



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T380(E)(J23)T

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

(8080164)

23 July 2018 (X-Paper)
09:00–12:00

This question paper consists of 6 pages and a formula sheet of 2 pages.

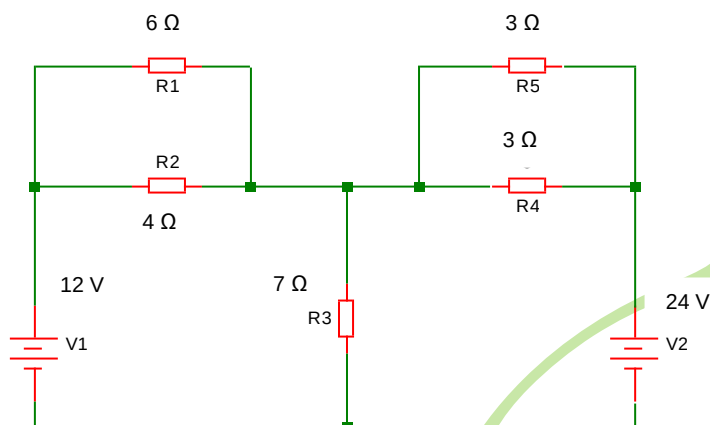
DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA
NATIONAL CERTIFICATE
INDUSTRIAL ELECTRONICS N4
TIME: 3 HOURS
MARKS: 100

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. Write neatly and legibly.
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QUESTION 1

- 1.1 Study the circuit diagram below and calculate the current flowing through the $7\ \Omega$ resistor using superposition.



Calculate the current flowing through the $7\ \Omega$ resistor using superposition. (8)

- 1.2 Define the following theorems in words:

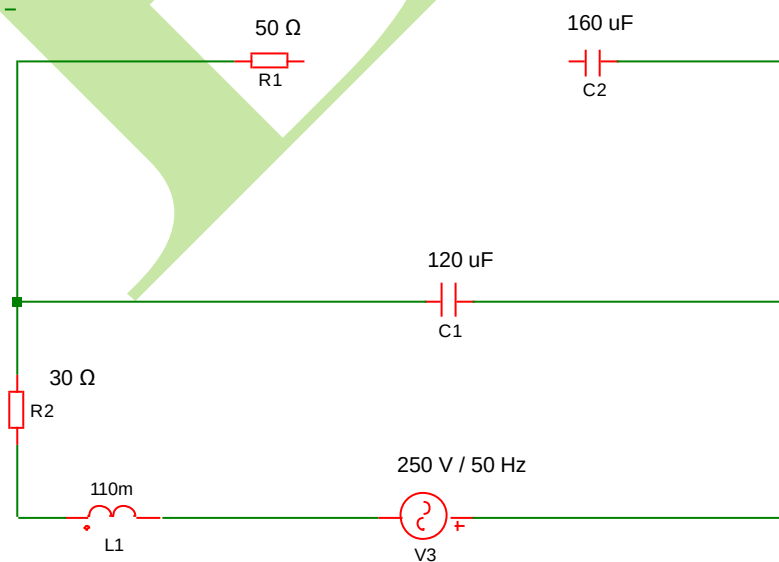
1.2.1 The superposition theorem (2)

1.2.2 Thevenin's theorem (2)

[12]

QUESTION 2

Study the circuit diagram below and calculate the total current using j-notation.



[12]

QUESTION 3

- 3.1 Explain the following terms:
- 3.1.1 Donor doping (2)
 - 3.1.2 Acceptor doping (2)
- 3.2 List FOUR characteristics of a Zener diode. (4)
- 3.3 Calculate a suitable value for a series resistor if a 20 mA current flows through a Zener diode of 10 V when connected to a 15 V DC supply. (3)
- [11]**

QUESTION 4

- 4.1 Differentiate between a full-wave bridge circuit and a full-wave centre-tap circuit. (4)
- 4.2 A transformer is used to step down 240 V to 30 V at 50 Hz. The secondary of the transformer is connected to a rectifier and the rectifier is then connected to a capacitor filter. The capacitor has a value of 120 μF and a load resistor of 200 Ω .
- Calculate the following:
- 4.2.1 The output voltage and the output current if a half-wave rectifier is used (4)
 - 4.2.2 The output voltage and the output current if a full-wave rectifier is used (4)
- [12]**

QUESTION 5

- 5.1 Transistor output characteristics show the relationships between V_{CE} , I_C , and I_B .
- Name and explain THREE important regions to consider in the output characteristic. (6)
- 5.2 The output of an amplifier changes from 3 V to 7 V and the current from 2 mA to 10 mA.
- Calculate the dynamic impedance. (3)
- 5.3 List THREE examples of push-pull amplifiers. (3)
- [12]**

QUESTION 6

- 6.1 A summing amplifier has $R_1 = 8 \text{ K}\Omega$, $R_2 = 15 \text{ K}\Omega$, $R_3 = 25 \text{ K}\Omega$, $R_f = 35 \text{ K}\Omega$ and the input voltages are $V_1 = 3,5 \text{ V}$, $V_2 = \text{unknown}$, $V_3 = 8,5 \text{ V}$ and $V_o = 6,14 \text{ V}$.

Calculate the value of the unknown V_2 . (4)

- 6.2 Which op-amp is used without feedback? (1)

- 6.3 Draw square input wave forms and output wave forms which are supplied with the following:

6.3.1 An integrator (2)

6.3.2 A differentiator (2)

[9]

QUESTION 7

- 7.1 Explain the working principle of a LASCR. (3)

- 7.2 List THREE disadvantages of using a triac. (3)

- 7.3 Choose the correct word(s) from those given in brackets and write only the word(s) next to the question number (7.3.1–7.3.5) in the ANSWER BOOK.

7.3.1 The characteristic curve of a LASCR is the same as that of a (triac/diac/SCR).

7.3.2 An amplifier (without feedback/with feedback) is a closed-loop system.

7.3.3 In a closed-loop system an automatic controller must (sense/trigger/correct) that the controlled condition is not at the desired value.

7.3.4 A (correcting signal/comparator) adjust the physical quantity on which the value of the controlled condition depends on a block diagram of a closed-loop system.

7.3.5 During the (positive half cycle/negative half cycle/ complete full cycle) of the input signal, the SCR will turn on.

(5 × 1)

(5)
[11]

QUESTION 8

8.1 State whether the following is referred to as CAPACITIVE, INDUCTIVE or RESISTIVE. Write only 'capacitive', 'inductive' or 'resistive' next to the question number (8.1.1–8.1.3) in the ANSWER BOOK.

8.1.1 Angular displacement

8.1.2 Liquid level

8.1.3 Potentiometer

(3 × 1) (3)

8.2 Draw a strain gauge used as a Wheatstone bridge. (4)

8.3 Briefly explain the operating principle of a photodiode. (4)
[11]

QUESTION 9

9.1 Name TWO choices of synchronisation provided for on the front panel of a cathode-ray oscilloscope. (2)

9.2 Explain *voltage scale* and *time scale*. (2)

9.3 Explain the following information which appears on the front panel of an oscilloscope:

9.3.1 Focus

9.3.2 Intensity

9.3.3 Volts/div

(3 × 2) (6)
[10]

TOTAL: 100

INDUSTRIAL ELECTRONICS N4

FORMULA SHEET

Any other applicable formula may be used.

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

$$Z = \sqrt{R^2 + (X_L - X_C)^2} \quad \cos \theta^\circ = \frac{R}{Z} \quad P = I^2 R \quad P = \frac{V^2}{R} \quad P = VI \cos \theta$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$V'_{dc} = \frac{R_L}{R_L + R_S} \times \frac{V_{dc}}{1}$$

$$V_{r'_{rms}} = \frac{V_{r_{rms}}}{(2\pi f)^2 LC}$$

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

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

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

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

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

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

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

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

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

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

$$I_b = \text{constant}$$

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

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

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

$$I_b = \text{constant}$$

$$V_{out} = \frac{R_f}{R_{in}} \times V_{in}$$

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

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

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

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

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