



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

**NATIONAL CERTIFICATE
INDUSTRIAL ELECTRONICS N4**

(8080164)

**28 July 2021 (X-paper)
09:00–12:00**

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 6 pages and a formula sheet of 2 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA
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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. Start each question on a new page.
 5. Only use a black or blue pen.
 6. Write neatly and legibly.
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QUESTION 1

1.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 Voltage law states that the algebraic sum of all voltages around any closed loop in a circuit is equal to zero. ☐

1.1.2 Superposition theorem states that any network can be viewed as two terminal networks and can be replaced by a single source. ☐

1.1.3 The first step when calculating a circuit with two power sources is to short one power source. ☐

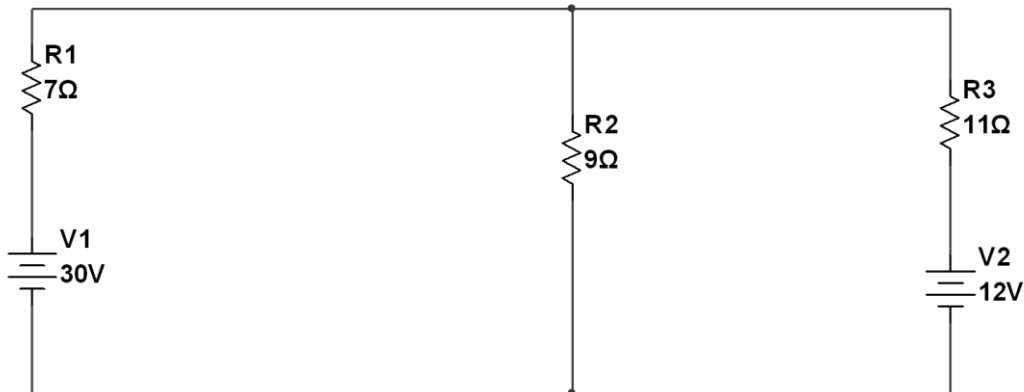
1.1.4 If a circuit has one power source on Thevenin's circuit, one should assume that the supply voltage equals V_{th} . ☐

1.1.5 The first step when calculating maximum power transfer in a circuit is to calculate V_{th} and R_{th} . ☐

(5 × 1)

(5)

1.2 Study the circuit diagram below and apply the superposition theorem to calculate the current through the $9\ \Omega$ resistor.

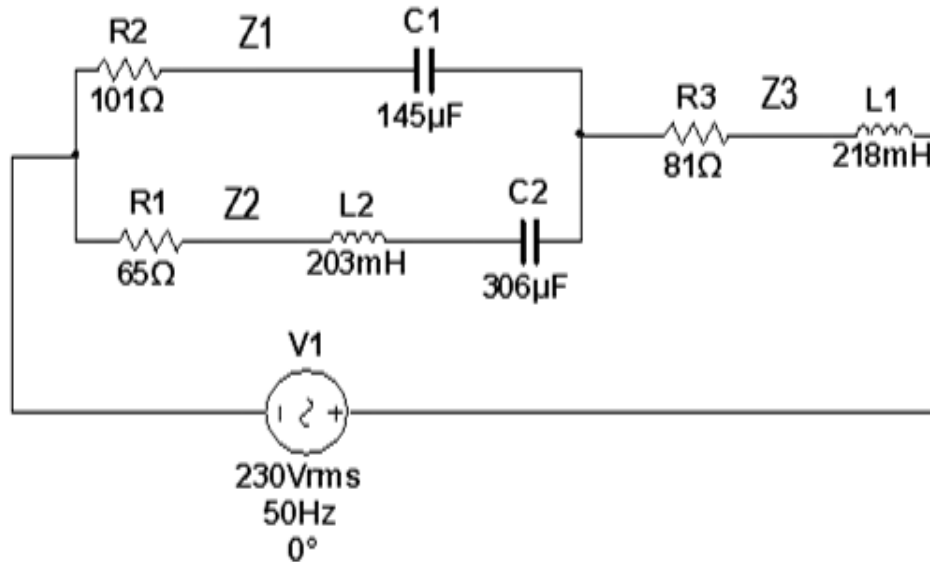


(8)

[13]

QUESTION 2

- 2.1 Explain how the Q factor affects bandwidth with the aid of a characteristic curve. (4)
- 2.2 Study the circuit diagram below and calculate the current flowing across resistor R_3 using J notation.



(12)
[16]

QUESTION 3

- 3.1 A germanium diode with $I_S = 45 \mu A$ is applied with a forward bias of 0,3 V at a room temperature of 27 °C.
Calculate the diode current.
- 3.2 A PN junction diode has a forward resistance of 3,115 Ω at a room temperature of 29 °C.
Calculate the forward current of the diode.
- 3.3 Calculate the current that must flow through a Zener diode of 20 V and a series resistor of 316 Ω connected to a 28-V DC supply.
- 3.4 Draw a characteristic curve of a varactor diode.

(4 × 3) [12]

QUESTION 4

4.1 Explain the following terms:

4.1.1 Rectification

4.1.2 Peak reverse voltage

4.1.3 Ripple voltage

(3 × 2) (6)

4.2 A centre-tap full-wave rectifier has the following data: $V_{ac} = 230 \text{ V}$ and $R_L = 200 \Omega$.

Calculate the following:

4.2.1 V_{dc}

(2)

4.2.2 The ripple factor

(4)

4.3 A common base emitter circuit has the following data: $V_{CC} = 25 \text{ V}$, $V_{RB} = 15 \text{ V}$ and $I_B = 10 \text{ mA}$.

Calculate V_{BE} and R_B .

(3)

4.4 An amplifier has the following data:

- Input power = 400 Mw
- Output power = 200 W
- Input voltage = 20 V
- Output impedance = 30 Ω

Calculate the current gain in dB.

(4)
[19]

QUESTION 5

5.1 Draw a two-transistor model of a silicon-controlled rectifier.

(4)

5.2 How do we switch on a light-activated silicon-controlled rectifier?

(2)

5.3 Explain the basic construction of a quadrac.

(2)

5.4 Explain the following components of a closed-loop system:

5.4.1 Controller

5.4.2 Feedback

(2 × 2) (4)
[12]

QUESTION 6

- 6.1 Name ONE transducer that converts a rotating shaft position to electrical signals. (1)
- 6.2 Explain the operational principle of a Bourdon tube. (5)
- 6.3 What happens when incident light falls on a light-dependent resistor? (2)
- 6.4 Explain the purpose of the base terminal in the three-terminal device of a photo transistor. (2)
- [10]**

QUESTION 7

- 7.1 Draw input and output waveforms of the following amplifiers using square- and sine-wave forms: (4 × 2) (8)
- 7.1.1 Integrator
- 7.1.2 Differentiator
- 7.2 A cathode ray tube may be divided into five sections. Name FOUR of the five sections. (4)
- 7.3 An oscilloscope screen displays the following information:
- 0-V reference line to the peak = 3,1 cm
 - From negative peak to positive peak = 6,2 cm
 - Amplifier gain setting = 0,5 V/div
 - Time-based setting = 4 μsec/div.
- Calculate the following:
- 7.3.1 The amplitude and peak voltage
- 7.3.2 The period and frequency, if we count five divisions for a full cycle (360°) (2 × 3) (6)
- [18]**

TOTAL: 100

INDUSTRIAL ELECTRONICS N4**FORMULA SHEET**

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

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

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

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

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

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

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

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

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

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

$$V'_{r(rms)} = \frac{X_C}{R} \cdot V_{r(rms)}$$

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

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

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

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

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

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

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

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

$$X_C = \frac{1}{2\pi f C}$$

$$X_C = \frac{1}{4\pi f C}$$

$$r' = \frac{V'_{r(rms)}}{V'_{dc}}$$

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

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

$$V_0 = -\left(\frac{R_f}{R_1}\right) \cdot V_i \quad V_0 = \left(\frac{R_f}{R_1} + 1\right) \cdot V_i \quad V_{out/uit} = -\frac{1}{CR_{in}} \int V_{in}(t) dt$$

$$V_0 = -\left(\frac{R_f}{R_1} \cdot V_1 + \frac{R_f}{R_2} \cdot V_2 + \frac{R_f}{R_3} \cdot V_3\right) \quad V_0 = -\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right) R_f$$

$$V_0 = -(V_1 + V_2 + V_3) \quad V_0 = -(I_1 + I_2 + I_3) R_f$$

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

$$R_b = \frac{V_{cc} - V_{be}}{I_b} \quad R_c = \frac{V_{cc} - V_{ce}}{I_c} \quad R_c = \frac{V_{cc} - V_{ce} - V_e}{I_c} \quad R_b = \frac{V_{cc} - V_{be} - V_e}{I_b}$$

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

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

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

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

$$\text{Static voltage gain/Statische spanningswinst} = \frac{V_{out}/V_{uit}}{V_{in}}$$

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

$$h_{ie} = \frac{\Delta V_{in}}{\Delta I_{in}} = \frac{\Delta V_{be}}{\Delta I_b} \quad V_{ce} = \text{constant/konstant}$$

$$h_{re} = \frac{\Delta V_{in}}{\Delta V_{out/uit}} = \frac{\Delta V_{be}}{\Delta V_{ce}} \quad I_b = \text{constant/konstant}$$

$$h_{fe} = \frac{\Delta I_{out/uit}}{\Delta I_{in}} = \frac{\Delta I_c}{\Delta I_b} \quad V_{ce} = \text{constant/konstant}$$

$$h_{oe} = \frac{\Delta I_{out/uit}}{\Delta V_{out/uit}} = \frac{\Delta I_c}{\Delta V_{ce}} \quad I_b = \text{constant/konstant}$$

Boltzmann's constant/

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

Electron charge/

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

NB: Any applicable formula may be used.

Enige toepaslike formules mag gebruik word.