higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T680(E)(A3)T
APRIL EXAMINATION

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N2

(8080602)

3 April 2014 (Y-Paper)
13:00–16:00

Calculators may be used.

Candidates will require drawing instruments.

This question paper consists of 6 pages, 1 diagram sheet and 1 formula sheet of 3 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 correctly according to the numbering system used in this question paper.
4. Write neatly and legibly.
5. Start each question on a NEW page.
6. All the sketches and diagrams must be large, clear and neat.
7. Marks will be deducted for untidy work.
8. Keep questions and subsections of questions together.
9. Answers must be clearly numbered.
10. Leave margins clear.
11. Questions must be answered in blue or black ink.
12. Use $\pi = 3,142$.
13. All the final answers must be approximated accurately to THREE decimal places.

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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 Kirchhoff's current law states that the algebraic sum of the currents entering and leaving a point is equal to zero.

1.2 Should an atom lose an electron it becomes a negative ion because it now possesses more protons than electrons.

1.3 In a series-resonant circuit the impedance is resistive and equal to R.

1.4 A diode may be defined as a two-terminal device offering a high resistance when forward biased and a low resistance when reverse biased.

1.1.5 The transistor is normally operated with the collector-base reverse biased and the emitter-base forward biased when used as an amplifier.

1.6 A decibel equals one-tenth of a Bel.

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

1.8 The total resistance in a circuit increases when the resistances are connected in parallel.

1.1.9 The base of an NPN transistor symbol is indicated by the arrow.

1.10 Resonance in a circuit occurs when the inductive reactance equals the capacitive reactance.

(10 x 1) **[10]**

TOTAL SECTION A: 10

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SECTION B

QUESTION 2

2.1 Study FIGURE 1 on the DIAGRAM SHEET and determine the following:

2.1.1 The total resistance (6)

2.1.2 The total current (2)

2.1.3 The value of I_1 (4)

2.1.4 The colour code of R_2 if it has a tolerance of 5% (2)

2.2 Write down Kirchhhoff's Current law and Voltage law. (4)
[18]

QUESTION 3

3.1 A sine-wave is represented by the equation e = 22 Sin 942,6t volts.

Use the equation to determine:

3.1.1 The amplitude of the wave (1)

3.1.2 The maximum value (1)

3.1.3 The frequency in Hz (2)

3.1.4 The value of e at 2ms. (2)

3.1.5 The value of e at 45° (2)

3.2 A coil of inductance 3H and a resistance of 700 Ω is connected to a 200 V 50 Hz ac supply.

Calculate the following:

3.2.1 The inductive reactance of the coil (2)

3.2.2 The impedance of the coil (3)

3.2.3 The value of the current through the coil (2)

3.2.4 The phase angle between the supply voltage and supply current (3)
[18]

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QUESTION 4

4.1 Draw a fully labelled circuit diagram of full-wave rectifier making use of two diodes, a centre-tap transformer and a filter capacitor. (6)

4.2 Draw labelled symbols for the following:

4.2.1 Zener diode (2)

4.2.2 Photodiode (2)

4.2.3 LED (2)

4.3 The following paragraph explains how semiconductor N-type material is formed. Complete the paragraph by making use of the words provided in the list below. You may only select words from the list below. Write only the number and your selected word in your ANSWER BOOK (e.g. 1.2.3 electrons).

(NB: A word may be used more than once)

If a 4.3.1 ... atom, like Phosphorous, is added to a pure silicon crystal, N-type material is formed. In this process 4.3.2 ... phosphorous valence electrons will form 4.3.3 ... bonds with 4.3.4 ... neighbouring silicon atom valence electrons. This leaves the 4.3.5.... phosphorous atom valence electron without a 4.3.6 ... bond and as a result, a free 4.3.7 ... exists. These atoms are therefore known as 4.3.8 ... atoms. The process of generating electrons is called 4.3.9 ... doping. Since the charge on a(n) 4.3.10 ... is negative, this type of material is referred to as N-type material. Here the majority charge carriers are the 4.3.11 ... and the minority charge carriers are the 4.3.12 ... .

tetravalent; five; fifth; metal; acceptor; trivalent; covalent; fourth; four; hole; holes; donor; pentavalent; ionic; electron; electrons; three; third.

(6)
[18]

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QUESTION 5

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

5.2 A transistor can be operated in three regions.

Explain each of the following regions in terms of how the junctions are biased and whether the transistor is on, off or amplifying:

5.2.1 Cut-off (2)

5.2.2 Active/linear (2)

5.2.3 Saturation (2)

5.3 Name THREE points that should be considered before a transducer is selected for a particular application. (3)

5.4 Explain the principle of operation of a thermocouple. (3)
[18]

QUESTION 6

6.1 Make a labelled sketch to show the construction of a moving coil meter. (6)

6.2 An ammeter with a meter resistance of 20Ω and a full-scale deflection current of 1mA is to be used to measure currents up to 5mA.

6.2.1 Calculate the value of the shunt resistor that should be connected across the meter. (3)

6.2.2 Draw and label the circuit. (2)

6.3 Draw a labelled circuit diagram of a synchro system to illustrate how 180° phase shift coupling between the transmitter and receiver is achieved. (7)
[18]

TOTAL SECTION B: 90
GRAND TOTAL: 100

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DIAGRAM SHEET 1

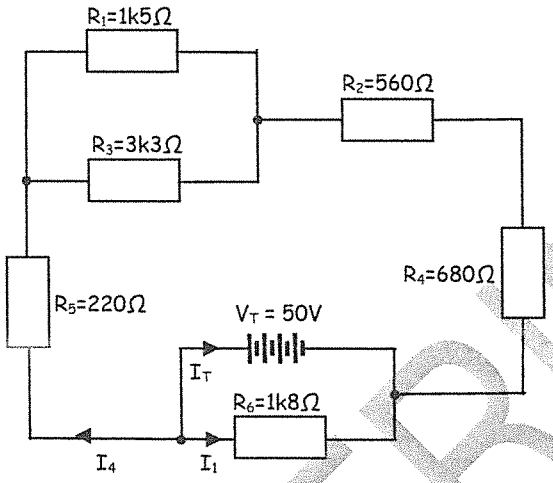

FIGURE 1

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INDUSTRIAL ELECTRONICS N2

FORMULA SHEET

DC THEORY

(i) $V = I \times R$

(ii) $R_T = R_1 + R_2$

(iii) $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$

(iv) $P = V \times I$

(v) $P = I^2 \times \mathrm{R}$

(vi) $P = \frac{V^2}{R}$

AC THEORY

(i) $t = \frac{1}{f}$

(ii) $e = E_m \ Sin\ 2\pi ft$

(iii) $i = I_m \ Sin\ 2\pi ft$

(iv) $\theta = 2\pi ft$

(v) $I_{AVE} = \frac{I_1 + I_2 + I_3}{n}$

(vi) $I_{RMS} = \sqrt{\frac{I_1^2 + I_2^2 + I_3^2}{n}}$

(vii) $V_{AVE} = \frac{V_1 + V_2 + V_3}{n}$

(viii) $V_{RMS} = \sqrt{\frac{V_1^2 + V_2^2 + V_3^2}{n}}$

(ix) $V_{AVE} = V_M \times 0{,}637$

(x) $V_{RMS} = V_M \times 0{,}707$

(xi) $\text{Form factor} = \frac{RMS\ value}{AVE\ value}$

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(xii) $\text{Crest factor} = \dfrac{Maximum\ value}{RMS\ value}$

(xiii) $\omega = 2\pi f$

(xiv) $X_C = \dfrac{1}{2\pi fC}$

(xv) $X_L = 2\pi fL$

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

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

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

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

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

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

(xxii) $I_T = \dfrac{V_T}{Z}$

(xxiii) $V_C = I_T \times X_C$

(xxiv) $V_R = I_T \times R$

(xxv) $V_L = I_T \times X_L$

(xxvi) $\theta = Cos^{-1}\dfrac{R}{Z}$

(xxvii) $fo = \dfrac{1}{2\pi\sqrt{LC}}$

MEASURING INSTRUMENTS

(i) $R_{SH} = \dfrac{I_M \times R_M}{I_{SH}}$

(ii) $R_S = \dfrac{V_T}{I_M} - R_M$

TRANSISTORS

(iii) $I_e = I_c + I_b$

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DECIBEL RATIOS

(iv) $N = 10 \log \frac{P_0}{P_1}$

(v) $N = 20 \log \frac{I_0}{I_1} + 10 \log \frac{R_0}{R_1}$

(vi) $N = 20 \log \frac{V_0}{V_1} + 10 \log \frac{R_1}{R_0}$

If/As $R_1 = R_0$

(vii) then $N = 20 \log \frac{I_0}{I_1}$

(viii) $N = 20 \log \frac{V_0}{V_1}$

(ix) RESISTANCE

$$R = \frac{p\ell}{a}$$

(x) $a = \frac{\pi d^2}{4}$

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