higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

(8080164)

14 November 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.

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 (1.1.1–1.1.3) in the ANSWER BOOK.

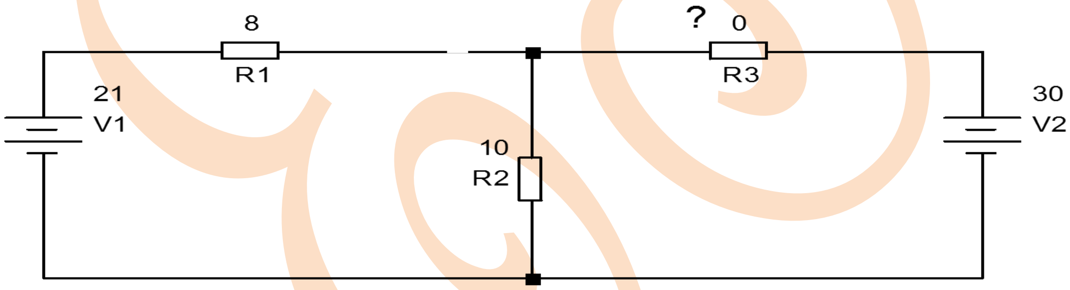
1.1.1 Kirchhoff's first law states that in any closed circuit the algebraic sum of the products of the current and the resistance of each part of the circuit is equal to the resistant emf in the circuit.

1.1.2 One of the application procedures when using Thévenin's theorem is to replace all voltage sources with short circuits and all current sources with open circuits.

1.1.3 The maximum power transfer theory states that the power transferred from a signal source into a load will be a maximum when the load resistance is not equal to the resistance of the source.

(3 × 1) (3)

1.2 Study the circuit diagram below and answer the questions.



1.2.1 Use the superposition theorem and calculate the value of the unknown resistor if the total resistance is R = 12 Ω.

HINT: Short-circuit V2. (3)

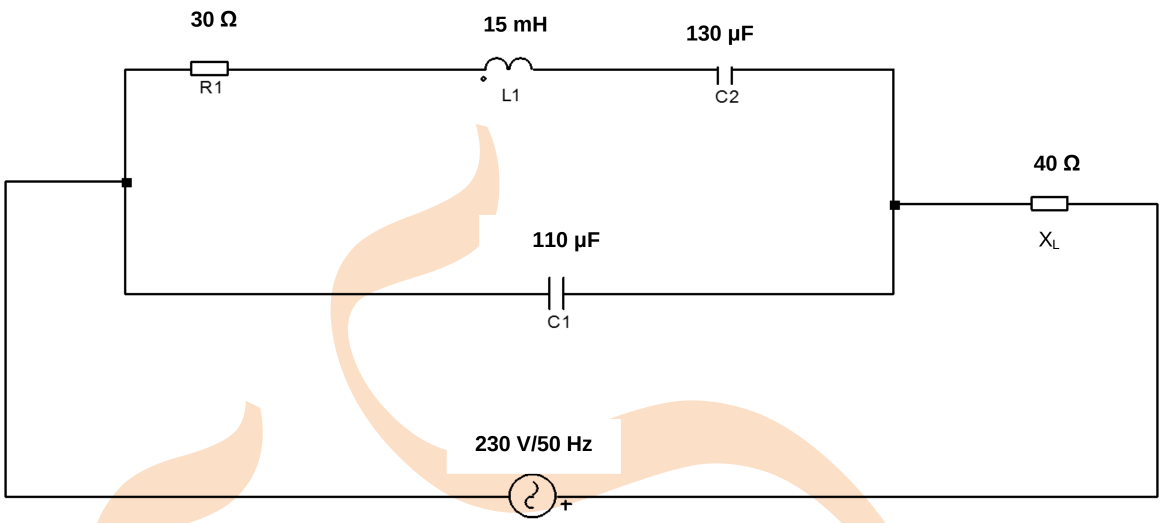
1.2.2 Use Thévenin's theorem and calculate the current flowing through 10 Ω. (6)

[12]

QUESTION 2

2.1 Give THREE factors which have an influence on the capacity of a capacitor. (3)

2.2 Study the circuit diagram below and answer the question.



Calculate the total current using j-notation. (9)
[12]

QUESTION 3

3.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' of 'False' next to the question number (3.1.1–3.1.4) in the ANSWER BOOK.

3.1.1 Positive and negative biases are used in transistor theory.

3.1.2 When a voltage regulator diode is forward biased it does not behave as a normal diode.

3.1.3 Diffusion is the movement of electrons crossing the junction.

3.1.4 From a Zener-characteristic curve there are voltage changes at Zener point.

(4 × 1) (4)

3.2 Calculate the diode current of a germanium diode with Id = 80 µF and an applied forward bias of 0,6 V at room temperature of 26 °C. (4)

3.3 Calculate the forward resistance of the diode in QUESTION 3.2 if the forward current is 0,38 A at room temperature of 28 °C. (3)
[11]

QUESTION 4

4.1 A half-wave rectifier has a load resistance of R_L= 250 Ω, a capacitor of C= 150 µF and maximum voltage of Vm = 210 V at 60 Hz.

Calculate the average DC voltage supplied to the load. (3)

4.2 The resistance in an RC filter is 130 Ω, the voltage to the RC filter is 80 V and the load resistance is 0,003 MΩ.

Calculate the load current. (4)

4.3 A filter capacitor has a value of 180 µF, the power supply operates at 18 V DC at 50 Hz, the load resistance is 2 000 Ω and there is half-wave rectification.

Calculate the ripple voltage. (3)
[10]

QUESTION 5

5.1 Compare Class-A amplifiers to Class-B amplifiers. (3 + 3) (6)

5.2 How is MOSFET operated in depletion mode? (3)

5.3 The following data was collected from a load-line circuit:

Vcc = 10 V, Rc = 2 KΩ, V_{BE} =1,2 V, I_B = 70 µA

Calculate the value of R_B. (3)
[12]

QUESTION 6

6.1 List and explain FOUR characteristics of an ideal op-amp. (4 × 2) (8)

6.2 An integrating amplifier has a capacitor of 20 µF, input resistance of R_{in}= 15 KΩ and input voltage of V_{in} = 10 V.

Calculate the rate of change of the output voltage. (3)
[11]

QUESTION 7

7.1 SCR is a diode with a third electrode which is the gate.

What is the function of the third electrode? (1)

7.2 Draw a labelled characteristic curve of DIAC. (5)

7.3 Explain negative resistance in terms of a DIAC-characteristic curve. (2)

7.4 List THREE components that must appear on a complete block diagram of a closed-loop system. (3)
[11]

QUESTION 8

8.1 Name THREE aspects to consider when selecting a transducer. (3)

8.2 Explain the operating principle of angular displacement. (4)

8.3 Explain the operating principle of a linear-differential transformer. (4)
[11]

QUESTION 9

9.1 A sine wave has a peak-to-peak voltage of 3,2 V. The amplifier gain setting is 0,4 V/div and the time setting is 4 µsec/div. Assume one full cycle (360°) to count 6 divisions.

Calculate:

9.1.1 The vertical number of divisions in cm

9.1.2 The frequency

9.1.3 The average value

(3 × 2) (6)

9.2 What is a function generator? (1)

9.3 List THREE basic waveforms produced by a function generator. (3)
[10]

TOTAL: 100

FORMULA SHEET

Any other applicable formula may be used.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Electron charge = 1,6 × 10^{-19} C