higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T700(E)(A9)T

APRIL EXAMINATION

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N2

(8080602)

9 April 2015 (Y-Paper)
13:00–16:00

Candidates will require drawing instruments.

Calculators may be used.

This question paper consists of 6 pages, 1 formula sheet of 2 pages and 1 diagram 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. ALL the sketches and diagrams must be large, clear and neat.
5. All the final answers must be approximated accurately to THREE decimal places.
6. QUESTIONS must be answered in BLUE or BLACK ink.
7. Use $\pi = 3,142$.
8. Keep questions and subsections of questions together.
9. Start each question on a NEW page.
10. Write neatly and legibly.

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SECTION A

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 In a capacitor, the applied voltage leads the line current.

1.2 All atoms are electrically neutral.

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

1.4 In a transistor the base layer is wider than the collector and emitter layers.

1.5 The major application of varactor diodes is as capacitors in tuning circuits.

1.6 A positive number of dBs represents a power loss.

1.7 When we measure voltage we place the meter in parallel with the component.

1.8 A diode has three terminals.

1.9 A cation is a negative ion.

1.10 A voltmeter has a very high internal resistance.

(10 × 1) **[10]**

TOTAL SECTION A: 10

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SECTION B

QUESTION 2

2.1 Study FIGURE 1 on the attached DIAGRAM SHEET and calculate:

2.1.1 R_T (4)

2.1.2 The current flowing through the 20 Ω (2)

2.1.3 The current flowing through the 100 Ω (2)

2.1.4 The current flowing through the 400 Ω (2)

2.1.5 The power consumed by the 20 Ω resistor (2)

2.2 Refer to FIGURE 2 on the DIAGRAM SHEET and use Kirchhoff's current law to calculate the following:

2.2.1 I_1 (1)

2.2.2 I_2 (2)

2.2.3 I_3 (3)
[18]

QUESTION 3

3.1 A series circuit consisting of a resistor of 12 Ω, an inductor of 0,12 H and a capacitor of 100 µF is connected to a 210 volt 50 Hz supply.

Calculate:

3.1.1 the total current (8)

3.1.2 the phase angle (2)

3.1.3 the voltage drop across each component (3)

3.1.4 the resonant frequency (1)

3.2 Use the data given in FIGURE 3 on the DIAGRAM SHEET to calculate the value of $P_{in.}$ (4)
[18]

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QUESTION 4

4.1 For each of the following diodes draw the circuit symbol, give an area where it is commonly used and say how it should be biased normally:

4.1.1 Varactor diode

4.1.2 Zener diode

4.1.3 Photodiode

4.1.4 LED

(4 × 3) (12)

4.2 Valence electrons determine the electrical (and chemical) properties of atoms. These properties are summarised in the following three points.

Select the correct statements from the options provided that would make the statement true. Write only the correct word/phrase next to the question number (4.2.1–4.2.3) in the ANSWER BOOK.

4.2.1 Conductors are elements with ((a) less/more) than four valence electrons. These elements ((b) give up/tend to acquire (gain)) one or more electrons.

4.2.2 Insulators are atoms with exactly ((a) eight/four) valence electrons. They ((b) neither lose nor gain/share) electrons.

4.2.3 Semiconductors are atoms that have exactly ((a) eight/four) valence electrons, They ((b) neither lose nor gain/share) electrons.

(3 × 2) (6)

[18]

QUESTION 5

5.1 For a common collector transistor amplifier answer the following questions:

5.1.1 Draw a labelled circuit diagram of a common collector transistor amplifier making use of an NPN transistor. (6)

5.1.2 What is the phase difference between input and output? (1)

5.1.3 As what is this amplifier also referred to? (1)

5.2 Name the FIVE groups into which transducers can be divided. (5)

5.3 Describe a bimetal strip used as a transducer by providing the following:

5.3.1 A labelled sketch of the construction (2)

5.3.2 The basic principle of operation (3)

[18]

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QUESTION 6

6.1 Define a *measuring instrument.* (2)

6.2 A moving-coil meter has an fsd of 10 mA and an internal resistance of 5 Ω.

Calculate the multiplier and shunt resistance values for the following ranges:

6.2.1 0–20 V (3)

6.2.2 0–2 A (4)

6.3 How is a meter (series or parallel) connected to the following:

6.3.1 Measure voltage (1)

6.3.2 Measure current (1)

6.4 Draw a neat, labelled circuit diagram of a synchro system to illustrate 240° phase coupling between the transmitter and the receiver. (7)
[18]

TOTAL SECTION B: 90
GRAND 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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DIAGRAM SHEET

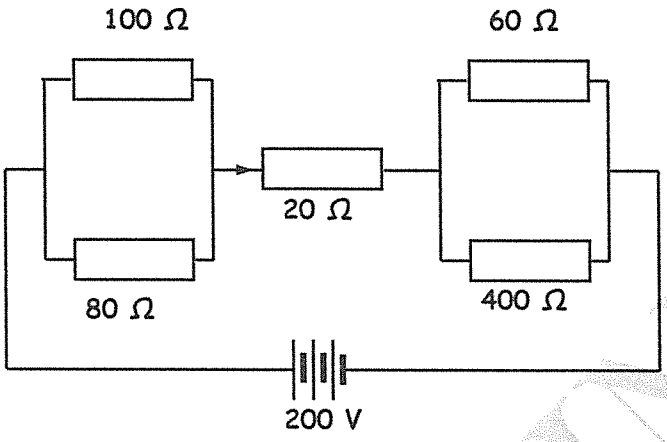

FIGURE 1

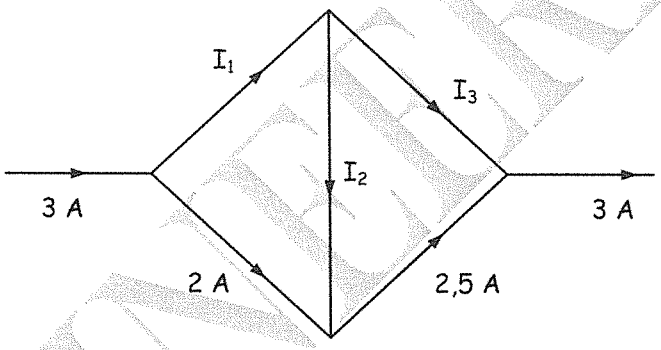

FIGURE 2

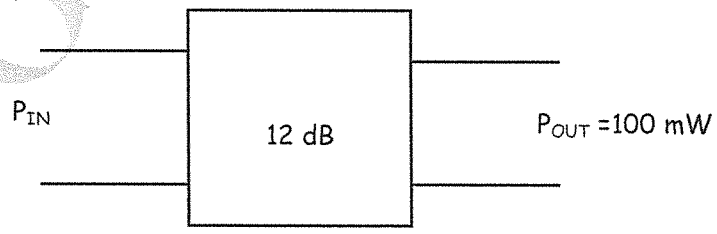

FIGURE 3

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