0000000000

higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T760(E)(A3)T
APRIL EXAMINATION

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

(8080164)

3 April 2013 (X-Paper)
09:00–12:00

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

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
INDUSTRIAL ELECTRONICS N4
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. ALL the calculations must be shown.
5. ALL the calculations must be approximated accurately to THREE decimal places.
6. Start each question on a NEW page.
7. Write neatly and legibly.

QUESTION 1

Use Thevenin's theorem to calculate the current flowing through the 10 ohm resistor in FIGURE 1.

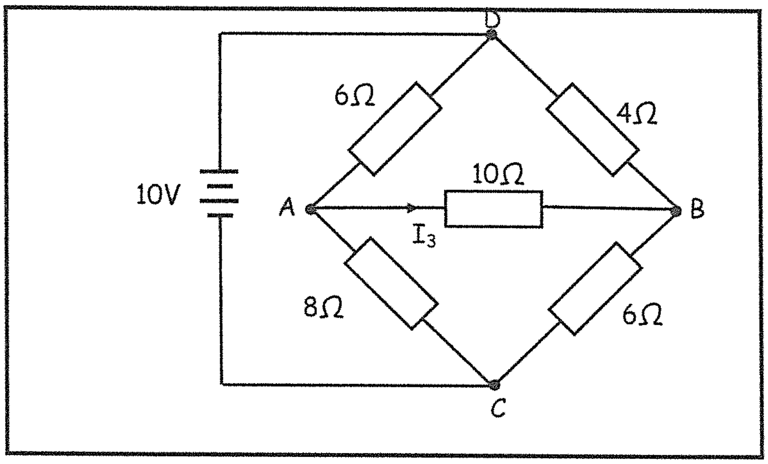

FIGURE 1 **[10]**

QUESTION 2

2.1 Define the following terms:

2.1.1 Q-factor (2)

2.1.2 Band width (2)

2.2 Consider the phasor diagram in FIGURE 2 and calculate the values of Z_A, Z_B and Z_C if the supply voltage is given as 120 V.

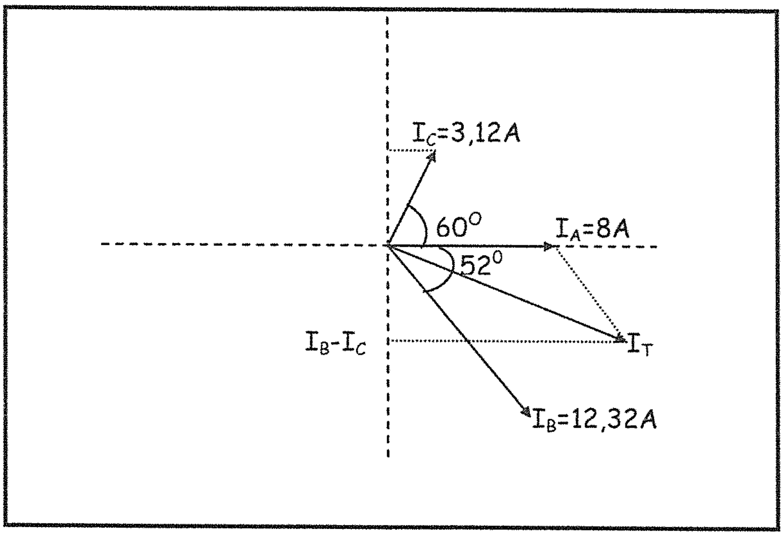

FIGURE 2 (6)
[10]

QUESTION 3

3.1 Choose a description from COLUMN B that matches an item in COLUMN A. Write only the letter (A–D) next to the question number (3.1.1–3.1.4) in the ANSWER BOOK.

COLUMN A		COLUMN B	
3.1.1	PN-junction diode	A	its operation depends on the capacitance that exists at the PN-junction which is reverse biased
3.1.2	Varactor diode	B	permits current to flow in the forward bias direction but it will also flow in the reverse bias when the voltage is above breakdown voltage
3.1.3	Tunnel diode	C	has a negative resistance region where an increase in terminal voltage results in reduction in diode current
3.1.4	Zener diode	D	has heavily doped p-type and n-type regions separated by an intrinsic region

(4 × 1) (4)

3.2 A diode has a forward resistance of 0,11 ohm. Calculate the current flow through the diode at a room temperature of 30 °C. (3)

3.3 FIGURE 3 shows a waveform obtained from a half-wave rectifier.

Calculate the following:

3.3.1 Transformer's secondary peak voltage (2)

3.3.2 Transformer's average output voltage (2)

3.3.3 Transformer's secondary RMS voltage (2)

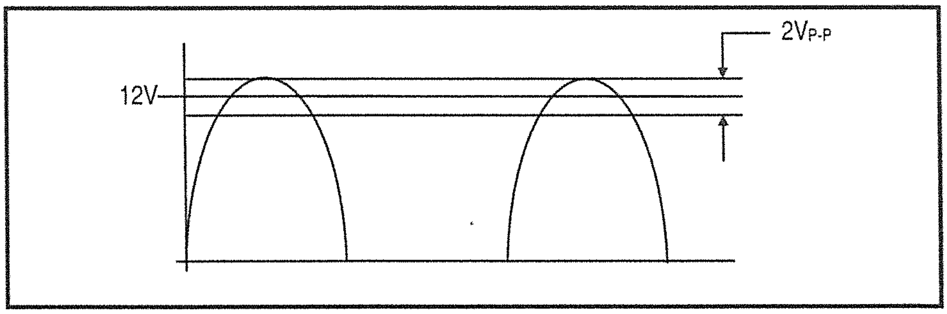

FIGURE 3

3.4 Calculate the output voltage of an LC-π-filter with a resistance of 200 ohms and a 1,5 kΩ load resistance. The voltage across the input capacitor is 200 V. (2)

[15]

QUESTION 4

4.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (4.1.1–4.1.5) in the ANSWER BOOK.

4.1.1 When transistor voltage and current are constant, the transistor is operating in its dynamic condition.

4.1.2 When the transistor operates in the active region its base-emitter junction is reverse biased and base-collector junction is forward biased.

4.1.3 Power amplifiers are designed to handle large signals.

4.1.4 The uni-junction transistor is a single junction device, which has negative resistance characteristics.

4.1.5 Field-effect transistors are relatively unaffected by radiation.

(5 × 1) (5)

4.2 Study the characteristic curves in FIGURE 4 and FIGURE 5. Using H-parameters, calculate the following dynamic values:

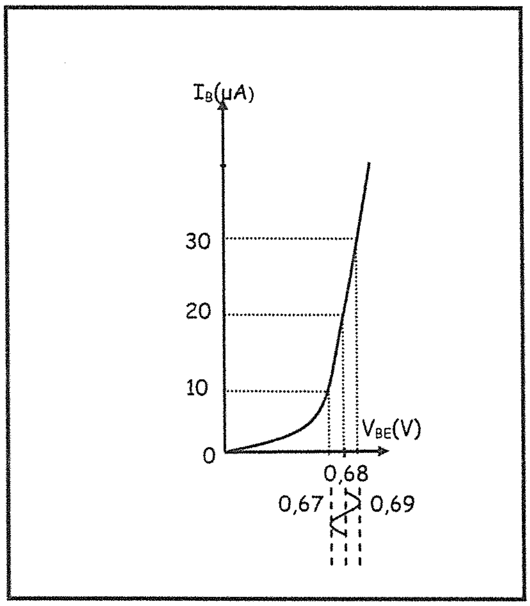

FIGURE 4

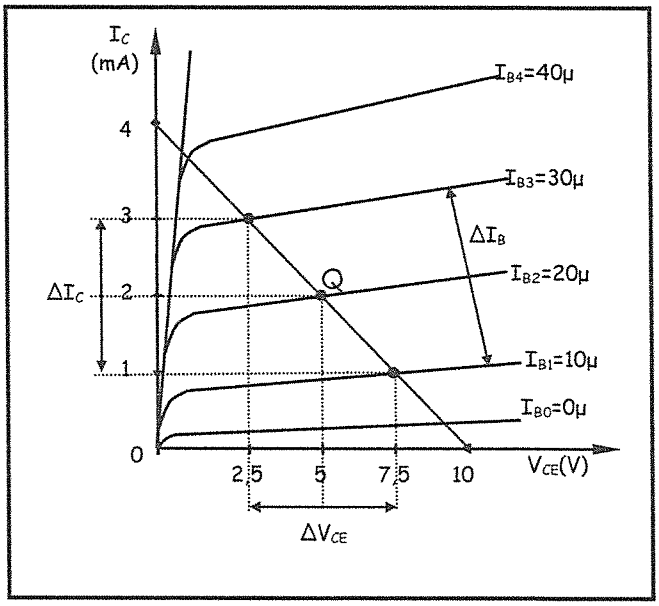

FIGURE 5

4.2.1 The input impedance (3)

4.2.2 The reverse voltage gain (2)

4.2.3 The forward current gain (2)

4.2.4 The output impedance (3)
[15]

QUESTION 5

5.1 Indicate the properties of an ideal operational amplifier. (4)

5.2 Explain how the internal gain of an operational amplifier can be changed. (2)

5.3 Calculate the rate of change of the output voltage for an integrator amplifier if C = 100 μF, Rin = 15 kΩ and Vin = 3 volts. (3)

5.4 Calculate the gain and expected output voltage for an amplifier whose output voltage is 180° out of phase with the input voltage if:

- Feedback resistance = 100 kΩ
- Input resistance = 200 kΩ
- Input voltage = 20 mV (4)

5.5 Draw a neat, labelled circuit symbol of a comparator amplifier. (2)
[15]

QUESTION 6

6.1 Give TWO differences between the SCR and the TRIAC. (2)

6.2 Explain how LASCR can be used in a circuit to replace an SCR. (3)

6.3 Draw the equivalent circuit of an LASCR by transistors. Clearly show ALL the terminals. (4)

6.4 Show, by means of a neat sketch, how a TRIAC is constructed. ALL the terminals must be shown. (4)

6.5 A QUADRAC is basically a triac and a diac combined together in a single package. (True/False)? Motivate your answer. (2)
[15]

QUESTION 7

7.1 Describe, with the aid of a circuit diagram how strain gauges are used in a Wheatstone bridge. (8)

7.2 Which formula describes the principle on which a strain gauge operates? (2)
[10]

QUESTION 8

8.1 What is a cathode-ray oscilloscope (CRO)? (2)

8.2 What is the function of the time-base generator as used in the oscilloscope? (2)

8.3 Which wave forms would you use for the following:

8.3.1 Digital electronic switching (1)

8.3.2 Transmission of radio signals (1)

8.4 An oscilloscope displays a sine wave over 6 vertical divisions and 4 horizontal divisions. The vertical amplifier setting is 2 V/div and the time base is at 15 μs/div.

Calculate:

8.4.1 The amplitude (2)

8.4.2 The period (2)
[10]

TOTAL: 100

INDUSTRIAL ELECTRONICS N4

FORMULA SHEET

$$\frac{1}{R_T}=\left(\frac{1}{R_1}+\frac{1}{R_2}+\ldots\frac{1}{R_n}\right) \qquad R_T=\frac{R_1R_2}{R_1+R_2} \qquad V_2=\frac{R_2}{R_1+R_2}\times\frac{V_T}{1}$$

$$Z=\sqrt{R^2+(X_L-X_c)^2} \qquad Cos\,\theta°=\frac{R}{Z} \qquad P=I^2R \qquad P=\frac{V^2}{R} \qquad P=VI\mathrm{Cos}\,\theta$$

$$P=V\,.\,I \qquad F_r=\frac{1}{2\pi\sqrt{LC}} \qquad Q=\frac{X_L}{R} \qquad OF \quad \frac{1}{R}\sqrt{\frac{L}{C}}$$

$$I_t=\sqrt{I_R^2+(I_c-I_L)^2} \qquad Z=\frac{1}{\sqrt{\left(\frac{1}{R}\right)^2+\left(\frac{1}{X_c}-\frac{1}{X_L}\right)^2}} \qquad \frac{N_1}{N_2}=\frac{V_1}{V_2}=\frac{I_2}{I_1}$$

$$V_{rms}=0{,}707\,V_m \qquad i=I_s\left(e^{\frac{gv}{kT}}-1\right) \qquad R=\frac{kT}{qi} \qquad V.R=\frac{V_{NL}-V_{FL}}{V_{FL}}$$

$$V_{ave}=0{,}637\,V_m$$

$$f=\frac{1}{t} \qquad Rate\ of\ change=-\frac{V_{in}}{CR_{in}}$$

$$V_{dc}=0{,}318\,V_m \qquad\qquad V_{dc}=0{,}637\,V_m$$

$$\mathrm{V}_{\mathrm{r}_{\mathrm{rms}}}=0{,}385\ \mathrm{V}_{\mathrm{m}}$$

$$PIV=V_m \quad \text{or} \quad 2\,V_m$$

$$V_{r_{rms}}=\frac{V_r\,(p-p)}{2\sqrt{3}} \qquad\qquad V_{dc}=V_m-\frac{V_r\,(p-p)}{2}$$

$$r=\frac{V_{r_{rms}}}{V_{dc}} \qquad\qquad V_{r_{rms}}=\frac{V_{dc}}{R_L\,2\sqrt{3}\,FC}$$

$$V_{dc}=V_m \quad \frac{I_{dc}}{2FC} \qquad\qquad r=\frac{I_{dc}}{V_{dc}\,2\sqrt{3}\,FC}$$

$$V_{r'_{rms}}=\frac{X_c}{\sqrt{R^2+X_c^2}}\times\frac{V_{r_{rms}}}{1}$$

$$V'_{dc}=\frac{R_L}{R_L+R_S}\times\frac{V_{dc}}{1} \qquad\qquad V_{r'_{rms}}=\frac{V_{r_{rms}}}{(2\pi f)^2\,LC}$$

$$R_{in} = \frac{V_{be}}{I_b} \qquad R_{out} = \frac{V_{ce}}{I_c} \qquad R_c = \frac{V_{CC}}{I_c} \qquad V_{out} = R_1 C \frac{dv_i}{dt}$$

$$Static\ current\ gain = \frac{I_{out}}{I_{in}}$$

$$Dynamic\ current\ gains = \frac{\Delta I_{out}}{\Delta I_{in}}$$

$$V_{CC} = V_{RC} + V_{ce} \qquad V_{ce} = V_{cc} - V_{RC} \qquad R = \frac{p\ell}{a}$$

$$A_p = 10 \log \frac{P_{out}}{P_{in}} \qquad A_v = 20 \log \frac{V_{out}}{V_{in}} \qquad A_i = 20 \log \frac{I_{outt}}{I_{in}}$$

$$Static\ voltage\ gain = \frac{V_{out}}{V_{in}}$$

$$Dynamic\ voltage\ gain = \frac{\Delta V_{out}}{\Delta V_{in}}$$

$$hie = \frac{\Delta V_{in}}{\Delta I_{in}} = \frac{\Delta V_{be}}{\Delta I_b} \qquad V_{ce} = constant$$

$$hre = \frac{\Delta V_{in}}{\Delta V_{out}} = \frac{\Delta V_{be}}{\Delta V_{ce}} \qquad I_b = constant$$

$$hfe = \frac{\Delta I_{out/uit}}{\Delta I_{in}} = \frac{\Delta I_c}{\Delta I_b} \qquad V_{ce} = constant$$

$$hoe = \frac{\Delta I_{out}}{\Delta V_{out}} = \frac{\Delta I_c}{\Delta V_{ce}} \qquad I_b = constant$$

$$V_{outt} = \frac{R_f}{R_{in}} \times V_{in} \qquad V_{outt} = -\left(\frac{R_f V_1}{R_1} + \frac{R_f V_2}{R_2} + \dots \frac{V_n R_f}{R_n}\right)$$

$$V_{out} = \left(1 + \frac{R_f}{R_{in}}\right) V_{in} \qquad V_{out} = -\frac{1}{CR_{in}} \int V_{in}(t)\, dt$$

Boltzmann's constant = 1,38 × 10^{-23} J/k

Electron charge = 1,6 × 10^{-19} C

NB: Any applicable formula may be used.