education

Department:
Education
REPUBLIC OF SOUTH AFRICA

T810(E)(J30)T
AUGUST 2010

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N3

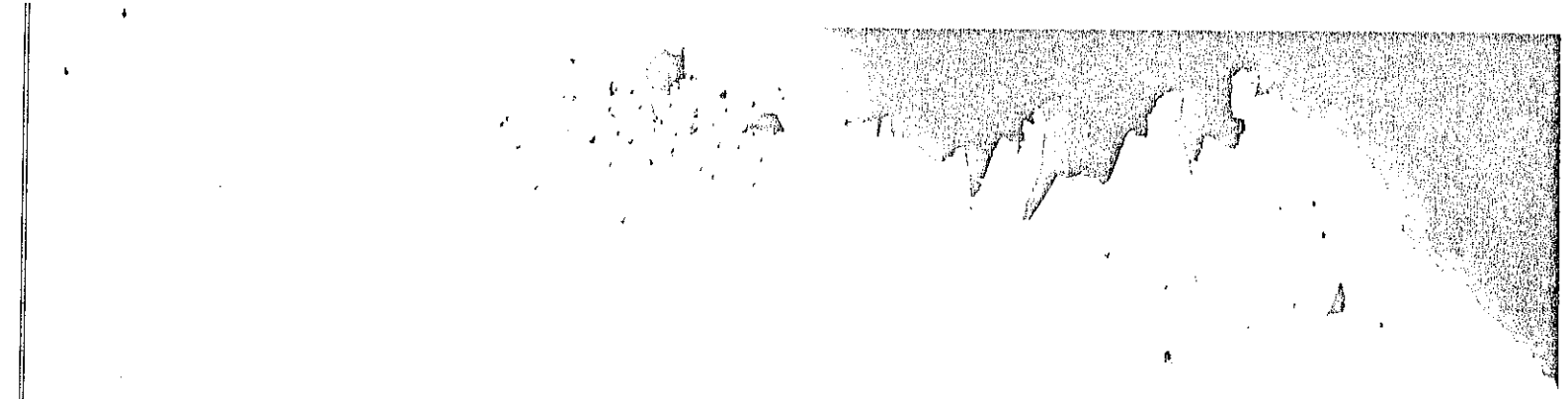
(8080613)

30 July (X-Paper)
09:00 – 12:00

Calculators may be used.

Candidates will require drawing instruments, pens and a ruler.

This question paper consists of 7 pages, 1 diagram sheet and a 1-page formula sheet.



DEPARTMENT OF EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
INDUSTRIAL ELECTRONICS
TIME: 3 HOURS
MARKS: 100

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. Start each question on a NEW page.
5. ALL sketches and diagrams must be large, clear and neat.
6. Keep questions and subsections of questions together.
7. Leave margins clear.
8. Questions must be answered in blue or black ink.
9. Use = π 3,142.
10. ALL the final answers must be approximated accurately to THREE decimal places.
11. Write neatly and legibly.

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 In a resonant series RLC alternating current-circuit, the current is amplified. (1)

1.1.2 When a coil is connected in parallel with a capacitor, then the total current is equal to the vector sum of the horizontal and vertical components of the two currents. (1)

1.1.3 Valence electrons exist in the highest energy level of an atom. (1)

1.1.4 In PN junctions there are two types of capacitances, namely transition capacitance and diffusion capacitance. (1)

1.1.5 When a photodiode is exposed to light a dark current flows. (1)

1.1.6 The direct-current bias point is a point on the load line that represents currents in a transistor and the voltages across it when no signal is applied. (1)

1.1.7 Negative feedback is a process used to improve the performance of a circuit by reducing distortion. (1)

1.1.8 Line commutation is used in alternating-current circuits. (1)

1.1.9 A wheatstone bridge is a resistive transducer. (1)

1.1.10 Instrumental errors are due to magnetic and electrostatic effects. (1)

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

1.2.1 The phasor diagram in FIGURE 1, DIAGRAM SHEET (attached), represents two alternating voltages:

A V_1 lags V_2 by 135°
B V_1 and V_2 are in antiphase
C V_2 leads V_1 by 45°
D V_2 lags V_1 by 135° (1)

1.2.2 For the current flow diagram in FIGURE 2, DIAGRAM SHEET (attached), the currents I_1 and I_2 are ...

A $I_1 = 2$ A, $1_2 = 6$ A.
B $I_1 = 2$ A, $1_2 = 6$ A.
C $I_1 = -2$ A, $1_2 = 6$ A.
D $I_1 = -2$ A, $1_2 = 6$ A. (1)

1.2.3 An alternating supply of constant voltage and variable frequency is applied to a purely resistive circuit. The frequency is varied from 50 Hz to 4 kHz. The value of the current will ...

A increase.
B decrease.
C fluctuate.
D not change. (1)

1.2.4 Atoms with fewer than four valence electrons are called ...

A conductors.
B resistors.
C insulators.
D semiconductors. (1)

1.2.5 The THREE methods of achieving full-wave phase control are ...

A cycle, cyclotronic and phase control methods.
B back to back, bridge and one scr control methods.
C static, cycle and cyclotronic control methods.
D static, cycle and phase control methods. (1)

1.2.6 Which ONE of the following statements about an operational amplifier used as a differentiator is WRONG?

A The output voltage is related to the rate at which the instantaneous value of the input voltage changes.
B Its output waveform is 180° out of phase with the input voltage.
C Its output waveform is 90° out of phase with the input voltage.
D It uses a resistor and a capacitor in its circuit. (1)

1.2.7 A delay line is added to the ...

A horizontal deflection plates.
B vertical deflection plates.
C horizontal amplifier.
D vertical amplifier. (1)

1.2.8 Which ONE of the following statements of a Zener diode is WRONG?

A It can be used as a voltage regulator.
B It can be used as a voltage reference source.
C It allows current to flow in both directions.
D It allows a large reverse current to flow when forward-biased. (1)

1.2.9 The following transducers do not require any external power source:

A Photovoltaic cell, crystal and thermocouple
B Crystal, strain gauge and thermistor
C Photovoltaic cell, thermocouple and thermistor
D Photovoltaic cell, crystal and thermistor (1)

1.2.10 In the active region ...

A both the collector-base and emitter-base junctions are reverse-biased.
B the collector-base is reverse-biased and the emitter-base is forward-biased.
C both the collector-base and emitter-base are forward biased.
D the collector-base is forward-biased and the emitter-base is reverse-biased. (1)

TOTAL SECTION A: 20

SECTION B

QUESTION 2

2.1 Study FIGURE 3 on the DIAGRAM SHEET (attached) and determine the following with the aid of Kirchhoff's Laws:

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

2.1.2 The equation for loop 2 (QRSLQ) (Set up the equation by starting at point Q and proceed in the direction of loop 2 (thin 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 Valence electrons determine the electrical (and chemical) properties of atoms. Summarise these properties in terms of:

2.2.1 Conductors (2)

2.2.2 Resistors (2)

2.2.3 Insulators (2)

2.2.4 Semi-conductors (2)

[16]

QUESTION 3

3.1 A coil of resistance 100 Ω and inductance of 0,1 H is connected in parallel with a 50 μF capacitor across a variable frequency source of 100 volts. If the frequency is varied such that the resultant current is in phase with the supply voltage, calculate the following:

3.1.1 Frequency (2)

3.1.2 Current in each branch (4)

3.1.3 Phase angle between the current through the coil and the supply voltage (2)

3.1.4 Resultant current (without calculating the dynamic impedance) (1)

3.1.5 Dynamic impedance (1)

3.2 Give a brief explanation of:

3.2.1 Drift current (2)

3.2.2 Diffusion current (2)

3.2.3 Forbidden gap (2)

[16]

QUESTION 4

4.1 Explain, with the aid of a block diagram, the concept of negative feedback. (6)

4.2 Show, with aid of a labelled circuit diagram, how series voltage negative feedback is achieved. (4)

4.3 State FOUR advantages of a field-effect transistor. (4)

4.4 Draw the symbol of an n-channel JFET. (2)

[16]

QUESTION 5

5.1 Describe a crystal transducer by providing the following:

5.1.1 A labelled sketch of the construction (4)

5.1.2 The basic principle of operation (2)

5.1.3 Give TWO examples of where it is used (2)

5.2 The circuit in FIGURE 4 on the attached DIAGRAM SHEET is that of a clipper.

5.2.1 Identify the type of clipper circuit. (1)

5.2.2 Explain its operation. (4)

5.2.3 Draw the input waveform given in FIGURE 5 (attached) and this clipper's corresponding output waveform in the ANSWER BOOK. (2)

5.2.4 Give a formula to calculate the output voltage. (1)
[16]

QUESTION 6

6.1 The diagram in FIGURE 6 (attached) shows a block diagram of an oscilloscope. Name ALL the numbered parts. (7)

6.2 Draw a neat, labelled circuit diagram to show how an optoisolator/optcoupler, which makes use of a photodiode, can switch a SCR on. (5)

6.3 Give brief explanations of the following Zener diode parameters:

6.3.1 Zener current I_z (1)

6.3.2 Zener voltage V_z (1)

6.3.3 Reverse current I_{zm} (1)

6.3.4 Average forward current $I_{F(AV)}$ (1)
[16]

TOTAL SECTION B: 80
GRAND TOTAL: 100

DIAGRAM SHEET

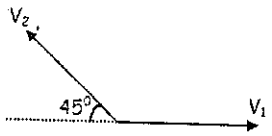


FIGURE 1

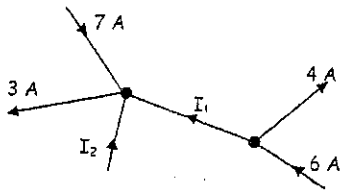


FIGURE 2

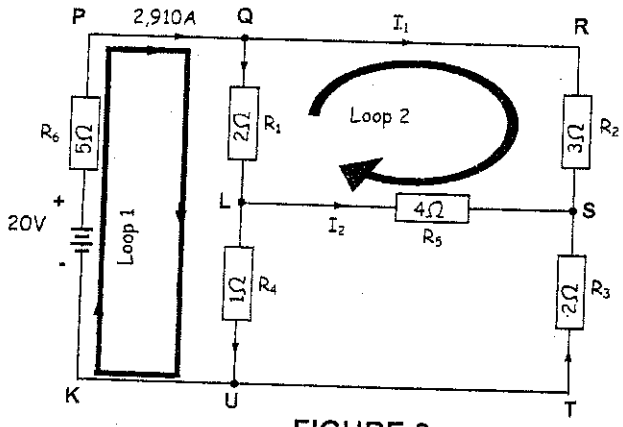


FIGURE 3

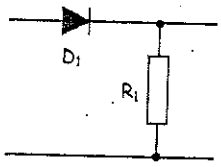


FIGURE 4

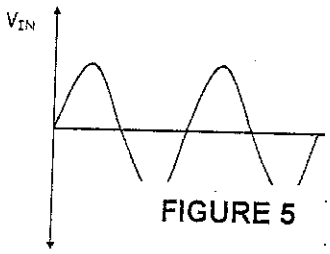


FIGURE 5

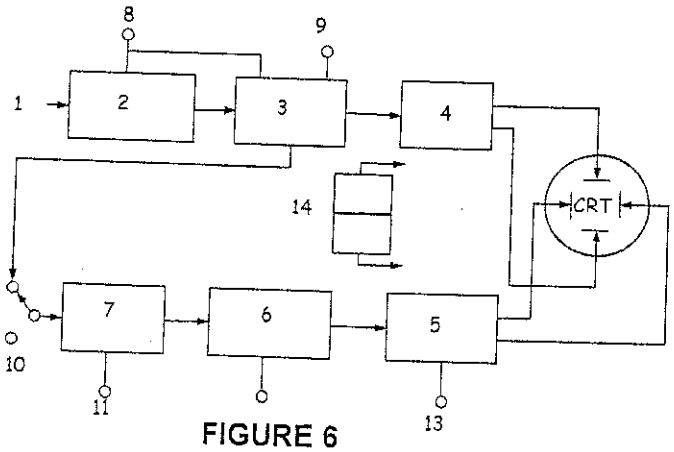


FIGURE 6

INDUSTRIAL ELECTRONICS N3

FORMULA SHEET

Direct-current theory

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

$P = I^2 \cdot R$

Alternating current theory:

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

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

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

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

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

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

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

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

Transistors:

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

Transducers:

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

higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T600(E)(A2)T
AUGUST 2010

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

(15070413)

2 August (X-Paper)
09:00 – 12:00

REQUIREMENTS: Properties of water and steam

Calculators may be used.

This question paper consists of 7 pages, a 2-page formula sheet and an information sheet.