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higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

(8080164)

15 November (X-Paper)
09:00 – 12:00

This question paper consists of 5 pages and a 3-page 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.

PTO

QUESTION 1: NETWORK THEORY

Use Kirchhoff's laws to calculate the current flowing through the load resistor (R_L) in FIGURE 1 below.

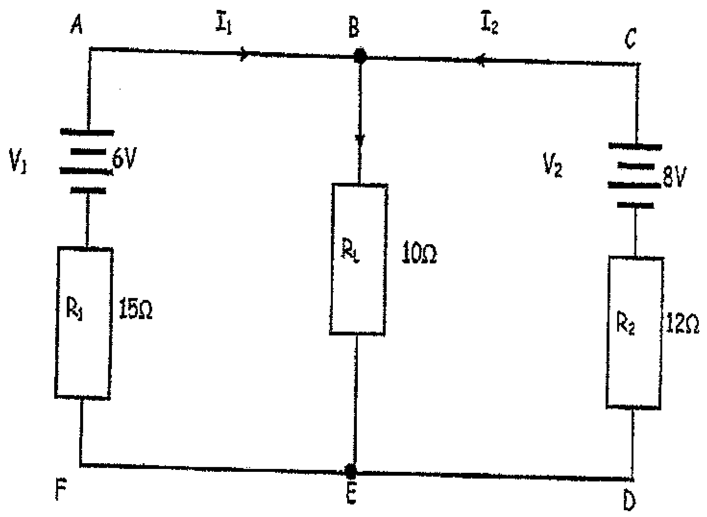

FIGURE 1 **[10]**

QUESTION 2: ALTERNATING CURRENT THEORY

A circuit consists of the following components:

$Z_1 = 110 - j\,21{,}21$
$Z_2 = 150 + j\,26{,}41$
$Z_3 = 100 + j\,46{,}31$

Z_1 and Z_2 are connected in parallel. The combination is connected in series with Z_3 across a 250 V, 50 Hz supply.

Calculate the following:

2.1 The total parallel impedance (4)

2.2 The total impedance of the circuit (2)

2.3 The current flowing through the parallel branch (4)
[10]

QUESTION 3: SEMI-CONDUCTORS AND POWER SUPPLY

3.1 Draw a neat, labelled characteristic curve of a silicon diode. (3)

3.2 Calculate the forward current of a diode if it has a forward resistance of 8,25 Ω at a room temperature of 30 °C. (2)

3.3 Explain the difference between the following types of transformers:

3.3.1 Step-down transformer
3.3.2 Step-up transformer
3.3.3 Centre-tap transformer
3.3.4 Auto-transformer
3.3.5 Multi winding transformer (5 × 2) (10)

[15]

QUESTION 4: TRANSISTORS AND AMPLIFIERS

4.1 Draw neat, labelled construction sketches of the following transistors:

4.1.1 PNP transistor
4.1.2 Unijunction transistor
4.1.3 N-channel junction field effect transistor
4.1.4 P-channel junction field effect transistor
4.1.5 NPN transistor (5 × 2) (10)

4.2 Use the characteristic curves of a common emitter amplifier in FIGURE 2 and FIGURE 3 below to calculate the following static values:

4.2.1 hie (3)
4.2.2 hre (2)
4.2.3 hfe (2)
4.2.4 1/hoe (3)

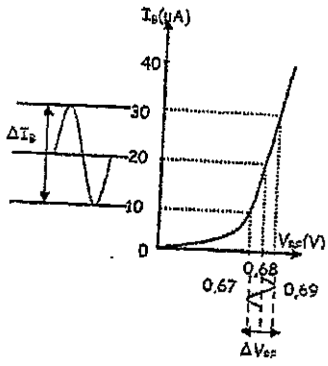

FIGURE 2

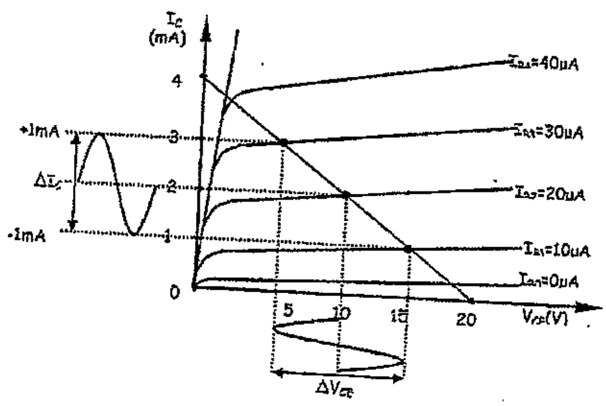

FIGURE 3

[20]

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QUESTION 5: OPERATIONAL AMPLIFIERS

5.1 State FIVE main advantages of operational amplifiers. (5)

5.2 THREE different input voltages must be added by means of a single operational amplifier. Draw a labelled circuit diagram that would satisfy this statement. (3)

5.3 Calculate the rate of change of the output voltage for an integrating amplifier if C = 15 μF, Rin = 15 kΩ and Vin = 10 V. (2)
[10]

QUESTION 6: ELECTRONIC POWER CONTROL

6.1 Draw a labelled block diagram of a loop system that will not be able to make corrective action should there be any deviation. (5)

6.2 Explain the operation of the loop system in QUESTION 6.1. (4)

6.3 Give ONE application of the following power controllers:

6.3.1 SCR
6.3.2 TRIAC
6.3.3 LASCR (3 × 1) (3)

6.4 State THREE advantages of the SCR. (3)
[15]

QUESTION 7: TRANSDUCERS

Briefly explain the principle of operation of the following transducers:

7.1 Photodiode
7.2 Negative temperature coefficient (NTC)
7.3 Light dependant resistor (LDR)
7.4 Photo-transistor
7.5 Positive temperature coefficient (PTC) (5 × 2) **[10]**

QUESTION 8: TESTING EQUIPEMENT

Draw a neat, labelled block diagram of a cathode-ray oscilloscope (CRO). **[10]**

TOTAL: 100

INDUSTRIAL ELECTRONICS N4

FORMULA SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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 $= \dfrac{\Delta V_{out/uit}}{\Delta V_{in}}$

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

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

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

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

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

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

PTO

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.