higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T680(E)(N21)T
NOVEMBER EXAMINATION

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N2

(8080602)

21 November 2014 (Y-Paper)
13:00–16:00

Candidates will require drawing instruments.
Calculators may be used.

ENGINEERING

This question paper consists of 6 pages, 1 diagram sheet 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

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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 (1.1.1–1.1.10) in the ANSWER BOOK.

1.1 Pure semiconductor material is referred to as extrinsic material.

1.2 If a circuit resonates the phase angle is equal to 0°

1.3 A common-base amplifier has a 0° phase shift between input and output.

1.4 A diode has TWO PN-junctions.

1.5 A negative number of dBs represents a power loss.

1.6 In positive temperature coefficient (PTC) thermistors, its resistance decrease as the temperature increases.

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

1.8 The arrow of a diode points in the direction of electron current flow.

1.9 The total current in a series circuit decreases when resistances are connected in parallel.

1.10 P-type material has a positive charge just after formation.

(10 × 1) **[10]**

TOTAL SECTION A: 10

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SECTION B

QUESTION 2

In the circuit of FIGURE.1 on the DIAGRAM SHEET, the battery supplies a current of 1 A.

Calculate the following:

2.1 Value of V_{AB} (4)

2.2 Value of R_{AB} and R_{CD} (4)

2.3 Value of I_1 and I_2 (3)

2.4 Value of V_{CD} (2)

2.5 Value of R (3)

2.6 Power consumed by the 70 Ω (2)
[18]

QUESTION 3

3.1 For the circuit of FIGURE 2 on the DIAGRAM SHEET calculate the:

3.1.1 Z

3.1.2 I_T

3.1.3 L

3.1.4 C

3.1.5 Phase angle

3.1.6 Resonant frequency

(6 × 2) (12)

3.2 A network has an overall gain of 25 dB. If the input and output impedances are equal, calculate the input voltage if the output voltage is 7,5 V. (6)
[18]

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QUESTION 4

4.1 Draw a labelled circuit diagram of half-wave rectifier by making use of a step-down transformer, a filter circuit and a load resistor. Show the polarities over the load resistor as well as the electron flow. Draw the relevant waveforms before and after the rectifier (without the filter capacitor) as well as the final output waveform (with the filter capacitor). (10)

4.2 The following paragraph explains the doping processes. Select the correct word from the options provided that would make the statements true. Write only the word/s next to the number (4.2.1-4.2.10) in your ANSWER BOOK.

The deliberate addition of controlled amounts of foreign atoms or impurities to a pure or intrinsic semiconductor is called doping. If a (4.2.1 *pentavalent/trivalent*) impurity atom (5 valence electrons) was added, an *excess* of (4.2.2 *holes/electrons*) would be produced. This process is called (4.2.3 *acceptor/donor*) doping and results in (4.2.4 *P-type/N-type*) material being formed. In this type of material, the majority charge carriers are the (4.2.5 *holes/electrons*).

However, if a (4.2.6 *pentavalent/trivalent*) atom (an atom that has 3 valence electrons) was added, an *excess of* (4.2.7 *holes/electrons*) will result and this process is called [4.2.8 *acceptor/donor*] doping. This process results in (4.2.9 *P-type/N-type*) material being formed. Here the majority charge carriers are (4.2.10 *holes/electrons*). (10 x ½) (5)

4.3 Briefly explain how an atom becomes:

4.3.1 Positive ion (1)

4.3.2 Negative ion (1)

4.4 Briefly explain what is meant by ionisation. (1)
[18]

QUESTION 5

5.1 Draw a labelled circuit diagram of a common base transistor amplifier making use of an NPN transistor. Show the input and output waveforms. (6)

5.2 Explain how the PN junctions of a transistor is biased in the:

5.2.1 Cut-off region (2)

5.2.2 Saturation region (2)

5.3 Describe a thermocouple used as a transducer by providing the following:

5.3.1 A labelled sketch of the construction (4)

5.3.2 The basic principle of operation (2)

5.3.3 Characteristic curve (2)
[18]

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QUESTION 6

6.1 Draw a neat, labelled circuit diagram of an analogue ohmmeter with THREE resistance ranges. (10)

6.2 A moving coil meter with a meter resistance of 5 Ω and a current of 25 mA causes a fsd.

Calculate the resistance necessary to modify the meter to measure voltages up to 250 V. (2)

6.3 Draw a neat, labelled circuit diagram of a synchro system to illustrate standard coupling between the transmitter and the receiver. (6)
[18]

TOTAL SECTION B: 90
GRAND TOTAL: 100

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INDUSTRIAL ELECTRONICS N2

FORMULA SHEET

Direct current theory:

$V = I \cdot R$

$P = V \cdot I$

$P = \frac{V^2}{R}$

$P = I^2 \cdot R$

$R_T = R_1 + R_2$

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$R_T = \frac{R_1 \times R_2}{R_1 + R_2}$

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

Alternating current theory:

$t = \frac{1}{f}$

$e = E_m Sin\theta$

$e = E_m Sin\omega t$

$e = E_m Sin2\pi ft$

$i = I_m Sin\theta$

$i = I_m Sin\omega t$

$V_{rms} = 0{,}707 V_{max}$

$I_{rms} = 0{,}707 I_{max}$

$V_{ave} = 0{,}637 V_{max}$

$I_{ave} = 0{,}637 I_{max}$

$Form\ factor = \frac{rms\ value}{average\ value}$

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

$E_{ave} = \frac{e_1 + e_2 + e_3 + e_4 + e_5 + ...e_n}{n}$

$I_{ave} = \frac{i_1 + i_2 + i_3 + i_4 + i_5 + ...i_n}{n}$

$\omega = 2\pi f$

$E_{rms} = \sqrt{\frac{e_1^2 + e_2^2 + e_3^2 + e_4^2 + e_5^2 + ...e_n^2}{n}}$

$I_{rms} = \sqrt{\frac{i_1^2 + i_2^2 + i_3^2 + i_4^2 + i_5^2 + ...i_n^2}{n}}$

$X_L = 2\pi fL$

$X_C = \frac{1}{2\pi fC}$

$V = I \cdot R$

$V_T = \sqrt{V_R{}^2 + V_C{}^2}$

$V_T = \sqrt{V_R{}^2 + V_L{}^2}$

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

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

$Z = \sqrt{R^2 + X_L{}^2}$

$Z = \sqrt{R^2 + X_C{}^2}$

$I = \frac{V_T}{Z}$

$I_R = \frac{V_T}{R}$

$I_L = \frac{V_T}{X_L}$

$I_C = \frac{V_T}{X_C}$

$I_T = \sqrt{I_R{}^2 + I_X{}^2}$

$I_X = I_L \sim I_C$

$V_L = I \cdot X_L$

$V_C = I \cdot X_C$

$Z = \frac{V}{I_T}$

$\theta = \tan^{-1} \frac{I_X}{I_R}$

$\theta = \cos^{-1} \frac{I_R}{I_T}$

$\theta = \cos^{-1} \frac{R}{Z}$

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

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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

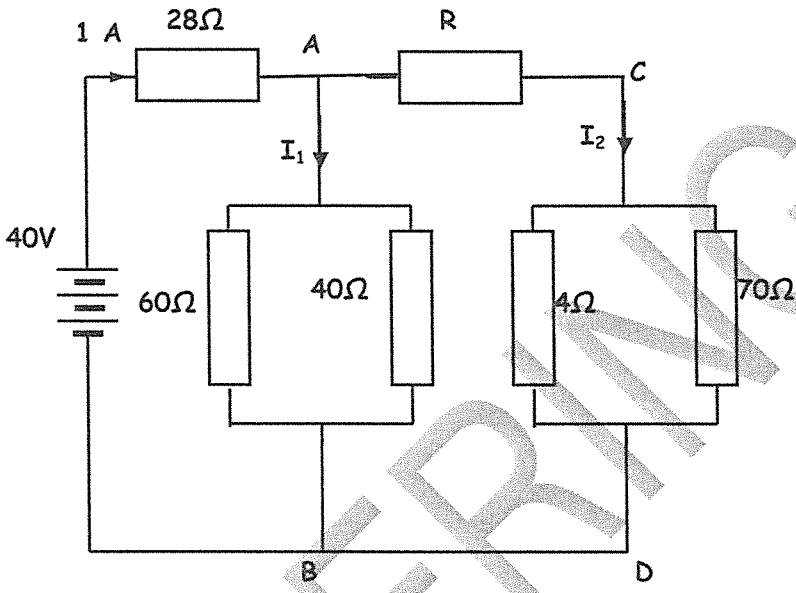


FIGURE 1

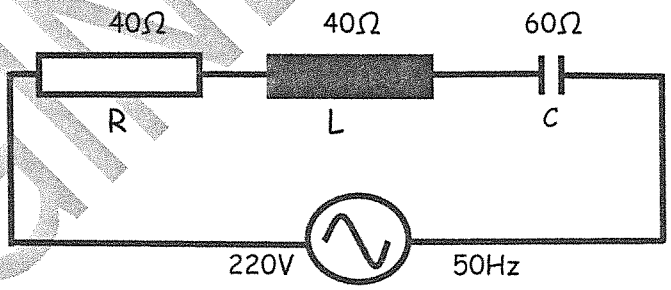


FIGURE 2

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