

**T700(E)(A4)T
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.

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.
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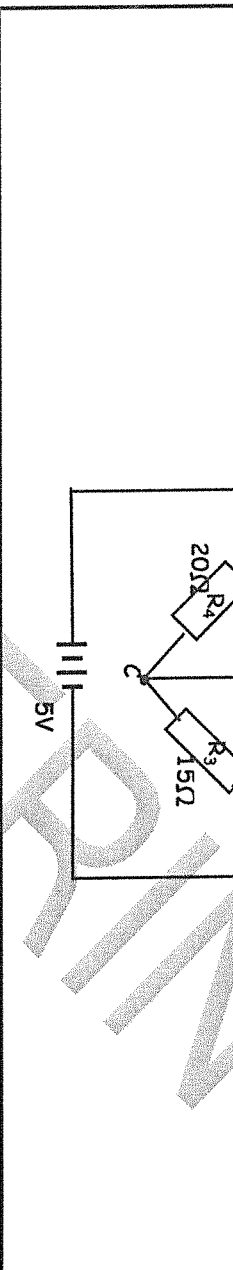


FIGURE 1

[10]

QUESTION 2

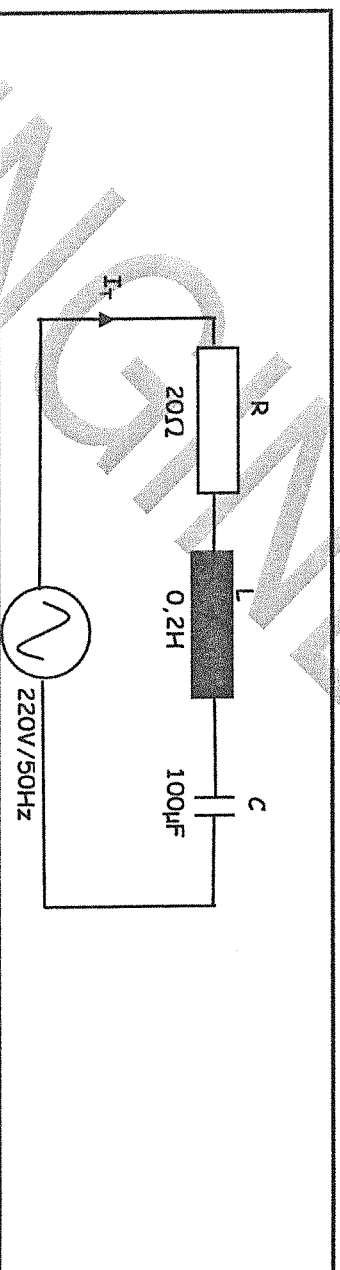


FIGURE 2

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]

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.

COLUMN 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 V_{cc} , R_{in} and R_{out} if the following information is given:

- $R_c = 1 \text{ k}\Omega$
- $V_{be} = 0,68 \text{ V}$
- $I_c = 3 \text{ mA}$
- $V_{ce} = 15 \text{ V}$
- $I_b = 20 \mu\text{A}$

(6)
[15]

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.

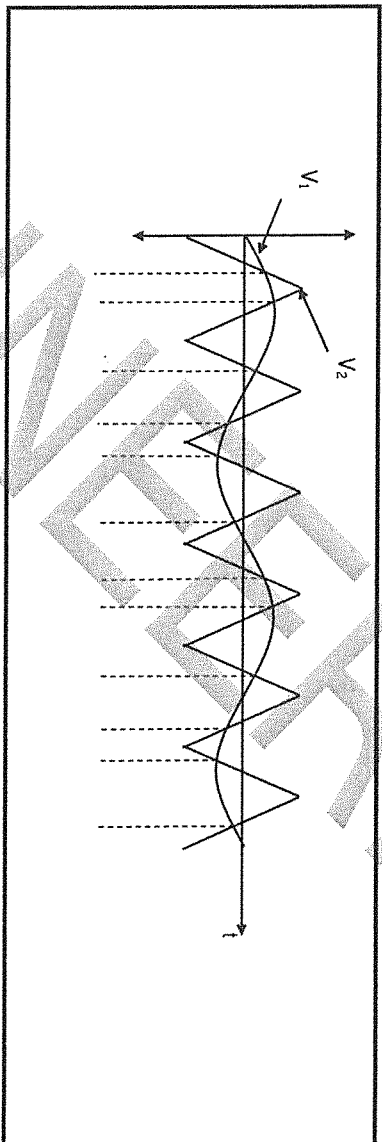


FIGURE 3

(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

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.

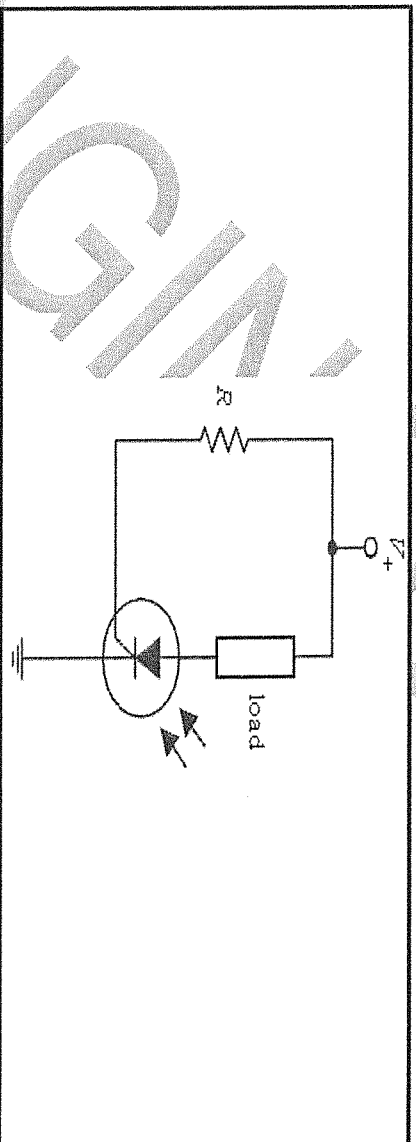


FIGURE 4

(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]

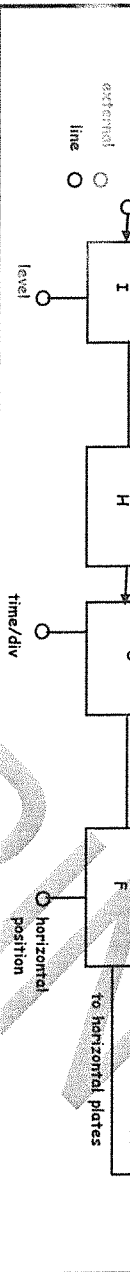


FIGURE 5

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

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

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

$$V_{rms} = 0,707 V_m \quad i = I_s \left(e^{\frac{gV}{kT}} - 1 \right) \quad R = \frac{kT}{qI} \quad V_R = \frac{V_{NL} - V_{FL}}{V_{FL}}$$

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

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

$$V_{dc} = 0,318 V_m$$

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

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

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

$$r = \frac{V_{rms}}{V_{dc}}$$

$$V_{dc} = V_m \quad \frac{I_{dc}}{2FC}$$

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

$$V_{dc} = \frac{R_L}{R_L + R_s} \times \frac{V_{dc}}{1}$$

$$V_{dc} = 0,637 V_m$$

$$V_{dc} = V_m - \frac{V_r (p-p)}{2}$$

$$V_{rms} = \frac{V_{dc}}{R_L \sqrt{3} FC}$$

$$r = \frac{I_{dc}}{V_{dc} \sqrt{3} FC}$$

$$V_{rms} = \frac{V_{rms}}{(2\pi f)^2 LC}$$

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

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

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

$$h_{ie} = \frac{\Delta V_{in}}{\Delta I_{in}} = \frac{\Delta V_{be}}{\Delta I_b}$$

$$V_{ce} = \text{constant}$$

$$h_{re} = \frac{\Delta V_{in}}{\Delta V_{out}} = \frac{\Delta V_{be}}{\Delta V_{ce}}$$

$$I_b = \text{constant}$$

$$h_{fe} = \frac{\Delta I_{out}}{\Delta I_{in}} = \frac{\Delta I_c}{\Delta I_b}$$

$$V_{ce} = \text{constant}$$

$$h_{oe} = \frac{\Delta I_{out}}{\Delta V_{out}} = \frac{\Delta I_c}{\Delta V_{ce}}$$

$$I_b = \text{constant}$$

$$V_{out} = - \left(\frac{R_f V_1}{R_1} + \frac{R_f V_2}{R_2} + \dots + \frac{V_n R_f}{R_n} \right)$$

$$V_{out} = \left(1 + \frac{R_f}{R_{in}} \right) V_{in}$$

$$V_{out} = - \frac{1}{CR_{in}} \int V_{in}(t) dt$$

$$\text{Boltzmann's constant} = 1,38 \times 10^{-23} \text{ J/K}$$

$$\text{Electron charge} = 1,6 \times 10^{-19} \text{ C}$$