education

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NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

(8080164)

25 March (X-Paper)
09:00 – 12:00

This question paper consists of 7 pages and a 3-page formula sheet.

DEPARTMENT OF EDUCATION
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 Thevenins theorem to calculate the current flowing through the 4 Ω resistor in FIGURE 1 below.

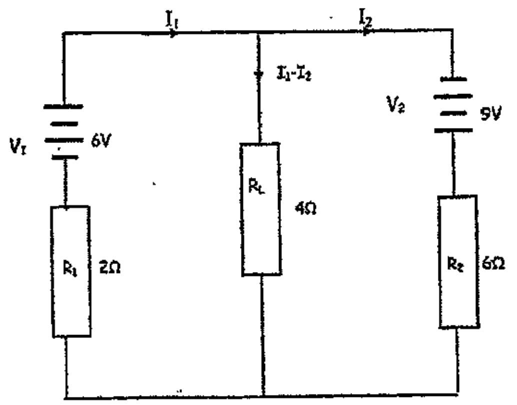

FIGURE 1 **[10]**

QUESTION 2: ALTERNATING CURRENT THEORY

2.1 Define *impedance.* (2)

2.2 Define the *Q-factor.* (2)

2.3 Choose the correct answer from the words in brackets. Write only the word next to the question number (2.3.1 – 2.3.6) in the ANSWER BOOK.

2.3.1 In a parallel resonant circuit at resonance, the impedance is (minimum/maximum) and the current is at 2.3.2 (minimum/maximum). (2)

2.3.3 At resonance is $X_L = X_C$ in a (series/parallel) circuit. (1)

2.3.4 A series resonant circuit is also known as an (acceptor/rejector). (1)

2.3.5 A Parallel resonance circuit is also known as an (acceptor/rejector). (1)

2.3.6 At resonance the power factor of a circuit is (1/0°). (1)

[10]

PTO

QUESTION 3: SEMI-CONDUCTORS AND POWER SUPPLY

3.1 Draw a neat, labelled diagram of a two-diode power supply which is equipped with an RC filter. (4)

3.2 The following information for a capacitor filter is given:

- Value of the capacitor = 100 F
- Input from a full-wave rectifier
- Load current = 10 mA
- Peak secondary voltage = 10 V
- Frequency = 50 Hz

Calculadte the following:

3.2.1 The output DC voltage (3)

3.2.2 The output ripple voltage (3)

3.3 Distinguish between the following terms:

3.3.1 Forward current flow (2)

3.3.2 Reverse saturated current (2)

3.4 In the forward bias condition the Zener diode reacts as a varactor diode.

True or False? (1)

[15]

QUESTION 4: TRANSISTORS AND AMPLIFIERS

4.1 Complete the following sentences/paragraph(s) by filling in the missing word(s). Write only the word(s) (A – C) next to the question number (4.1.1 – 4.1.5) in the ANSWER BOOK.

4.1.1 A depletion type MOSFET has ...

A the gate insulated from the channel.
B a p-type gate.
C no gate.

4.1.2 A MOSFET can operate with ...

A negative bias only.
B either positive or negative bias.
C positive bias only.

4.1.3 Uni-junction transistor devices are commonly used as ...

A trigger for SRC circuits.
B amplifiers.
C rectifiers.

4.1.4 An enhancement type MOSFET has the advantage ...

A of low input impedance.
B that no bias is required.
C that drain current is zero when no gate is biased.

4.1.5 The gate to source bias in a JFET depends on ...

A both Vgs and Vds
B Vgs only
C Vds only (5 x 2) (10)

4.2 A common emitter amplifier produces an output current of 6 mA with an input current of 4 μA. The output voltage changes with 8 V by means of 4 V input voltage.

Calculate the following:

4.2.1 The input impedance
4.2.2 The output impedance
4.2.3 The current gain
4.2.4 The voltage gain
4.2.5 The power gain (5 x 2) (10)
[20]

QUESTION 5: OPERATIONAL AMPLIFIERS

5.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (51.1 – 5.1.5) in the ANSWER BOOK.

5.1.1 The output voltage of an invertor amplifier is the sum of all input voltages.

5.1.2 In a differentiator amplifier the rate at which the output voltage changes is related to the value of the input voltage at that instant.

5.1.3 The output voltage is related to the rate at which the input voltages change at a particular instant in an integrator amplifier.

5.1.4 The output voltage is in phase with the input voltage in a summer amplifier.

5.1.5 The output voltage is 180° out of phase with the input voltage in a non-invertor. (5 x 1) (5)

5.2 State FOUR characteristics of operational amplifiers. (4)

5.3 Operational amplifiers can operate from dual power supply voltage.

True or False? (1)
[10]

QUESTION 6: ELECTRONIC POWER CONTROL

6.1 Draw a neat, labelled circuit diagram to show how a triac in a phase control, can control the alternating current power of the load by switching on or off. (5)

6.2 Draw neat, labelled circuit symbols of the following thyristors:

6.2.1 LASCR
6.2.2 Quadrac
6.2.3 SCR (3 x 2) (6)

6.3 Explain the difference between open-loop and closed-loop control systems. Sketches are NOT necessary. (4)
[15]

QUESTION 7: TRANSDUCERS

7.1 Name TWO groups of transducers. (2)

7.2 State TWO important requirements for the design of a transducer to ensure reliable operation of a control system. (2)

7.3 Draw a neat, labelled diagram of a typical Wheatstone bridge, which makes use of a strain gauge to measure stress. (4)

7.4 State TWO physical properties that can be converted to corresponding electrical values by means of a transducer. (2)
[10]

QUESTION 8: TESTING EQUIPMENT

A sine wave is displayed on a CRO screen (oscilloscope). The peak-to-peak distance is 5 cm and the distance between cycles is 4 cm. The volts/cm dial is set at 10 V/cm and the time/div is set at 100 μsec/cm. Choose from the following list the answer for each of the questions.

5 volts;	4 ms;	0,4 volts;	25 volts;	35,4 volts;
250 Hz;	2,5 kHz;	17,7 volts;	17,7 volts;	2,5 volts

8.1 The peak-tot-peak value
8.2 The periodic time of the wave-form
8.3 The maximum value of the voltage
8.4 The frequency of the wave-form
8.5 The RMS value of the wave-form (5 x 2) **[10]**

TOTAL: 100

INDUSTRIAL ELECTRONICS N4

FORMULA SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

PTO

$R_{in} = \frac{V_{be}}{I_b}$ $\quad R_{out}/R_{uit} = \frac{V_{ce}}{I_c}$ $\quad R_c = \frac{V_{cc}}{I_c}$ $\quad V_{out}/V_{uit} = R_1C\frac{dv_i}{dt}$

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

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

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

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

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

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

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

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

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

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

$V_{out/uit} = \frac{R_f}{R_{in}} \times V_{in}$ $\qquad V_{out/uit} = -\left(\frac{R_fV_1}{R_1} + \frac{R_fV_2}{R_2} + \dots\frac{V_nR_f}{R_n}\right)$

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

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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.