higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T760(**E**)(N15)T

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N2

(8080602)

15 November 2017 (X-Paper)
09:00–12:00

This question paper consists of 7 pages and a formula sheet of 2 pages.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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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. ALL sketches and diagrams must be drawn with a pencil.
5. ALL final answers must be rounded off to THREE decimal places.
6. Write neatly and legibly.

QUESTION 1

Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A–N) next to the question number (1.1–1.10) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.1	A process which will generate a hole in the crystal lattice structure	A	amplitude
1.2	N-type material is a majority carrier of …	B	extrinsic material
1.3	A device which converts one form of energy to another	C	element
1.4	The silicon atom has four electrons in the …	D	electrons
1.5	A material that consists of only one type of atom	E	donor doping
1.6	The source of charge carriers in the transistor	F	transducer
1.7	The height of the waveform	G	acceptor doping
1.8	When the base-emitter junction is forward biased and the base-collector junction is reverse biased	H	m-shell
1.9	A minus sign is used to indicate this in decibels	I	emitter
1.10	The semiconductor material formed as a result of doping	J	saturation
		K	base
		L	negative
		M	N-shell
		N	linear region

(10 × 1) **[10]**

QUESTION 2

2.1 State the relationship between current, voltage, resistance and temperature according to Ohm's law. (3)

2.2 Referring to the circuit diagram in FIGURE 1 below, R_1 = 100 Ω, R_2 = 50 Ω, R_3 = 60 Ω, R_4 = 20 Ω, R_5 = 5 Ω, R_6 = 36 Ω, I_T = 0,5 A, I_{R5} = 0,2 A, I_4 = 0,25 A, and V_T = 50 V.

Determine the following:

2.2.1 The total resistance of the circuit (R) (5)

2.2.2 The current I_3 (3)

2.2.3 The voltage drop across R_6 (2)

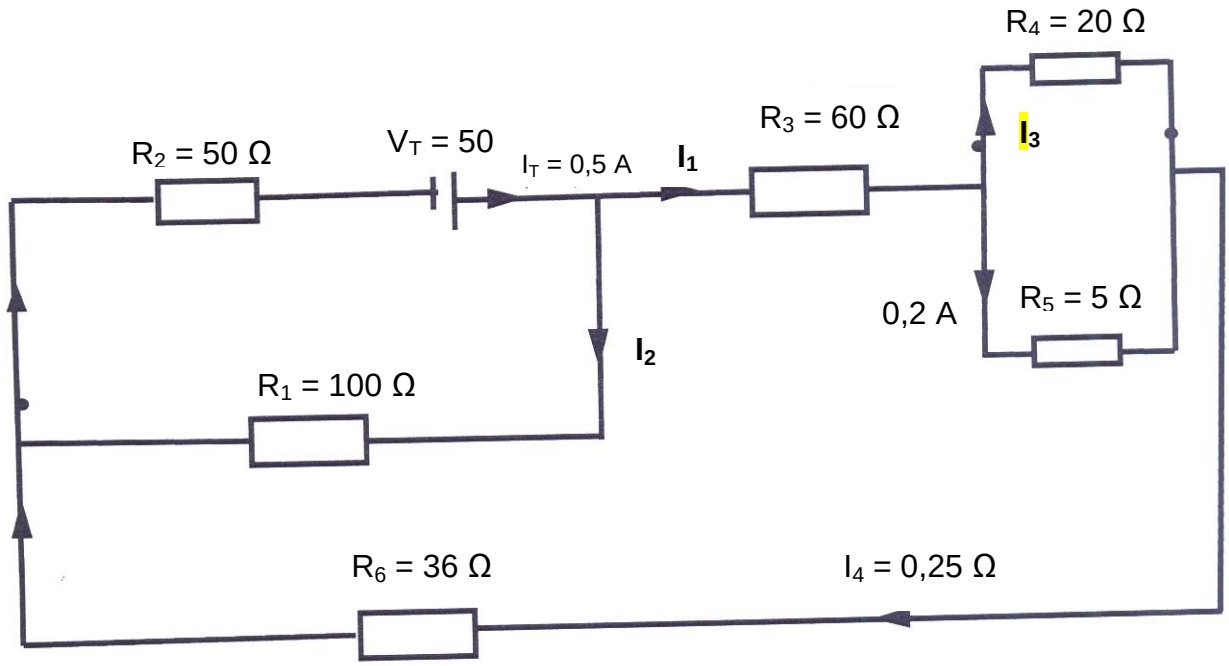

FIGURE 1

2.3 State Kirchhoff's first law. (2)

[15]

QUESTION 3

3.1 A series circuit consists of a 10 Ω resistance, a 10 µF capacitance and a 30 mH inductance connected across a 100 V alternating supply.

Determine the following:

3.1.1 The frequency at which the circuit will resonate (4)

3.1.2 The current at resonance (3)

3.1.3 The voltage drop across each component (6)

3.2 Label the parts of the sinewave marked A–E in FIGURE 2 below. Write only the answer next to the letter (A–E) in the ANSWER BOOK.

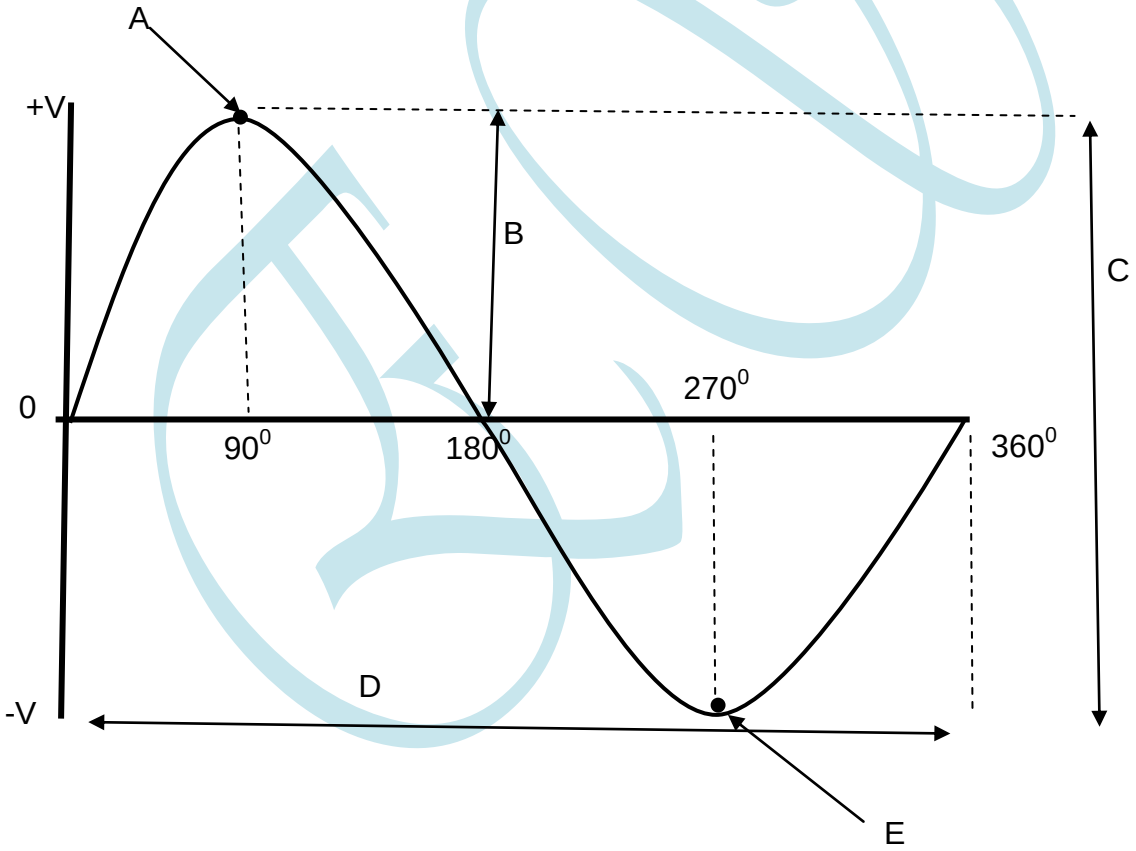

FIGURE 2

(5)
[18]

QUESTION 4

4.1 Give TWO breakdown mechanisms that can occur if the reserve bias voltage of a PN junction is greatly increased. (2 × 2) (4)

4.2 Explain the term *dark current.* (2)

4.3 Draw the circuit symbol of a photodiode (2)

4.4 Draw a half-wave rectifier circuit with a smoothing capacitor filter, and show the output wave before and after the capacitor. (6)

[14]

QUESTION 5

5.1 Name the THREE ways a transistor can be connected as an amplifier in a circuit. (3)

5.2 Give FIVE characteristics of a common-base amplifier. (5)

5.3 Draw a labelled common-base amplifier circuit using a PNP transistor, and clearly indicate the input and the output. (5)

5.4 A moving-coil meter has a full-scale deflection of 10 mA and an internal resistance of 100 Ω.

Calculate the value of a multiplier resistor that would enable the meter to measure a voltage of 10 V. (5)

[18]

QUESTION 6

6.1 What is a *decibel*? (1)

6.2 A 100 mV input to an amplifier produces a current of 1,5 A in a loudspeaker with an 8 Ω impedance.

Calculate the gain of this amplifier if it has an input impedance of 300 Ω. (6)

6.3 A synchro system can only operate successfully if certain basic requirements are met.

Give FIVE of these basic requirements. (5 × 2) (10)

[17]

QUESTION 7

7.1 Name TWO types of thermistors. (2)

7.2 A bi-metal strip is a temperature-sensitive device, but instead of generating a voltage it indicates only the change in temperature.

Explain the operating principle of a bi-metal strip. (6)
[8]

TOTAL: 100

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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