education

Department:
Education
REPUBLIC OF SOUTH AFRICA

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APRIL 2010

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N3

(8080613)

29 March (X-Paper)
09:00 – 12:00

Calculators may be used.

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

DEPARTMENT OF EDUCATION
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 correctly 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. Keep questions and subsections of questions together.
7. Leave margins clear.
8. Questions must be answered in blue or black ink.
9. Use $\pi = 3,142$.
10. ALL the final answers must be approximated accurately to THREE decimal places.
11. 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 When operating below its resonant frequency, a series RLC circuit has the characteristics of a series RL circuit. (1)

1.1.2 In a parallel tuned circuit voltage magnification takes place. (1)

1.1.3 Diffusion capacitance occurs when a PN-junction is reverse biased. (1)

1.1.4 Drift current occurs when a voltage is applied across a semiconductor material. (1)

1.1.5 The output frequency of a half-wave voltage doubler is double the supply frequency. (1)

1.1.6 In a transistor the base layer is wider than the emitter and collector layers. (1)

1.1.7 In negative feedback amplifiers, the signal that is fed back is in phase with the input signal. (1)

1.1.8 The SCR can be switched on by increasing the anode to cathode voltage to such an extent that the breakover voltage is reached. (1)

1.1.9 A positive temperature coefficient (PTC) thermistor's resistance decreases with increasing temperature. (1)

1.1.10 An operational amplifier has a high input impedance. (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 – 1.2.9) in the ANSWER BOOK.

1.2.1 Refer to the circuit in FIGURE 1 (DIAGRAM SHEET attached). At the resonant frequency ...

A I_{RL} leads I by 90°.
B I_C is a minimum.
C I is in phase with V_T.
D I_C lags I_{RL} by 90°. (1)

1.2.2 At the junction in FIGURE 2 (DIAGRAM SHEET attached) the value of I is ...

A $I_2 - I_3 - I_2$.
B $I_1 + I_3 - I_2$.
C $I_1 + I_2 + I_3$.
D $I_1 - I_3 + I_2$. (1)

1.2.3 In the circuit shown in FIGURE 3 (DIAGRAM SHEET attached) the component X has a reactance of 10 kΩ and I lags V by 45°, X is therefore ...

A an inductor and R is 10 kΩ.
B an inductor and R is 20 kΩ.
C a capacitor and R is 10 kΩ.
D a capacitor and R is 20 kΩ. (2)

1.2.4 The bond formed when ALL the atoms share ALL their valence electrons is called a(n) ...

A ionic bond.
B metallic bond.
C covalent bond.
D non-metallic bond. (1)

1.2.5 An SCR can be switched off by ...

A a negative pulse on the gate.
B increasing the current to above the holding current.
C making the anode negative with respect to the cathode.
D a positive pulse on the anode. (1)

1.2.6 Which ONE of the following is not characteristic of an operational amplifier?

A High input impedance
B High output impedance
C High voltage gain
D Wide bandwidth (1)

1.2.7 Synchronisation between ... is of utmost importance in oscilloscopes.

A time-base generator and trigger circuit
B horizontal amplifier and vertical amplifier
C input signal and timebase-generator
D input signal and trigger circuit (1)

1.2.8 Which ONE of the following transducers cannot be used for the measurement of pressure?

A Potentiometer transducer
B LVDT
C Thermistor
D Crystal (1)

1.2.9 In the saturation 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 Consider FIGURE 4 on the attached DIAGRAM SHEET and determine, with the aid of Kirchhoff's laws:

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

2.1.2 The equation for loop 2 (ULQRSTU). Set up the equation by starting at point U 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 Transients occur when an SCR is switched on and can have disastrous consequences for the circuit. Name and describe FOUR methods used to eliminate transients. (8)
[16]

QUESTION 3

3.1 Consider FIGURE 5 on the attached DIAGRAM SHEET. If the total current is a minimum for the circuit, calculate the following:

3.1.1 The impedance of the coil (2)
3.1.2 The current I_{RL} (1)
3.1.3 The phase angle between I_{RL} and V_T (1)
3.1.4 The current I_C (3)
3.1.5 The value of the capacitor in μF (3)

PTO

3.2 State SIX advantages of operational amplifiers. (6)
[16]

QUESTION 4

4.1 Describe a phototransistor by providing the following:

4.1.1 A labelled sketch of the construction (5)
4.1.2 The basic principle of operation (4)
4.1.3 The symbol (1)

4.2 For transformer coupling, give:

4.2.1 THREE advantages (3)
4.2.2 THREE disadvantages (3)
[16]

QUESTION 5

5.1 Describe how a capacitive transducer can be used to measure pressure by providing the following:

5.1.1 A labelled sketch of the construction (5)
5.1.2 The basic principle of operation (2)
5.1.3 Name TWO examples of where it is used (2)

5.2 Draw a labelled symbol of an SCR. (1)

5.3 Two methods are used to switch an SCR on, namely, the gate turn on and the breakover voltage turn on methods.

Briefly explain the following:

5.3.1 The gate turn-on method (3)
5.3.2 The breakover voltage turn-on method (3)
[16]

QUESTION 6

6.1 Choose a description from COLUMN B that matches a/an word/item in COLUMN A. Write only the letter (A – J) next to the question number (6.1.1 – 6.1.10) in the ANSWER BOOK.

	COLUMN A		COLUMN B
6.1.1	Accuracy	A	the smallest change in measured value to which an instrument will respond
6.1.2	Precision	B	the nearest an instrument reading will reach to the true value of the quantity measured
6.1.3	Sensitivity	C	shortcomings of instruments such as defective or worn parts
6.1.4	Resolution	D	to do with mainly human errors made in reading and/or using measuring instruments
6.1.5	Error	E	the highest and lowest frequencies outside which accurate readings cannot be obtained
6.1.6	Environmental errors	F	due to causes that cannot be directly established because of variations in parameter or system of measurement
6.1.7	Bandwidth	G	due to variations in temperature, humidity and also magnetic or electrostatic field effects
6.1.8	Gross errors	H	the measure of the degree to which successive measurements differ from one another
6.1.9	Instrumental errors	I	the deviation from the true value of the quantity being measured
6.1.10	Random errors	J	the ratio of the output signal of the instrument to the change of input

(10)

6.2 The circuit in FIGURE 6 on the attached DIAGRAM SHEET is that of a clipper.

6.2.1 Identify the type of clipper circuit. (1)
6.2.2 Explain its operation. (4)

6.3 State a use of a clipper. (1)
[16]

TOTAL SECTION B: 80
GRAND TOTAL: 100

DIAGRAM SHEET

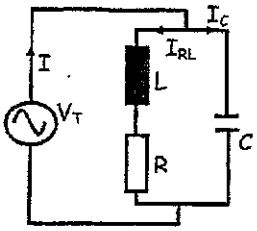

FIGURE 1

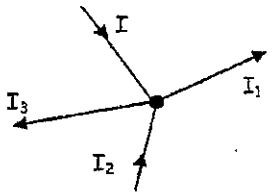

FIGURE 2

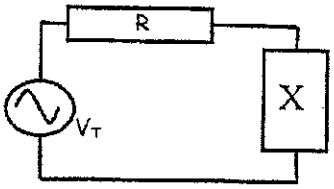

FIGURE 3

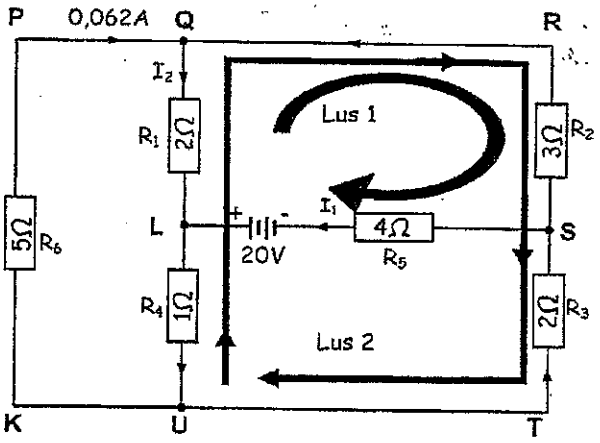

FIGURE 4

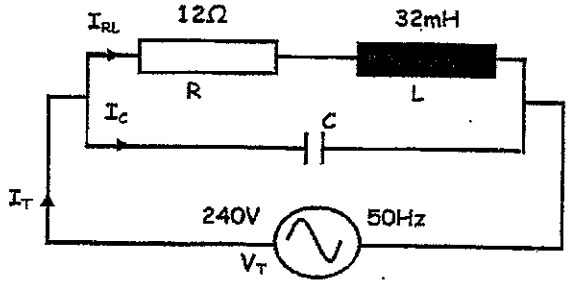

FIGURE 5

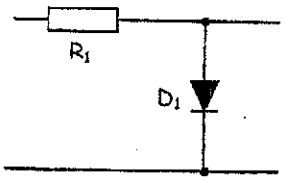

FIGURE 5

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:

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