higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T690(E)(J25)T

AUGUST EXAMINATION

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N3

(8080613)

25 July 2014 (Y-Paper)
13:00–16:00

Candidates will require drawing instruments.

Calculators may be used.

This question paper consists of 8 pages, 1 diagram sheet and 1 formula sheet.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
INDUSTRIAL ELECTRONICS N3
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. Start each question on a NEW page.
5. All the sketches and diagrams must be large, clear and neat.
6. Marks will be deducted for untidy work
7. Keep questions and subsections of questions together.
8. Answers must be clearly numbered.
9. Leave margins clear.
10. Questions must be answered in blue or black ink.
11. Use $\pi = 3,142$.
12. All the final answers must be approximated accurately to THREE decimal places.
13. Write neatly and legibly.

SECTION A

QUESTION 1

1.1 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.

1.1.1 Bipolar transistors are current-operated devices.

1.1.2 In a series RLC circuit, the impedance at resonance is a maximum.

1.1.3 The output from a negative series clipper consists only of the positive half of the input signal.

1.1.4 Standard-type oscilloscopes can measure voltage, current and resistance.

1.1.5 The parallax error is a gross error.

1.1.6 Current can flow through a Zener diode in both directions.

1.1.7 A silicon-controlled rectifier can be switched off only by removing the gate current.

1.1.8 An operational amplifier has a high output impedance.

1.1.9 Digital variables change continuously with time.

1.1.10 An electron has a negative charge of approximately $1,602 \times 10^{-19}$ coulombs.

(10 x 1) (10)

1.2 Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–C) next to the question number (1.2.1–1.2.10) in the ANSWER BOOK.

1.2.1 In a parallel resonant circuit, the following conditions exist:

A Z is a maximum, I is a maximum
B Z is a maximum, I is a minimum
C Z is a minimum, I is a maximum

1.2.2 The maximum time taken for the diode to switch from the on-state to the off-state is called the …

A duty cycle.
B fall time.
C reverse recovery time.

1.2.3 The number of electrons that pentavalent atoms have in their outer shell are …

A 3
B 4
C 5

1.2.4 The following diodes are normally used in the reverse-bias condition:

A pn-junction, Zener, varactor
B photo diode, Zener, varactor
C pn-junction, photo diode, Zener

1.2.5 A transistor has an emitter current of 22 mA and a collector current of 21 mA. The base current is …

A 43 mA.
B 1 mA.
C 22 mA.

1.2.6 The forbidden energy gap for a semiconductor is …

A small.
B large.
C non-existent.

1.2.7 The transducer used to measure the force applied to bridging structures is a ...

A wheatstone bridge.
B linear variable differential transformer.
C strain gauge.

1.2.8 The operational amplifier whose gain is always more than one is the ...

A inverting amplifier.
B non-inverting amplifier.
C voltage follower.

1.2.9 One section of the horizontal-deflection system of an oscilloscope is the ...

A probe.
B input attenuator.
C time-base generator.

1.2.10 The nearest an instrument reading will reach the true value of the quantity being measured is called the ...

A accuracy.
B precision.
C resolution.

(10 x 1) (10)

TOTAL SECTION A: 20

SECTION B

QUESTION 2

2.1 Study FIGURE 1 on the attached DIAGRAM SHEET and determine, with the aid of Kirchhoff's laws:

2.1.1 The equation for loop 1 (ABCDA). Set up the equation by starting at point A and proceed in the direction of loop 1 (thick arrow). (2)

2.1.2 The equation for loop 2 (CDEFABC). Set up the equation by starting at point C and proceed in the direction of loop 2 (thick arrow). (2)

2.1.3 The magnitude of the currents I_1 and I_2 by making use of the equations in QUESTION 2.1.1 and QUESTION 2.1.2. (4)

2.2 An SCR can be controlled by making use of four different methods. The following statements are descriptions or definitions of these methods. Name the method that best describes the given statement.

2.2.1 This method of control is used when the SCR performs simple switching.

2.2.2 This method of control is a combination of phase and cycle control.

2.2.3 This method of control is achieved by controlling the time at which the gate of the SCR is triggered.

2.2.4 This method of control is achieved by switching the control device on for a number of full cycles and then switching the control device off for a number of full cycles.

(4 x 1) (4)

2.3 Show by means of a labelled circuit diagram how two SCRs connected to form a *SCR-diode bridge* can be used for FULL-WAVE control. (4)

[16]

QUESTION 3

3.1 A series circuit consists of an inductor of 0,5H, a resistance of 12 ohms and a capacitor of 100 µF connected across a 220 volt 50 Hz supply.

Calculate the:

3.1.1	Impedance	(3)
3.1.2	Current	(2)
3.1.3	Voltage across R	(1)
3.1.4	Voltage across L	(1)
3.1.5	Voltage across C	(1)
3.1.6	phase angle between the current and the supply voltage	(2)

3.2 Draw neat, labelled circuit diagrams of an operational amplifier used in the following modes:

3.2.1 Summing

3.2.2 Integrator

(2 x 3) (6)
[16]

QUESTION 4

4.1 Draw a neat, labelled circuit diagram of a push-pull amplifier. Indicate on the circuit ALL relevant waveforms and bias polarities. (7)

4.2 Draw a labelled output-characteristic curve of a COMMON EMITTER amplifier. On the curve draw a loadline and indicate where you would place the Q-point on the load line for a class-C amplifier. (4)

4.3 The following paragraph explains the operation of a phototransistor. Complete the paragraph by making use of the words provided in the list below. (**NOTE:** A word may be used more than once.) Write only the word next to the question number (4.3.1–4.3.5) in the ANSWER BOOK.

The light that shines on the (4.3.1) … region causes (4.3.2) … leakage current to flow. This, in effect, is a withdrawal of (4.3.3) … from the base, which is necessary to turn the transistor on. A(n) (4.3.4) … in the light intensity would correspond with a(n) (4.3.5) … in base current and a larger increase in the collector current.

holes; electrons; reverse; forward; decrease; increase; collector-base; emitter-base

(5)
[16]

QUESTION 5

5.1 Refer to FIGURE 2 on the attached DIAGRAM SHEET to answer the questions below.

5.1.1 Identify the transducer. (1)
5.1.2 Name the parts **a** to **d** given in FIGURE 2. (2)
5.1.3 Provide a brief explanation of its operating principle. (3)
5.1.4 Name TWO areas of application. (2)

5.2 Valence electrons determine the electrical (and chemical) properties of atoms. These properties are summarised in the following four points. Select the correct statements from the options provided in brackets that would make the statement true.

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

5.2.2 Resistors are elements that have [(a)*less/more*] than four valence electrons and [(b) *give up/tend to acquire (gain)*] one or more electrons.

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

5.2.4 Semiconductors are atoms that have exactly [(a) *eight/four*] valence electrons. They [(b) *neither lose nor gain/share*] electrons.

(4 x 2) (8)
[16]

QUESTION 6

6.1 With reference to an oscilloscope describe the purpose of the following:

6.1.1 Deflection plates

6.1.2 Delay line

(2 x 2) (4)

6.2 Draw a labelled block diagram of a continuous-balance digital voltmeter. (Use arrows to indicate data flow). (7)

6.3 Name FIVE characteristics of operational amplifiers. (5)
[16]

TOTAL SECTION B: 80
GRAND TOTAL: 100

DIAGRAM SHEET

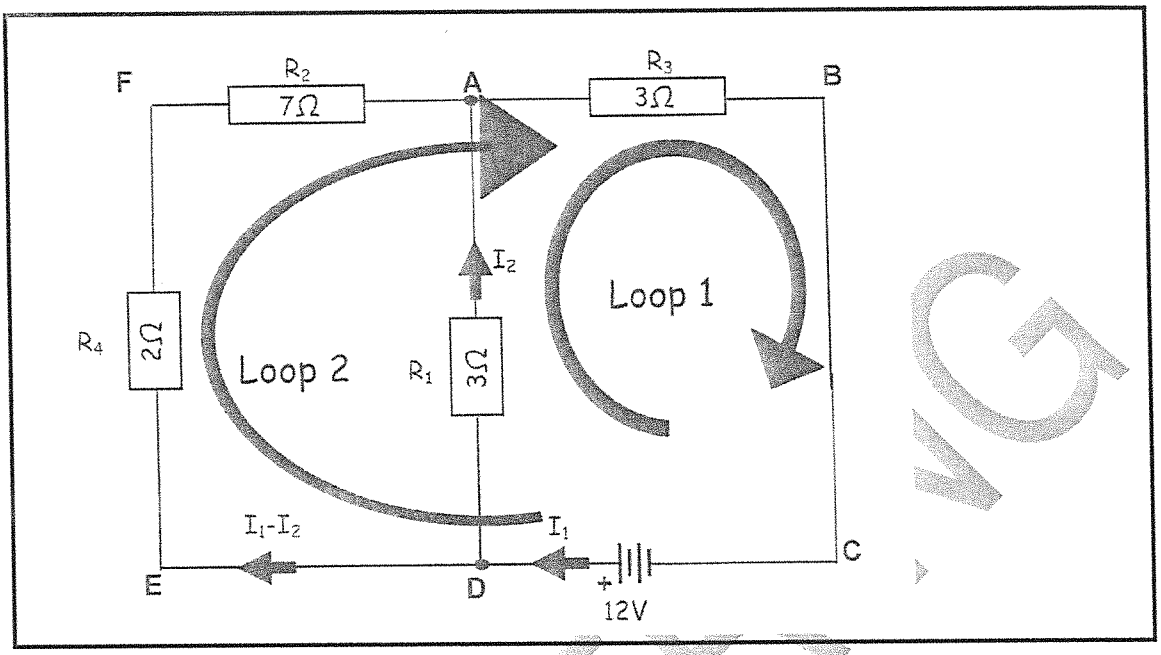

FIGURE 1

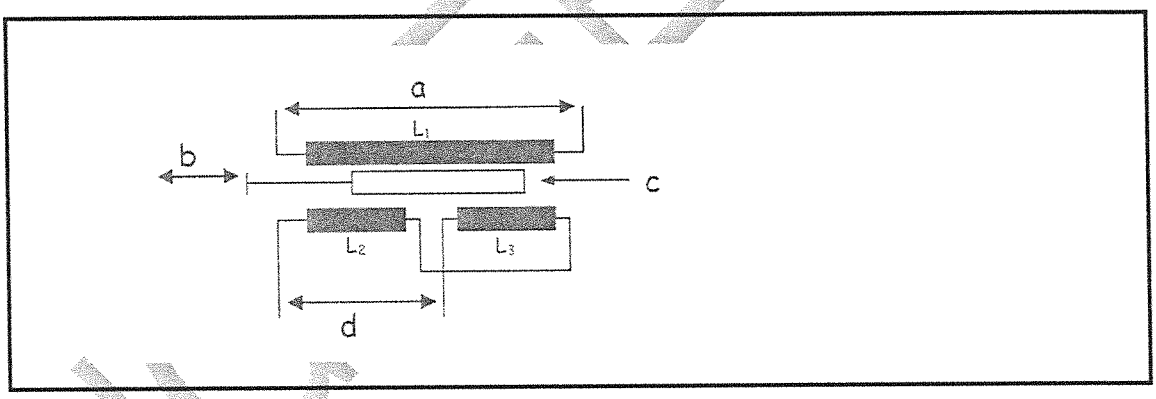

FIGURE 2

INDUSTRIAL ELECTRONICS N3

FORMULA SHEET

Direct-current theory:

$V = I \cdot R$ $\quad P = V \cdot I$ $\quad P = \frac{V^2}{R}$

$P = I^2 \cdot R$

Alternating current theory:

$X_L = 2\pi fL$ $\quad X_C = \frac{1}{2\pi fC}$ $\quad Z = \sqrt{R^2 + (X_L \sim X_C)^2}$

$V_T = \sqrt{V_R^2 + (V_L \sim V_C)^2}$ $\quad I = \frac{V_T}{Z}$ $\quad \theta = \cos^{-1}\frac{R}{Z}$

$V = I \cdot R$ $\quad V = I \cdot X_L$ $\quad V = I \cdot X_C$

$f_r = \frac{1}{2\pi\sqrt{LC}}$ $\quad I_R = \frac{V_T}{R}$ $\quad I_L = \frac{V_T}{X_L}$

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

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

$Z_D = \frac{L}{RC}$ $\quad I_T = \frac{V}{Z_D}$ $\quad f_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$

$I_C = I_{RL}\, Sin\theta_L$ $\quad I_T = I_{RL}\, Cos\,\theta_L$ $\quad I_T = \sqrt{{I_{T_H}}^2 + {I_{T_V}}^2}$

Transistors:

$I_C = \frac{V_{CC}}{R_L}$

Transducers:

$R = \frac{\rho \cdot l}{a}$ $\quad C = \frac{k \cdot A \cdot E_o}{d}$