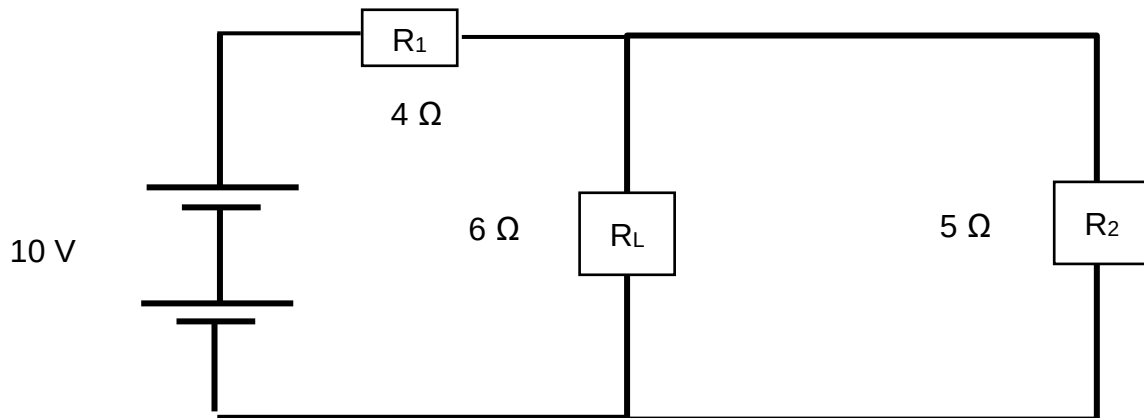
This question paper consists of 8 pages and a formula sheet of 2 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA
NATIONAL CERTIFICATE
INDUSTRIAL ELECTRONICS N4
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 blue or black pen.
 5. Write neatly and legibly.
-

QUESTION 1**FIGURE 1**

Determine the current flow through the load resistor R_L in FIGURE 1 by using the following:

1.1 Ohm's law (5)

1.2 Thevenin's theorem (6)

[11]

**QUESTION 2**

2.1 A circuit consists of $Z_1 = 23 + j18\Omega$, $Z_2 = 40 - j31\Omega$, $Z_3 = 55 + j30\Omega$ and $Z_4 = 20 - j45\Omega$. Z_1 is connected in series with Z_2 . The combination is connected in parallel with Z_3 and the entire combination is then connected in series with Z_4 .

Calculate the total impedance of the circuit using j-notation. (8)

2.2 Define the following terms:

2.2.1 Inductive reactance

2.2.2 Q-factor

2.2.3 Impedance

2.2.4 Phase angle

2.2.5 Resonant frequency

(5 × 1) (5)



- 2.3 A resistance of $250\ \Omega$, an inductor of $0,127\ \text{H}$ and a variable capacitor are connected in series across a 250-V , 50-Hz AC supply.



Calculate the following:

- 2.3.1 The capacitance to give resonance (3)
- 2.3.2 The voltages across the inductor and the capacitor (2)

[18]



QUESTION 3

- 3.1 Explain the following items in connection with PN-junction semiconductor diodes.



- 3.1.1 Reverse-bias voltage
- 3.1.2 Holes

(2 × 2) (4)

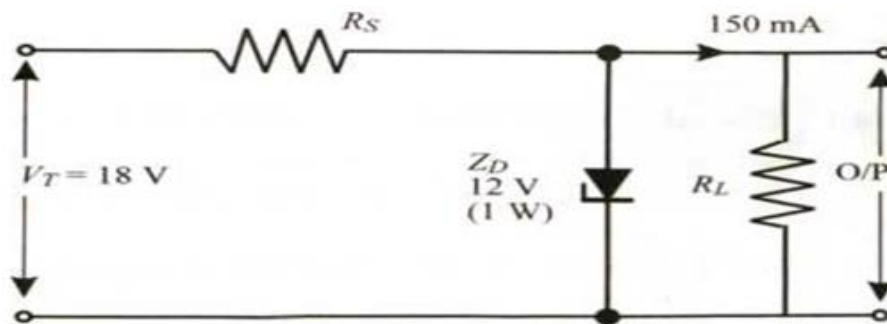


FIGURE 2

- 3.2 Use FIGURE 2 above to answer the following 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 number (3.2.1–3.2.5) in the ANSWER BOOK.

- 3.2.1 What is the value of the voltage across the load resistor?

A $0\ \text{V}$
 B $12\ \text{V}$
 C $6\ \text{V}$
 D Information not sufficient to calculate V_L

- 3.2.2 What is the value of the Zener diode?

A $6\ \Omega$
 B $12\ \Omega$
 C $144\ \Omega$
 D Information not sufficient to calculate Z_D



3.2.3 What is the amount of current flowing across the Zener diode?

- A 83,33 mA
- B 12 A
- C 12 mA
- D Information not sufficient to calculate I_z



3.2.4 What is the amount of current flowing across the series resistor?

- A 12,15 A
- B Information not sufficient to calculate I_s
- C 300 mA
- D 233,333 mA

3.2.5 What is the value of the series resistor?

- A 0 Ω
- B Information not sufficient to calculate R_s
- C 25,715 Ω
- D 0,494 Ω

(5 × 1)

(5)
[9]



QUESTION 4

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (4.1.1–4.1.5) in the ANSWER BOOK.

4.1.1 Rectification is the process of converting an alternating voltage to a unidirectional voltage.



4.1.2 Rectification efficiency is defined as the ratio of the DC input power to the AC output power.

4.1.3 The measure of the smoothness of the DC output of a rectifier is called the ripple factor.

4.1.4 The advantage of the ripple factor is that rectification efficiency is quite low (approximately 40%).

4.1.5 Ripple voltage (AC variation) is defined as the deviation of the load voltage from its DC value.

(5 × 1)

(5)



4.2 A half-wave rectifier circuit is connected from a 240-V, 50-Hz supply and has the following specifications:



- Peak secondary voltage = 17 V
- Value of filter capacitor = 35 μF
- Load current = 20 mA

Calculate the following:

4.2.1 The output DC voltage

4.2.2 The output ripple voltage

4.2.3 The ripple factor expressed as a percentage



(3 × 2)

(6)
[11]

QUESTION 5

5.1 How can cross-over distortion be limited?

(1)

5.2 Sketch neat and labelled IEC symbols for each of the following transistors:

5.2.1 P-N-P transistor

5.2.2 P-channel MOSFET

5.2.3 P-channel unijunction transistor

5.2.4 N-P-N transistor

5.2.5 N-channel JFET (JUGFET)



(5 × 1)

(5)

5.3 The following information on an amplifier is given:

- Input power = 500 MW
- Output power = 500 W
- Input voltage = 10 V
- Output impedance = 10 Ω

Calculate the following:



5.3.1 Power gain in dB

(2)

5.3.2 Voltage gain in dB

(4)
[12]

QUESTION 6

- 6.1 Make a neat, labelled circuit diagram of an integrator operational amplifier. (2)
- 6.2 State ONE use of the feedback resistance found on operational amplifiers circuits. (1)
- 6.3 Determine the output voltage in the non-inverting mode of an op-amp with an input voltage of 4 V, a feedback resistance of 15 k Ω and an input resistance of 1,2 k Ω . (3)

[6]**QUESTION 7**

- 7.1 After a kettle has been filled with water and switched on, the element keeps on transferring heat to the water without realising the objective.
Draw the loop system that corresponds with this action. (4)
- 7.2 Briefly explain the principle of operation of a linear variable differential transformer. (3)
- 7.3 What is the purpose of the diode in the gate of an SCR? (2)

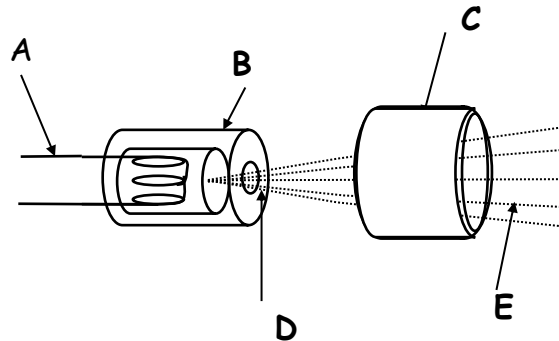
[9]**QUESTION 8**

- 8.1 Name THREE factors that determine the capacity of a capacitor. (3)
- 8.2 Give an application of the following transducers:
- 8.2.1 Tachometer generator
- 8.2.2 Linear variable differential transformer (2 × 1) (2)
- 8.3 Draw a simple circuit where the negative temperature coefficient is used to control the temperature of a heater. (5)

[10]

QUESTION 9

- 9.1 What is the effect of poor synchronisation in an oscilloscope? (2)
- 9.2 Label the parts marked A–E in FIGURE 3 below. (5)

**FIGURE 3**

- 9.3 Name the THREE uses of a triangular wave form. (3)
- 9.4 An oscilloscope displays a time-base setting of $3 \mu\text{sec/div}$, $0,6 \text{ V/div}$. A total of $2,9 \text{ cm}$ is measured from the 0-V reference line to the peak.

Calculate the following:

9.4.1 The peak voltage

9.4.2 V_{rms} and V_{ave}

(2 × 2) (4)
[14]

TOTAL: 100

INDUSTRIAL ELECTRONICS N4**FORMULA SHEET**

$$\frac{1}{R_T} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \dots \frac{1}{R_n} \right) \quad R_T = \frac{R_1 R_2}{R_1 + R_2} \quad V_2 = \frac{R_2}{R_1 + R_2} \times \frac{V_T}{1}$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2} \quad \cos \theta^\circ = \frac{R}{Z} \quad P = I^2 R \quad P = \frac{V^2}{R} \quad P = VI \cos \theta$$

$$P = V \cdot I \quad F_r = \frac{1}{2\pi\sqrt{LC}} \quad Q = \frac{X_L}{R} \quad \text{OF} \quad \frac{1}{R} \sqrt{\frac{L}{C}}$$

$$I_t = \sqrt{I_R^2 + (I_C - I_L)^2} \quad Z = \frac{1}{\sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{X_C} - \frac{1}{X_L}\right)^2}} \quad \frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1}$$

$$V_{rms/wgk} = 0,707 V_m \quad i = I_s \left(e^{\frac{qv}{kT}} - 1 \right) \quad R = \frac{kT}{qi} \quad V.R = \frac{V_{NL} - V_{FL}}{V_{FL}}$$

$$V_{ave/gem} = 0,637 V_m$$

$$f = \frac{1}{t} \quad \text{Rate of change/Tempo van verandering} = - \frac{V_{in}}{CR_{in}}$$

$$V_{dc}/V_{gs} = 0,318 V_m$$

$$V_{dc}/V_{gs} = 0,637 V_m$$

$$V_{r_{rms}}/V_{r_{wgk}} = 0,385 V_m$$

$$PIV = V_m \quad \text{or/of} \quad 2 V_m$$

$$V_{r_{rms}}/V_{r_{wgk}} = \frac{V_r (p - p)}{2\sqrt{3}}$$

$$V_{dc}/V_{gs} = V_m - \frac{V_r (p - p)}{2}$$

$$r = \frac{V_{r_{rms}}/V_{r_{wgk}}}{V_{dc}/V_{gs}}$$

$$V_{r_{rms}}/V_{r_{wgk}} = \frac{V_{dc}/V_{gs}}{R_L 2\sqrt{3} FC}$$

$$V_{dc}/V_{gs} = V_m \quad \frac{I_{dc}/I_{gs}}{2FC}$$

$$r = \frac{I_{dc}/I_{gs}}{V_{dc}/V_{gs} 2\sqrt{3} FC}$$

$$V_{r'_{rms}}/V_{r'_{wgk}} = \frac{X_C}{\sqrt{R^2 + X_C^2}} \times \frac{V_{r_{rms}}/V_{r_{wgk}}}{1}$$

$$V'_{dc}/V'_{gs} = \frac{R_L}{R_L + R_S} \times \frac{V_{dc}/V_{gs}}{1}$$

$$V_{r'_{rms}}/V_{r'_{wgk}} = \frac{V_{r_{rms}}/V_{r_{wgk}}}{(2\pi f)^2 LC}$$

$$R_{in} = \frac{V_{be}}{I_b} \quad R_{out} / R_{uit} = \frac{V_{ce}}{I_c} \quad R_c = \frac{V_{cc}}{I_c} \quad V_{out} / V_{uit} = R_1 C \frac{dv_i}{dt}$$

$$\text{Static current gain/Statieseestroomwins} = \frac{I_{out/uit}}{I_{in}}$$

$$\text{Dynamic current gain/Dinamieseestroomwins} = \frac{\Delta I_{out/uit}}{\Delta I_{in}}$$

$$V_{cc} = V_{RC} + V_{ce} \quad V_{ce} = V_{cc} - V_{RC} \quad R = \frac{p\ell}{a}$$

$$A_p = 10 \log \frac{P_{out/uit}}{P_{in}} \quad A_v = 20 \log \frac{V_{out/uit}}{V_{in}} \quad A_i = 20 \log \frac{I_{out/uit}}{I_{in}}$$

$$\text{Static voltage gain/Statiese spanningwins} = \frac{V_{out/uit}}{V_{in}}$$

$$\text{Dynamic voltage gain/Dinamiese spanningwins} = \frac{\Delta V_{out/uit}}{\Delta V_{in}}$$

$$h_{ie} = \frac{\Delta V_{in}}{\Delta I_{in}} = \frac{\Delta V_{be}}{\Delta I_b}$$

$$V_{ce} = \text{constant/konstant}$$

$$h_{re} = \frac{\Delta V_{in}}{\Delta V_{out/uit}} = \frac{\Delta V_{be}}{\Delta V_{ce}}$$

$$I_b = \text{constant/konstant}$$

$$h_{fe} = \frac{\Delta I_{out/uit}}{\Delta I_{in}} = \frac{\Delta I_c}{\Delta I_b}$$

$$V_{ce} = \text{constant/konstant}$$

$$h_{oe} = \frac{\Delta I_{out/uit}}{\Delta V_{out/uit}} = \frac{\Delta I_c}{\Delta V_{ce}}$$

$$I_b = \text{constant/konstant}$$

$$V_{out/uit} = \frac{R_f}{R_{in}} \times V_{in}$$

$$V_{out/uit} = - \left(\frac{R_f V_1}{R_1} + \frac{R_f V_2}{R_2} + \dots + \frac{V_n R_f}{R_n} \right)$$

$$V_{out/uit} = \left(1 + \frac{R_f}{R_{in}} \right) V_{in}$$

$$V_{out/uit} = - \frac{1}{CR_{in}} \int V_{in}(t) dt$$

Boltzmann's constant/

$$\text{Boltzmann se konstante} = 1,38 \times 10^{-23} \text{ J/k}$$

Electron charge/

$$\text{Elektronlading} = 1,6 \times 10^{-19} \text{ C}$$

NB: Any applicable formula may be used.

Enige toepaslike formules mag gebruik word.