higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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APRIL EXAMINATION

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

(8080164)

4 April 2014 (Y-Paper)
13:00–16:00

This question paper consists of 7 pages and 1 formula sheet of 2 pages.

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. Start each answer on a NEW page.
5. ALL the calculations must be shown.
6. ALL the final answers must be approximated accurately to THREE decimal places.
7. Write neatly and legibly.

QUESTION 1

Use Kirchhoff's method to determine the current flowing through 5 Ω in FIGURE 1 below.

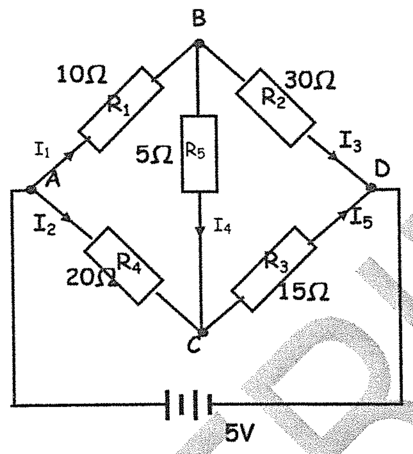

FIGURE 1 **[10]**

QUESTION 2

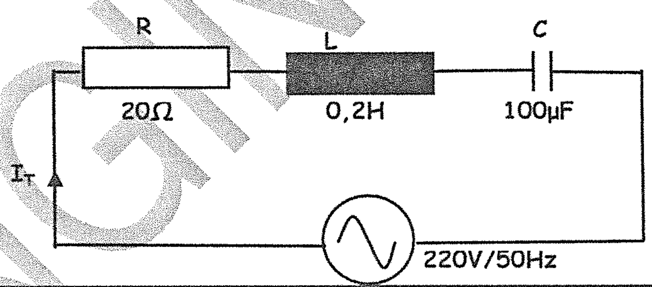

FIGURE 2

Consider FIGURE 2 above and, using complex numbers, calculate the following:

2.1 The total impedance of the circuit (4)

2.2 The current flowing in the circuit (2)

2.3 The voltage drop across the inductor (2)

2.4 The voltage drop across the capacitor (2)
[10]

QUESTION 3

3.1 Draw a simple Zener diode voltage-regulator circuit and explain how the output load will be regulated. (6)

3.2 The input voltage of a 100 kVA transformer is 2 000 V and the output voltage is 500 V at a frequency of 50 Hz.

If the transformer has 110 secondary windings, calculate the following:

3.2.1 The primary current

3.2.2 The secondary current

3.2.3 The primary turns

(3 × 2) (6)

3.3 A 12 V full-wave power supply operates from a 50 Hz supply.

If a load draws a 15 mA current from the supply, calculate the output DC voltage if a 100 μF capacitor is used. (3)

[15]

QUESTION 4

4.1 Draw a neat push-pull amplifier circuit which uses two NPN transistors. Clearly show the output wave forms. (5)

4.2 Choose a description from COLUMN B that matches an item in COLUMN A. Write only the letter (A–D) next to the question number (4.2.1–4.2.4) in the ANSWER BOOK.

COLOMN A		COLUMN B
4.2.1	UJT	A current-controlled amplifier device
4.2.2	MOSFET	B possesses a negative resistance characteristic
4.2.3	BJT	C voltage-controlled device
4.2.4	FET	D insulated gate field effect transistor

(4 × 1) (4)

4.3 Calculate the values of Vcc, Rin and Rout if the following information is given:

- Rc = 1 kΩ
- Vbe = 0,68 V
- Ic = 3 mA
- Vce = 15 V
- Ib = 20 μA

(6)

[15]

QUESTION 5

5.1 State FIVE main advantages of an operational amplifier. (5)

5.2 Calculate the gain and output of an operational amplifier whose output voltage is in phase with input voltage, if the following information is available:

- Input voltage = 0,5 V
- Feedback resistance = 20 kΩ
- Input resistance = 2 kΩ (4)

5.3 Draw the circuit diagram of the amplifier mentioned in QUESTION 5.2. (2)

5.4 Draw the expected output waveform if the input waveform shown in FIGURE 3 below is fed into the comparator operational amplifier. Also draw the symbol for the amplifier.

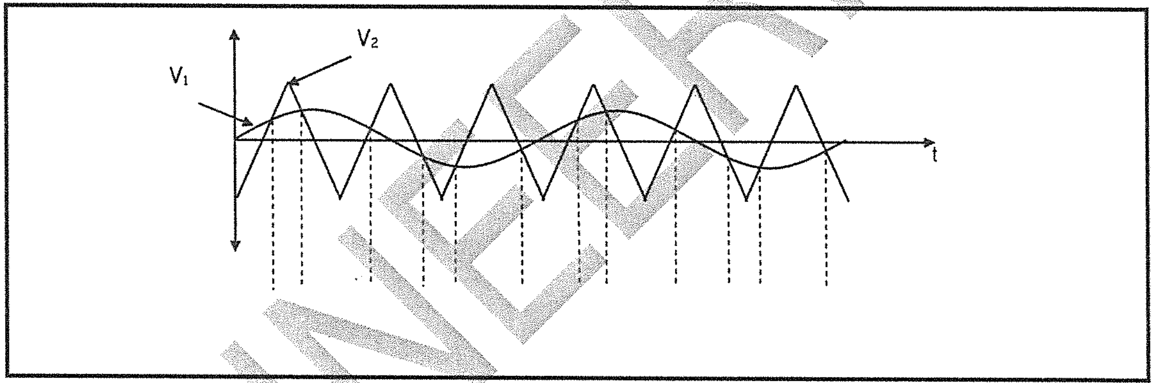

FIGURE 3

(4)
[15]

QUESTION 6

6.1 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 (6.1.1–6.1.5) in the ANSWER BOOK.

6.1.1 You need a sufficient thyristor to control the speed of an AC motor. A good one to use would be:

A diac
B BJT
C triac

6.1.2 You have a need to trigger an SCR. A good device to use would be:

A UJT
B triac
C four-layer diode

6.1.3 The SCR can be triggered on by a pulse at the …

A anode.
B gate.
C cathode.

6.1.4 The … is like a diode with a gate terminal.

A quadrac
B SCR
C triac

6.1.5 The application of a(n) … is used in lighting systems for power interruptions.

A triac
B SCR
C diac

(5 × 1) (5)

6.2 Consider FIGURE 4 below. Explain the operation of the circuit in THREE points. Include the function of the resistor in the explanation.

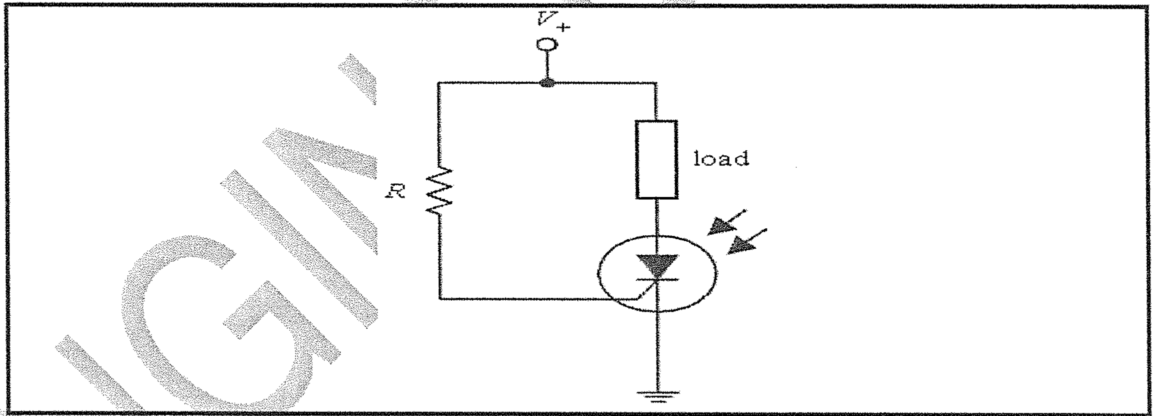

FIGURE 4 (3)

6.3 Draw a neat, labelled block diagram of an open-loop motor speed-control system and explain the function of each block. (7)
[15]

QUESTION 7

7.1 Name the FOUR groups into which transducers can be divided. (4)

7.2 Demonstrate, by means of a neat, labelled sketch of a simple transducer, how you would measure the following:

7.2.1 Pressure with bellows

7.2.2 Displacement with a potentiometer

(2 × 3) (6)
[10]

QUESTION 8

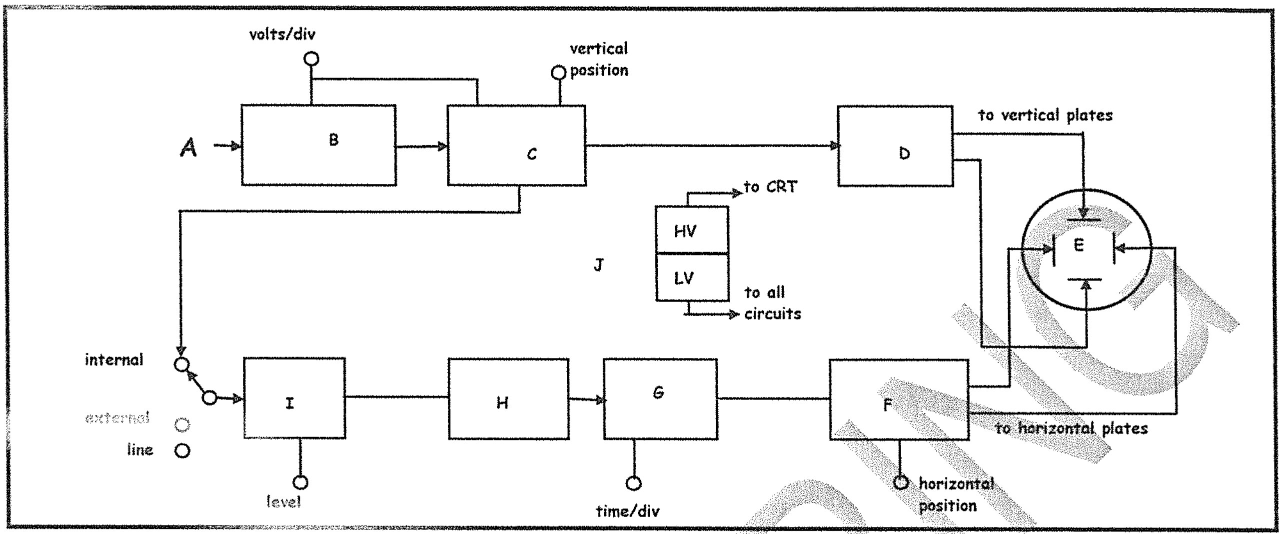

FIGURE 5

FIGURE 5 above shows a block diagram of an oscilloscope.

Label the parts marked A–J in the figure. Write the name next to the letter (A–J) in the ANSWER BOOK. **[10]**

TOTAL: 100

INDUSTRIAL ELECTRONICS N4

FORMULA SHEET

Any other applicable formula may be used.

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

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

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

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

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

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

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

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

$$V_{r_{rms}} = 0{,}385\ V_m$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Electron charge = 1,6 × 10^{-19} C