higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

(8080164)

27 July (X-Paper)
09:00 – 12:00

This question paper consists of 6 pages and a 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 correctly according to the numbering system used in this question paper.
4. ALL the calculations MUST be shown.
5. ALL the sketches and diagrams MUST be large, clear and neat.
6. Start each question on a NEW page.
7. ALL the final answers must be approximated to THREE decimal places.
8. Write neatly and legibly.

QUESTION 1: NETWORK THEORY

Use the superposition method to calculate the current flowing through R_L in FIGURE 1, as given below:

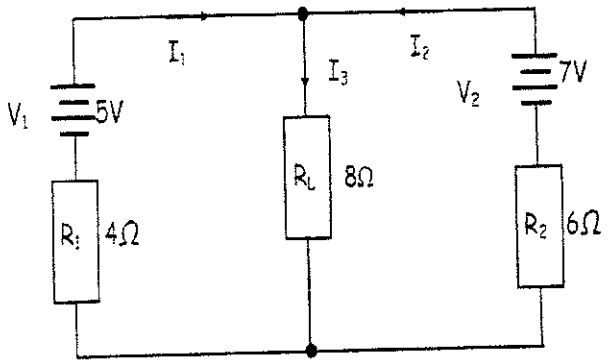

FIGURE 1 **[10]**

QUESTION 2: ALTERNATING CURRENT THEORY

A series circuit consists of a resistor of 10 Ω, an inductor of 0,15 H and a capacitor of 150 µF. The circuit is connected across a 150 V, 50 Hz supply.

Calculate the following by using complex numbers:

2.1 The total impedance of the circuit (4)

2.2 The total current flowing in the circuit (2)

2.3 The voltage drop across the inductor (2)

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

QUESTION 3: SEMI-CONDUCTORS AND POWER SUPPLY

3.1 Use characteristics curves to indicate the different operating principles of the following diodes:

3.1.1 Zener diode
3.1.2 Varactor diode
3.1.3 Tunnel diode

(3 x 2) (6)

3.2 Give TWO advantages and TWO disadvantages of a capacitor filter circuit. (4)

3.3 A germanium diode with I_s = 10 µA conducts current of 6 mA at a room temperature of 30°.

Calculate the voltage drop across the junction. (5)

[15]

QUESTION 4: TRANSISTORS AND AMPLIFIERS

4.1 The following information is given for a common emitter amplifier:

- Input power = 400 mW
- Output impedance = 15Ω
- Output power = 400 W
- Input voltage = 15V

Calculate the following:

4.1.1 Power gain in dB (2)
4.1.2 Voltage gain in dB (4)
4.1.3 Current gain in dB (4)

4.2 Sketch labelled symbols and characteristic curves of the following depletion type MOSFETS:

4.2.1 N-channel (5)
4.2.2 P-channel (5)

[20]

QUESTION 5: OPERATIONAL AMPLIFIERS

5.1 With suitable input and feedback impedances the operational amplifier could perform different tasks. Name THREE such tasks. (3)

5.2 Draw a neat, labelled circuit diagram of an amplifier whose output voltage is 180° out of phase with the input voltage. (3)

5.3 Calculate the gain and expected output voltage for the amplifier in QUESTION 5.2, if the following information is given:

- Input to amplifier = 60 mV
- Feedback resistor = 2 kΩ
- Input resistor = 1 kΩ

(4)
[10]

QUESTION 6: ELECTRONIC POWER CONTROL

6.1 What effect will the gate current have on the anode current after an SCR has turned on? (2)

6.2 State THREE methods to switch off an SCR. (3)

6.3 Demonstrate, with the aid of labelled characteristic curve, the principle of operation of the following thyristors:

(3)

6.3.1 LASCR (3)

6.3.2 TRIAC

(4)

6.4 Name FOUR applications of an SCR. **[15]**

QUESTION 7: TRANSDUCERS

7.1 Demonstrate by means of a neat, labelled circuit diagram how you would measure the following, by means of transducers:

(4)

7.1.1 Temperature with a thermistor

(4)

7.1.2 Liquid level with a capacitive transducer

(2)

7.2 What is the function of a transducer in a control system? **[10]**

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QUESTION 8: TESTING EQUIPMENT

8.1 Draw a neat, labelled block diagram of a cathode ray tube. (6)

8.2 State TWO applications of each of the following wave forms:

8.2.1 Rectangular wave (2)
8.2.2 Square wave (2)
[10]

TOTAL: 100

FORMULA SHEET

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

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

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

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

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

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

$$f = \frac{1}{t} \qquad \textit{Rate of change/Tempo van verandering} = -\frac{V_{in}}{CR_{in}}$$

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

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

$$PIV = V_m \quad or/of \quad 2\,V_m$$

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

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

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

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

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

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

Static current gain/Statiese stroomwins $= \dfrac{I_{out/uit}}{I_{in}}$

Dynamic current gain/Dinamiese stroomwins $= \dfrac{\Delta I_{out/uit}}{\Delta I_{in}}$

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

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

Static voltage gain/Statiese spanningswins $= \dfrac{V_{out}/V_{uit}}{V_{in}}$

Dynamic voltage gain/Dinamiese spanningswins $= \dfrac{\Delta V_{out/uit}}{\Delta V_{in}}$

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

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

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

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

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

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

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

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

NB: Any applicable formula may be used.
Enige toepaslike formule mag gebruik word.