higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

(8080164)

22 November 2022 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

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

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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. Drawings should be clear, neat and labelled and may be done in pencil.
6. Write neatly and legibly.

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QUESTION 1

1.1 Use Thevenin's method to calculate the current across the load resistor R_L in FIGURE 1.

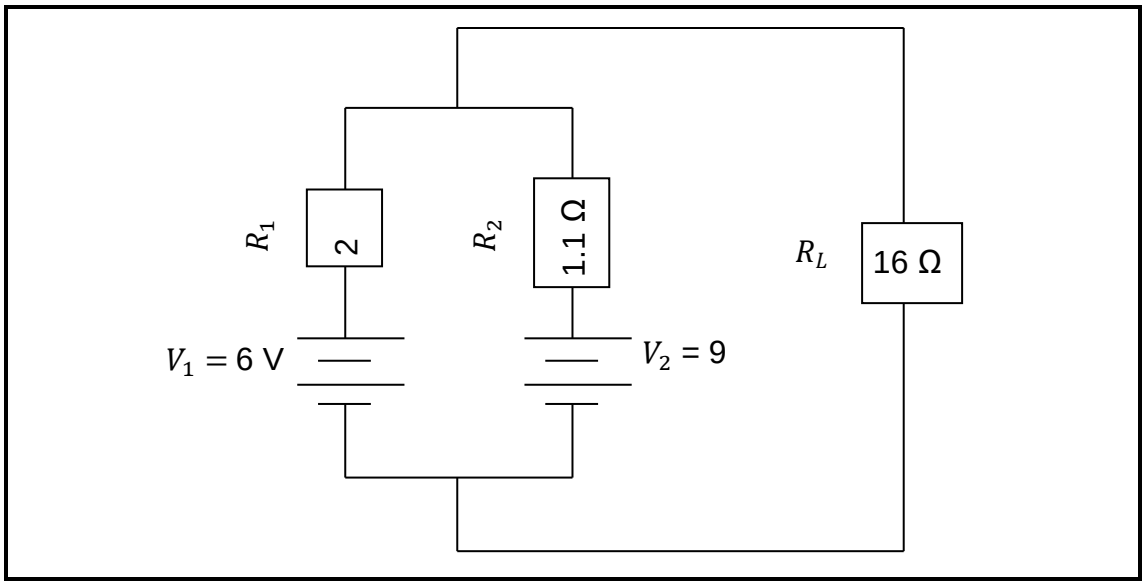


FIGURE 1 (8)

1.2 State TWO application procedures followed in QUESTION 1.1. (2)
[10]

QUESTION 2

2.1 Draw a neat waveform of an RLC series circuit illustrating each of the following:

2.1.1 V_R (voltage across the resistor) in-phase with the I (total current of the circuit)

2.1.2 V_L (voltage across an inductor) leads the I (total current of the circuit) by 90°

2.1.3 V_C (voltage across a capacitor) lags the I (total current of the circuit) by 90°

(3 × 2) (6)

2.2 An LC circuit resonating at 5 MHz has a Q of 250.

Find the total bandwidth Δf and the edge frequencies f_H and f_L. (3)

2.3 A phasor diagram is shown in FIGURE 2.

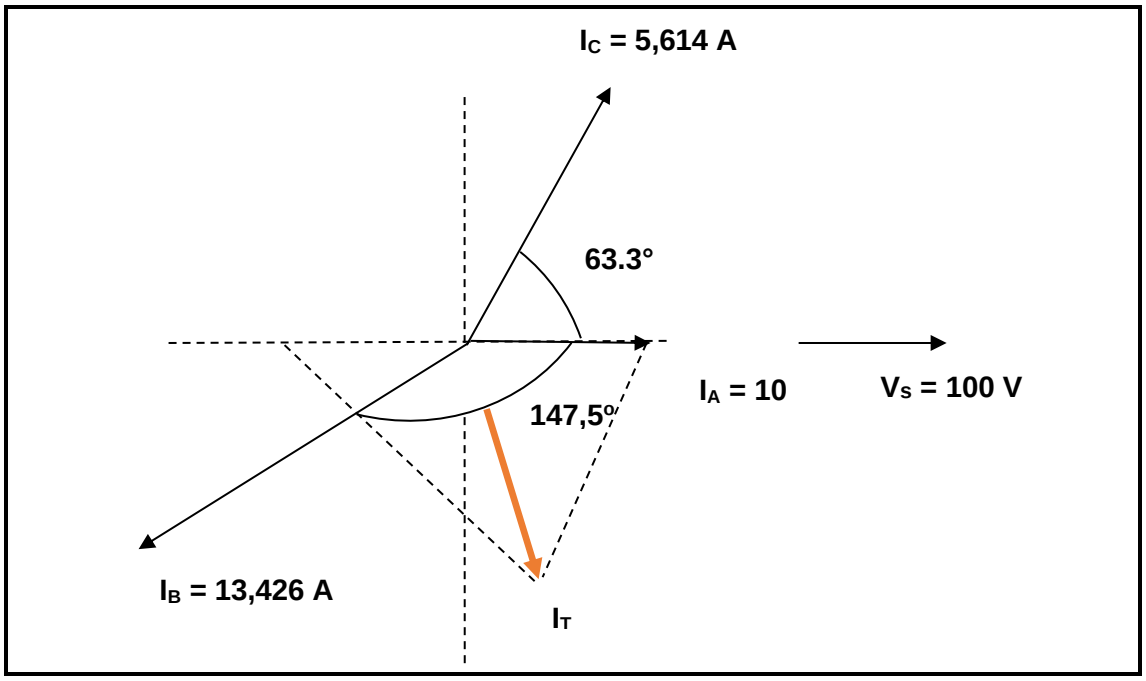


FIGURE 2

Calculate the following values:

2.3.1 Z_A

2.3.2 Z_B

2.3.3 Z_C

(3 × 2) (6)
[15]

QUESTION 3

3.1 3.1.1 Draw a simple Zener diode voltage-regulator circuit. (3)

3.1.2 Explain how the output load will be regulated. (2)

3.2 Calculate the voltage drop across the junction diode of a germanium diode with a reverse saturation current of 12 µA if it conducts 1,5 mA at a room temperature of 17 °C. (3)

3.3 State TWO significant properties of varactor diodes. (2)
[10]

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QUESTION 4

4.1 Answer QUESTION 4.1 with regard to the circuit shown in FIGURE 3.

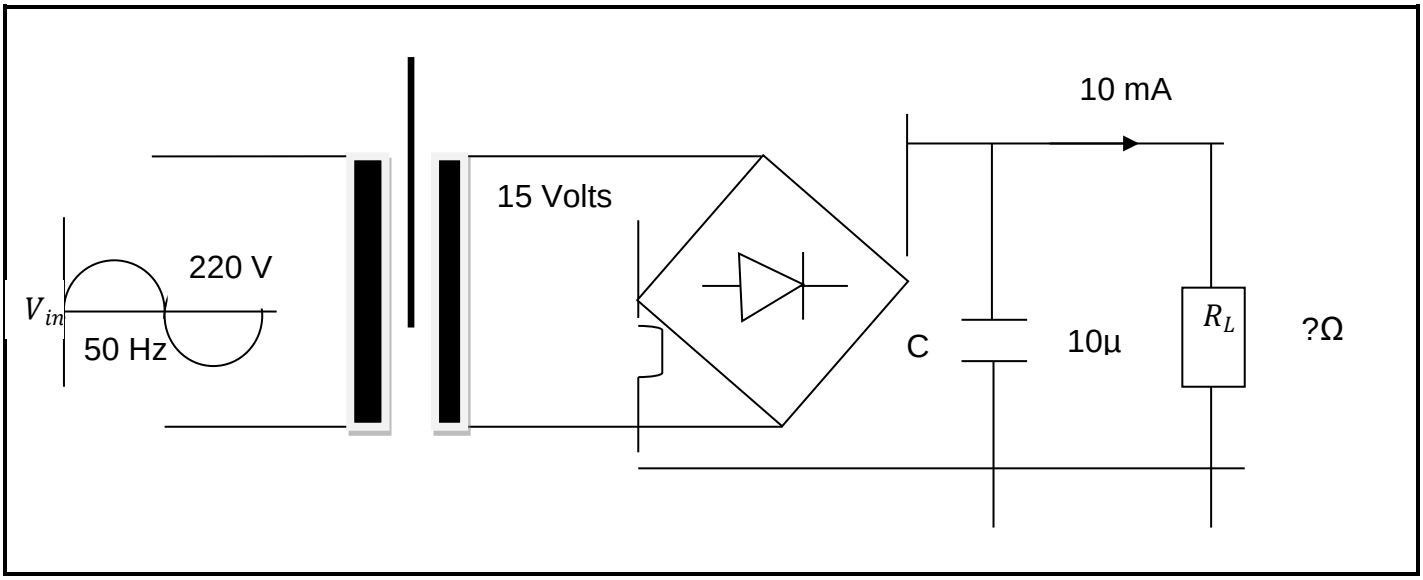


FIGURE 3

4.1.1 The circuit represents a … wave rectifier. (1)

4.1.2 Draw the output waveform from 0° to 540°. (2)

4.1.3 Calculate the output DC voltage. (3)

4.1.4 Calculate the output ripple voltage. (3)

4.1.5 Calculate the load resistance. (2)

4.2 Name TWO types of transformers. (2)

4.3 What is *rectification*? (2)
[15]

QUESTION 5

5.1 Define the term *transistor.* (1)

5.2 Explain the difference between the following values in amplifiers:

5.2.1 Static values

5.2.2 Dynamic values

(2 × 2) (4)

5.3 Draw a neat, labelled circuit diagram of the UJT relaxation oscillator. (4)

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5.4 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (5.4.1–5.4.5) in the ANSWER BOOK.

5.4.1 When a transistor's voltage and current are constant, the transistor is operating in its dynamic condition.

5.4.2 Power amplifiers are designed to handle large signals.

5.4.3 The unijunction transistor is a single-junction device that has negative resistance characteristics.

5.4.4 The operation of MOSFET under forward bias is called the enhancement mode.

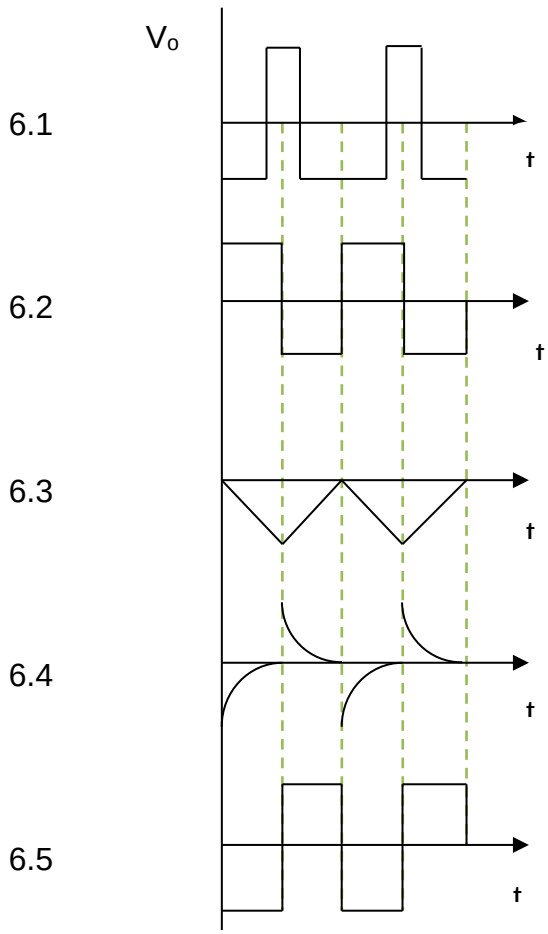
5.4.5 The depletion mode, MOSFET can be operated only with a negative gate.

(5 × 1) (5)

[14]

QUESTION 6

Choose the amplifier from COLUMN B that matches an output wave in COLUMN A. Write only the letter (A–F) next to the question number (6.1–6.5) in the ANSWER BOOK.

COLUMN A	COLUMN B
	A non-inverting amplifier B differentiator C inverting amplifier D summing amplifier E integrator F comparator

(5 × 2) **[10]**

QUESTION 7

7.1 Draw a diagram of the circuit of an LASCR, explain the operation of the circuit in THREE points and also include the function of the resistor in the explanation. (6)

7.2 Make a neat, labelled drawing of a simple transducer to show how the following would be measured:

7.2.1 Pressure with bellows

7.2.2 Displacement with a potentiometer

(2 × 4) (8)

7.3 Name TWO groups into which transducers can be divided. (2)

[16]

QUESTION 8

8.1 The signal displayed in FIGURE 4 has the following settings:

- Volts/div = 4
- Time/div = 2 µs

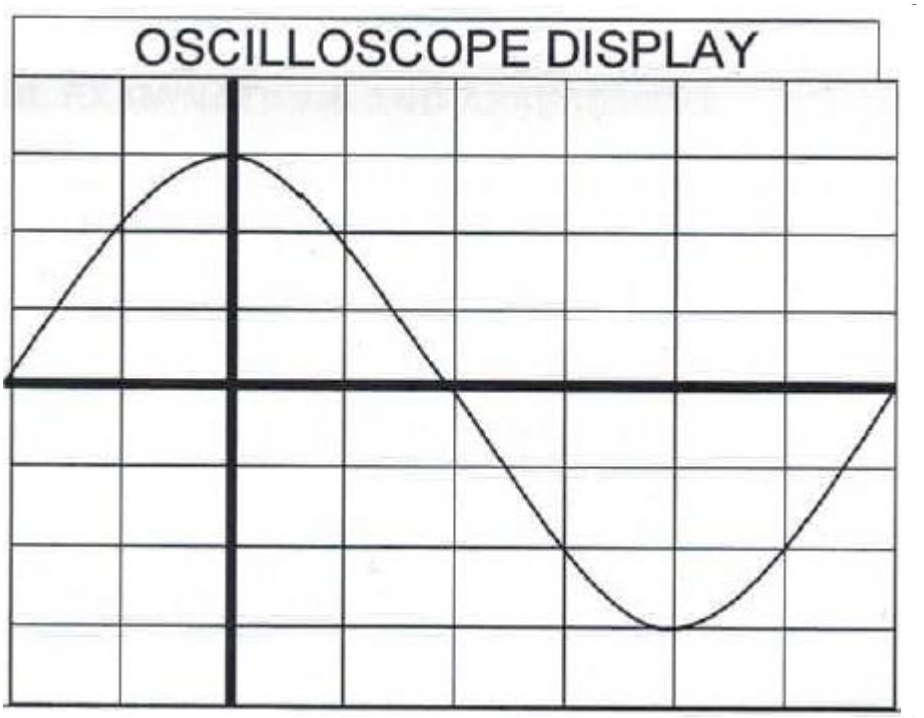


FIGURE 4

Calculate the following:

8.1.1 The input voltage of the signal (2)

8.1.2 The frequency (4)

8.2 The function generator is an extremely useful test instrument in the electronics industry. It is used to generate waveforms.

Name TWO waveforms generated. (2)

8.3 Name TWO ways of focusing the electron beam. (2)

[10]

TOTAL: 100

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INDUSTRIAL ELECTRONICS N4

FORMULA SHEET

Any applicable formula may also be used.

$$\frac{1}{R_T}=\left(\frac{1}{R_1}+\frac{1}{R_2}+\ldots\frac{1}{R_n}\right)\quad R_T=\frac{R_1R_2}{R_1+R_2}\quad V_2=\frac{R_2}{R_1+R_2}\times\frac{V_T}{1}$$

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

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

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

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

$$V_{ave}=0{,}637\;V_m$$

$$f=\frac{1}{t}\qquad Rate\ of\ change=-\frac{V_{in}}{CR_{in}}$$

$$V_{dc}=0{,}318\;V_m\qquad V_{dc}=0{,}637\;V_m$$

$$\mathrm{V_{r_{rms}}}=0{,}385\;\mathrm{V_m}$$

$$PIV=V_m\quad \text{or}\quad 2\,V_m$$

$$V_{r_{rms}}=\frac{V_r\;(p-p)}{2\sqrt{3}}\qquad V_{dc}=V_m-\frac{V_r\;(p-p)}{2}$$

$$r=\frac{V_{r_{rms}}}{V_{dc}}\qquad V_{r_{rms}}=\frac{V_{dc}}{R_L\;2\sqrt{3}\;FC}$$

$$V_{dc}=V_m\quad\frac{I_{dc}}{2FC}\qquad r=\frac{I_{dc}}{V_{dc}\;2\sqrt{3}\;FC}$$

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

$$V'_{dc}=\frac{R_L}{R_L+R_S}\times\frac{V_{dc}}{1}\qquad V_{r'_{rms}}=\frac{V_{r_{rms}\,r}}{(2\pi f)^2\;LC}$$

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

Static current gain $= \frac{I_{out}}{I_{in}}$

Dynamic current gain $= \frac{\Delta I_{out}}{\Delta I_{in}}$

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

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

Static voltage gain $= \frac{V_{out}}{V_{in}}$

Dynamic voltage gain $= \frac{\Delta V_{out}}{\Delta V_{in}}$

$hie = \frac{\Delta V_{in}}{\Delta I_{in}} = \frac{\Delta V_{be}}{\Delta I_b}$ $V_{ce} = constant$

$hre = \frac{\Delta V_{in}}{\Delta V_{out}} = \frac{\Delta V_{be}}{\Delta V_{ce}}$ $I_b = constant$

$hfe = \frac{\Delta I_{out}}{\Delta I_{in}} = \frac{\Delta I_c}{\Delta I_b}$ $V_{ce} = constant$

$hoe = \frac{\Delta I_{out}}{\Delta V_{out}} = \frac{\Delta I_c}{\Delta V_{ce}}$ $I_b = constant$

$V_{out} = \frac{R_f}{R_{in}} \times V_{in}$ $V_{out} = -\left(\frac{R_f V_1}{R_1} + \frac{R_f V_2}{R_2} + \ldots \frac{V_n R_f}{R_n} \right)$

$V_{out} = \left(1 + \frac{R_f}{R_{in}} \right) V_{in}$ $V_{out} = -\frac{1}{CR_{in}} \int V_{in}(t)\, dt$

Boltzmann's constant = 1,38 × 10^{-23} J/k

Electron charge = 1,6 × 10^{-19} C

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