higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N2

(8080602)

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

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 6 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 N2
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. Diagrams should be neat and in good proportion. A pencil may be used.
6. Write neatly and legibly.

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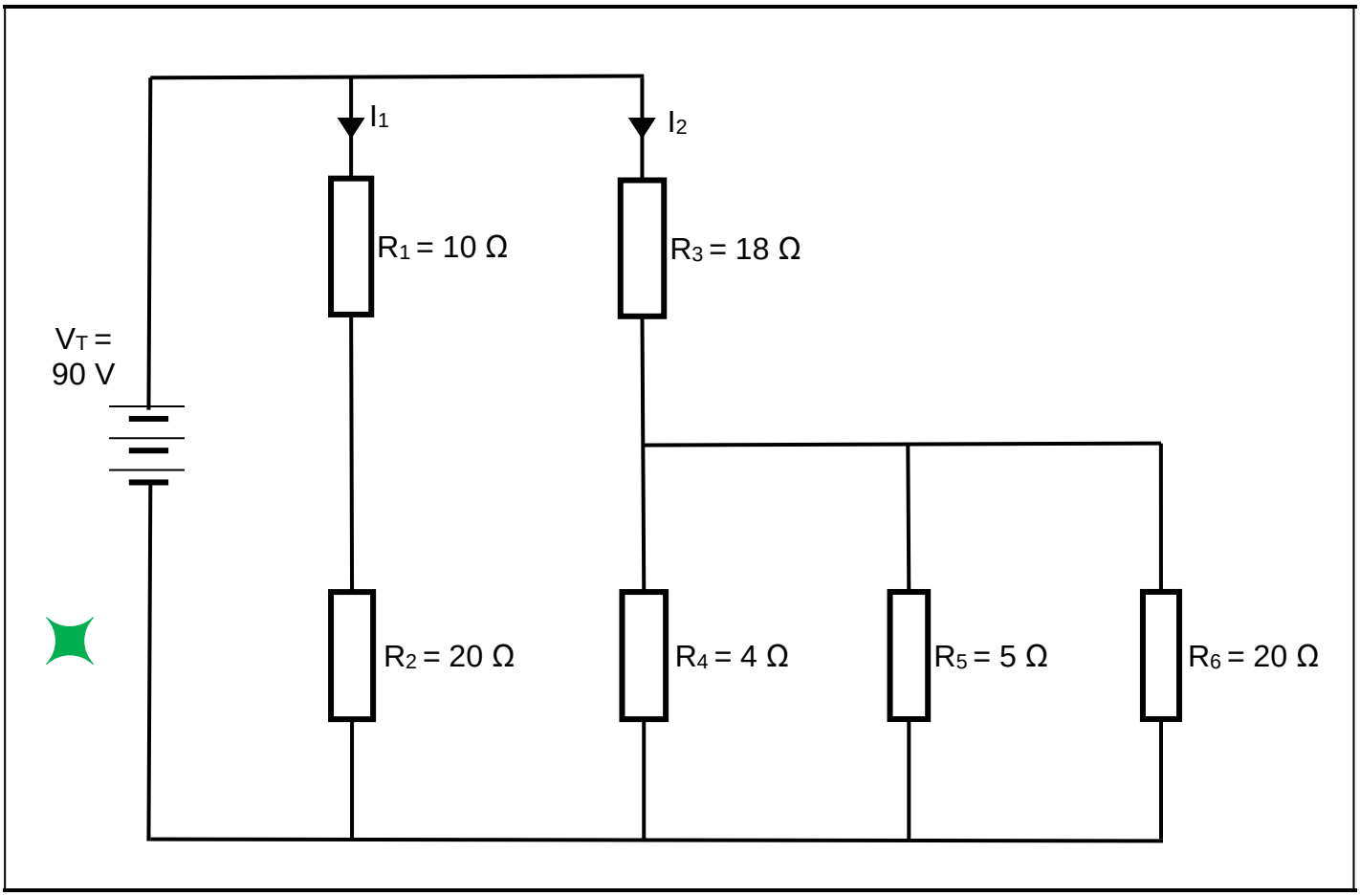
QUESTION 1

Refer to the circuit below and calculate the following:



1.1	The total resistance in the circuit	(8)
1.2	The total current flowing through the circuit	(2)
1.3	The currents I_1 and I_2	(4)
1.4	The voltage drop across resistor R_5	(3)
1.5	Power consumed by R_6	(3)
		[20]

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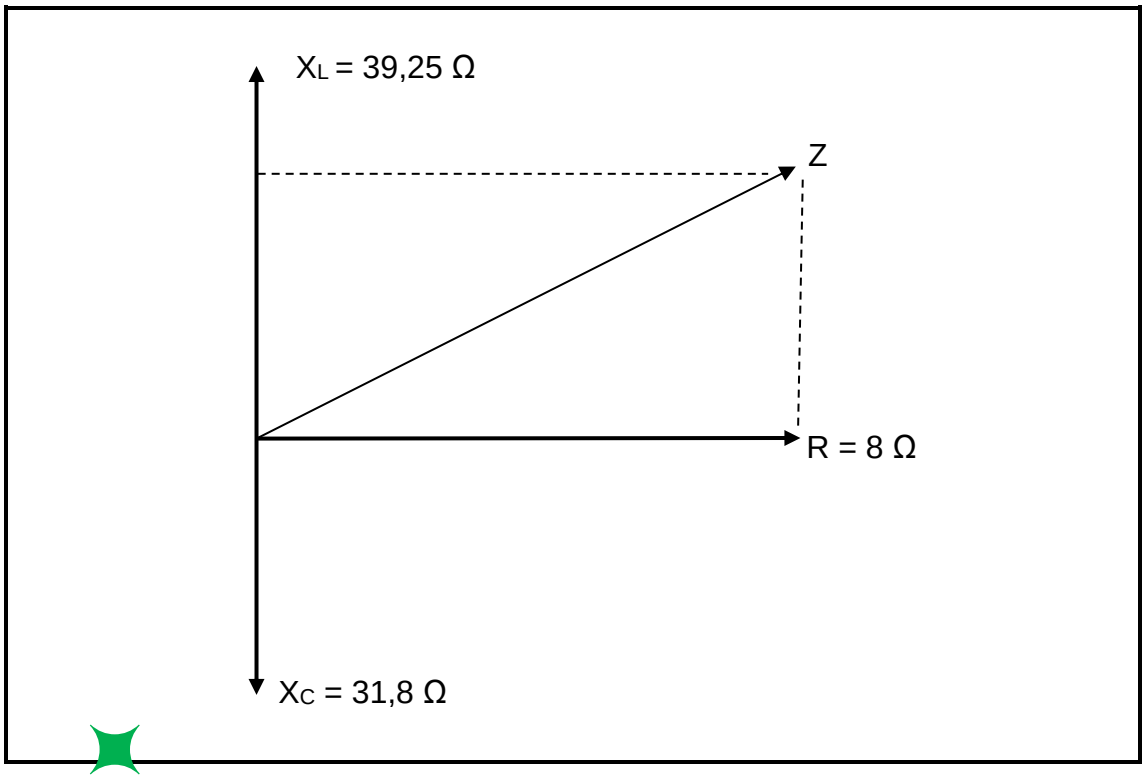
QUESTION 2

2.1 State THREE factors which influence the capacitance of the capacitors in an AC circuit. (3)

2.2 Refer to the vector diagram below and calculate the following for a 250 V 50 Hz AC-system :



2.2.1 The value of the inductor in mH (2)

2.2.2 The value of the capacitor in µF (2)

2.2.3 The impedance Z (3)

2.2.4 The supply current (2)

2.2.5 The voltage drop across the inductor and the capacitor (4)

2.2.6 The phase angle (2)

2.2.7 Draw the circuit diagram (2)
[20]

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QUESTION 3

3.1 Name and explain THREE types of bias that can be applied to a PN junction. (3 × 2) (6)

3.2 Define the term *peak-to-peak*. (2)

3.3 Draw a full-wave rectifier circuit using two diodes, with a centre-tapped connection, with a smoothing capacitor and a load resistor. Also draw the output waveform without and with the smoothing capacitor. (9)

3.4 Name THREE factors that will influence the ripple voltage. (3)

[20]

QUESTION 4

4.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (4.1.1–4.1.2) in the ANSWER BOOK.

4.1.1 To turn a PNP transistor on, the base is biased negative with respect to the emitter and the collector is biased to a higher negative value than the base.

4.1.2 A common base amplifier has a 0° phase shift between the input and the output.

(2 × 1) (2)

4.2 Explain how a transistor is biased in the following regions:

4.2.1 Cut-off region

4.2.2 Saturated region

(2 × 2) (4)

4.3 Name FOUR advantages of using a transistor as a switch. (4)

4.4 Draw a neat, labelled diagram to show the construction and characteristic curve of a typical thermocouple. (8)

4.5 Determine the collector current in a transistor circuit, where the emitter current is 50 mA and the base current is 100 µA. (2)

[20]

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QUESTION 5

5.1 Assume that the basic movement of a measuring instrument has a full-scale deflection when a current of 1 mA flows through it. The resistance of the coil is 20 Ω.

5.1.1 Determine the multiplier resistor value that will enable the instrument to measure voltages up to 5 V. (6)

5.1.2 Draw the circuit to show how the multiplier should be connected. (2)

5.2 Calculate the gain of an amplifier which produces a current of 1 A to an 8 Ω loudspeaker, when a voltage of 300 mV is applied to its input. The input impedance of this amplifier is 100 kΩ. (6)

5.3 Draw a neat, labelled synchro system circuit diagram of opposite-direction rotation. (6)

[20]

TOTAL: 100

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INDUSTRIAL ELECTRONICS N2

FORMULA SHEET

DIRECT-CURRENT THEORY

$$V = I \cdot R \qquad P = V \cdot I \qquad P = \frac{V^2}{R}$$

$$P = I^2 \cdot R \qquad R_T = R_1 + R_2 \qquad \frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$R_T = \frac{R_1 \times R_2}{R_1 + R_2} \qquad I_1 = \frac{R_2}{R_1 + R_2} \times I_T$$

ALTERNATING-CURRENT THEORY

$$t = \frac{1}{f} \qquad e = E_m Sin\theta \qquad e = E_m Sin\omega t$$

$$e = E_m Sin2\pi ft \qquad i = I_m Sin\theta \qquad i = I_m Sin\omega t$$

$$V_{rms} = 0{,}707 V_{max} \qquad I_{rms} = 0{,}707 I_{max} \qquad V_{ave} = 0{,}637 V_{max}$$

$$I_{ave} = 0{,}637 I_{max} \qquad Form\ factor = \frac{rms\ value}{average value}$$

$$Crest\ factor = \frac{maximum\ value}{rms\ value}$$

$$E_{ave} = \frac{e_1 + e_2 + e_3 + e_4 + e_5 + ...e_n}{n} \qquad I_{ave} = \frac{i_1 + i_2 + i_3 + i_4 + i_5 + ...i_n}{n} \qquad \omega = 2\pi f$$

$$E_{rms} = \sqrt{\frac{e_1^2 + e_2^2 + e_3^2 + e_4^2 + e_5^2 + ...e_n^2}{n}} \qquad I_{rms} = \sqrt{\frac{i_1^2 + i_2^2 + i_3^2 + i_4^2 + i_5^2 + ...i_n^2}{n}}$$

$$X_L = 2\pi fL \qquad X_C = \frac{1}{2\pi fC} \qquad V = I \cdot R$$

$$V_T = \sqrt{V_R{}^2 + V_C{}^2} \qquad V_T = \sqrt{V_R{}^2 + V_L{}^2} \qquad V_T = \sqrt{V_R{}^2 + (V_L \sim V_C)^2}$$

$$Z = \sqrt{R^2 + (X_L \sim X_C)^2} \qquad Z = \sqrt{R^2 + X_L{}^2} \qquad Z = \sqrt{R^2 + X_C{}^2}$$

$$I = \frac{V_T}{Z} \qquad I_R = \frac{V_T}{R} \qquad I_L = \frac{V_T}{X_L}$$

$$I_C = \frac{V_T}{X_C} \qquad I_T = \sqrt{I_R{}^2 + I_X{}^2} \qquad I_X = I_L \sim I_C$$

$$V_L = I \cdot X_L \qquad V_C = I \cdot X_C \qquad Z = \frac{V}{I_T}$$

$$\theta = \tan^{-1}\frac{I_X}{I_R} \qquad \theta = \cos^{-1}\frac{I_R}{I_T} \qquad \theta = \cos^{-1}\frac{R}{Z}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

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MEASURING INSTRUMENTS

$$R_{SH} = \frac{I_M R_M}{I_{SH}} \qquad R_S = \frac{V}{I_M} - R_M$$

TRANSISTORS

$$I_E = I_C + I_B$$

DECIBEL RATIOS

$$N = 10 \log \frac{P_{OUT}}{P_{IN}} \qquad N = 20 \log \frac{I_{OUT}}{I_{IN}} + 10 \log \frac{R_{OUT}}{R_{IN}} \qquad N = 20 \log \frac{V_{OUT}}{V_{IN}} + 10 \log \frac{R_{IN}}{R_{OUT}}$$

If $R_{IN} = R_{OUT}$:

$$N = 20 \log \frac{V_{OUT}}{V_{IN}} \qquad N = 20 \log \frac{I_{OUT}}{I_{IN}}$$

RESISTANCE

$$R = \frac{\rho \ell}{A} \qquad A = \frac{\pi d}{4}$$

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