higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T760**(E)**(M29)T

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N2

(8080602)

29 March 2019 (X-Paper)
09:00–12:00

This question paper consists of 5 pages and a formula sheet of 2 pages.

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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. Approximate ALL final answers accurately to THREE decimal spaces.
5. Write neatly and legibly.

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QUESTION 1

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (1.1–1.10) in the ANSWER BOOK.

1.1 The transistor is a three-terminal device that consists of three PN-junctions.

1.2 An uneven or non-sinusoidal graph is solved by means of the mid-ordinate rule.

1.3 In an AC circuit the inductive reactance of the inductor is directly proportional to the frequency.

1.4 The collector current of a transistor will increase when the forward-bias voltage of the base emitter is decreased.

1.5 A P-type semiconductor material is formed by using a pentavalent atom.

1.6 A diode acts as a conductor when it is forward biased and as an inductor when it is reverse biased.

1.7 The synchro stator is composed of three windings spaced 180° apart.

1.8 The ohmmeter must be connected in parallel across the circuit or component of which the resistance needs to be measured.

1.9 A transducer is a device that converts one form of energy into another.

1.10 A parallel circuit is also known as a voltage divider.

(10 × 1) **[10]**

QUESTION 2

2.1 Define the following SI units:

2.1.1 Ampere (3)

2.1.2 A volt (2)

2.2 A resistor of 3 ohms is connected in series with two resistors in parallel, having values of 3 ohms and 6 ohms. This combination is connected across a 10 volts direct-current supply.

2.2.1 Draw the circuit. (1)

2.2.2 Calculate the total current in the circuit. (4)

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2.2.3 Calculate the total current in the circuit if the series resistor is short-circuited. (4)

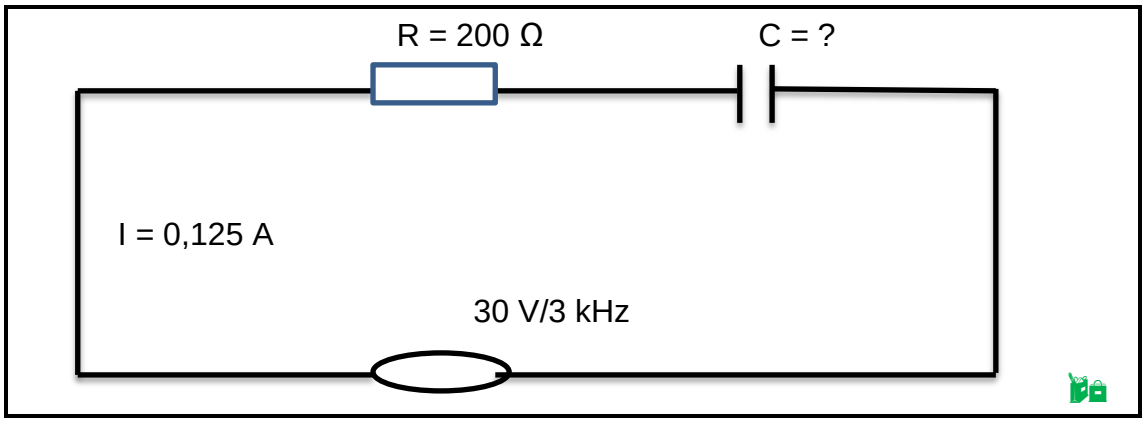
2.2.4 Calculate the power consumed by each resistor in the parallel branch. (6)

[20]

QUESTION 3

3.1 Define the term *in phase.* (3)

3.2



Refer to the sketch above and calculate:

3.2.1 The impedance (3)

3.2.2 The capacitive reactance (3)

3.2.3 The voltage drop across each component (4)

3.2.4 The phase angle (2)

3.3 Draw the phasor diagram. (2)

[17]

QUESTION 4

4.1 Discuss the following processes:

4.1.1 Donor doping

4.1.2 Acceptor doping

(2 × 2) (4)

4.2 Draw a two-dimensional diagram of the germanium atom, where the electrons move in a three-dimensional space. Number the orbits/shells and calculate the number of electrons on each shell. Also indicate the number of protons in the nucleus. (8)

4.3 Name THREE properties of a Zener diode. (6)
[18]

QUESTION 5

5.1 Draw a clearly labelled schematic diagram indicating the biasing voltage (the biasing of the transistor) of a PNP and an NPN transistor. (6)

5.2 Draw the characteristic curve of a transistor, showing the *saturation region*, *active region* and the *cut-off region.* Also explain how the transistor can be operated in each region. (10)
[16]

QUESTION 6

6.1 Draw a circuit symbol and briefly discuss the operating principle of the light dependent resistor (LDR). (3)

6.2 Show, by means of a neat graph, the difference between *underdamping*, *overdamping* and *critical damping*. (3)

6.3 A network produces a 200 W output from a 20 mW input.

Calculate the gain or loss of the network in *bels* and in *decibels*. (6)
[12]

QUESTION 7

7.1 State Lenz's law. (3)

7.2 Show the principle of Lenz's law by using the transformer principle on which a synchro mechanism and a servo-mechanism operates. (4)
[7]

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Measuring instruments

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

Transistors

$I_E = I_C + I_B$

Decibel ratios

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

If R_{IN}=R_{OUT}:

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

Resistance

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

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