higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T760**(E)**(M28)T

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N2

(8080602)

28 March 2018 (X-Paper)
09:00–12:00

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

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. ALL sketches and diagrams must be done in pencil.
5. ALL final answers must be rounded off to THREE decimal places.
6. Write neatly and legibly.

QUESTION 1

Various possible options are given as answers to the following questions. Choose the correct answer and write only the letter (A–C) next to the question number (1.1–1.10) in the ANSWER BOOK.

1.1 Silicon is a good …

A conductor.
B semiconductor.
C insulator.

1.2 A half-wave rectifier consists of … diode/s.

A 4
B 1
C 2

1.3 1uF is the same as …

A 1000 nF.
B 10 nF.
C 100 nF.

1.4 In an NPN transistor the collector will have a … polarity.

A negative
B positive
C neutral

1.5 Supply voltage lags the current by an angle of 90 in a/an …

A capacitive circuit.
B resistive circuit.
C inductive circuit.

1.6 An ampere meter must always be connected in …

A parallel.
B series-parallel.
C series.

1.7 The angular velocity equation is …

A 2π.
B πft.
C 2πf.

1.8 In the K-shell there can only be … electrons.

A 4
B 2
C 8

1.9 The nucleus of an atom contains …

A electrons and protons.
B neutrons and electrons.
C neutrons and protons.

1.10 Acceptor doping is a process which generates an extra free hole in the …

A outer shell.
B germanium semiconductor.
C crystal lattice structure.

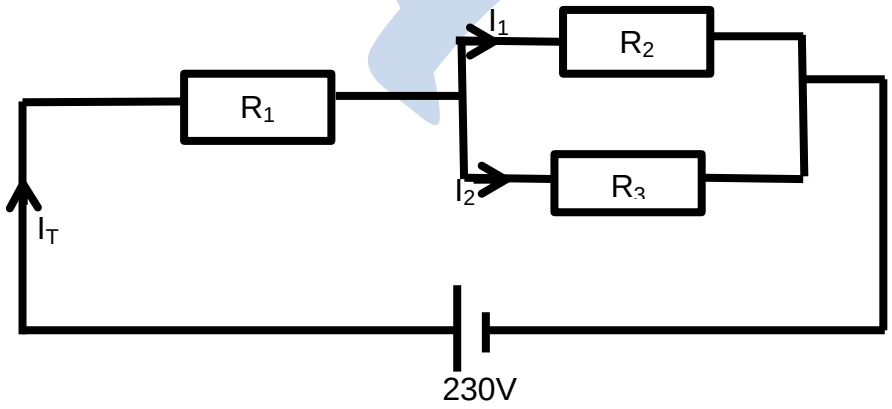
(10 × 1) **[10]**

QUESTION 2

2.1 Complete the following sentence by writing down the missing word next to the question number (2.1.1–2.1.2) in the ANSWER BOOK.

The total voltage (V) divides proportionally in a (2.1.1) … circuit and the total current (I) divides proportionally in a (2.2.2) … circuit. (2)

2.2 In the circuit below R_1=550Ω, R_2=350Ω, R_3=430Ω and E_T=230V.



Use the information above and calculate the following using Ohm's Law:

2.2.1 The current I_1 (11)

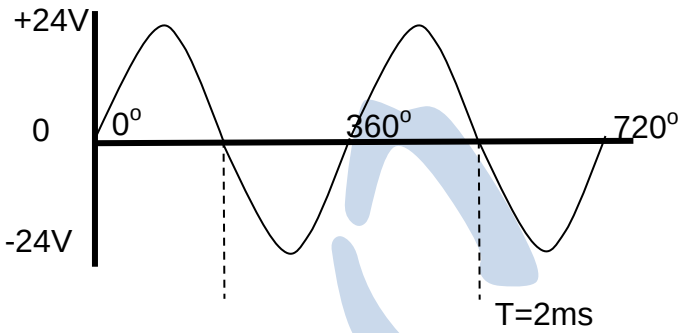
2.2.2 The power consumed by R_3 (3)

2.2.3 The amount of power consumed by R_3 if R_1 is short-circuited (4)

[20]

QUESTION 3

3.1 Study the sine wave below.



Calculate each of the following:

3.1.1 The peak-to-peak value (2)

3.1.2 The RMS value and the average value (4)

3.1.3 The frequency of the wave (2)

3.1.4 The crest and form factors (4)

3.2 What is the relationship between voltage and current in each of the following AC circuits:

3.2.1 Pure resistive circuit

3.2.2 Capacitive circuit

3.2.3 Inductive circuit

(3 × 2) (6)
[18]

QUESTION 4

4.1 Name the THREE regions in which a transistor can operate and explain each region. (3 × 3) (9)

4.2 Draw a labelled circuit diagram of a common-collector amplifier using a PNP transistor. (5)

4.3 Calculate the collector current of a circuit if the emitter current is 90 mA and the base current is 20 µA. (3)
[17]

QUESTION 5

5.1 Explain the operation of each of the following transducers:

5.1.1 Thermocouple

5.1.2 Bimetal strip

(2 × 3) (6)

5.2 Calculate the gain of an amplifier if an input current of 1 A produces an output current of 10 A in each of the following situations:

5.2.1 The input impedance and the output impedance are both equal to 600 Ω

5.2.2 The output impedance is half the input impedance

(2 × 3) (6)

5.3 Complete the following sentence by writing down the missing word next to the question number (5.3.1–5.3.2) in the ANSWER BOOK.

A negative decibel value represents a (5.3.1) … dB and a positive decibel value represents a (5.3.2) … dB. (2)

[14]

QUESTION 6

6.1 State and explain the TWO forces acting on an orbiting electron. (2 × 2) (4)

6.2 Show by means of neat, labelled sketches the crystal lattice structure of an acceptor-doped (p-type) material and the crystal lattice structure of a donor-doped (n-type) material. (2 × 2) (4)

6.3 Draw labelled circuit symbols for each of the following:

6.3.1 PN-junction diode

6.3.2 Light-emitting diode

6.3.3 Varactor diode

(3 × 2) (6)

[14]

QUESTION 7

7.1 State Lenz's law. (3)

7.2 State TWO applications of a synchro system. (4)

[7]

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

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