higher education & training

Department:
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REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

(8080164)

26 November 2024 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used

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

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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. Use only a black or blue pen.
5. Write neatly and legibly.

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QUESTION 1

1.1 Name FOUR steps of the application procedure using the superposition theorem. (4)

1.2 Study the circuit diagram shown in FIGURE 1 below:

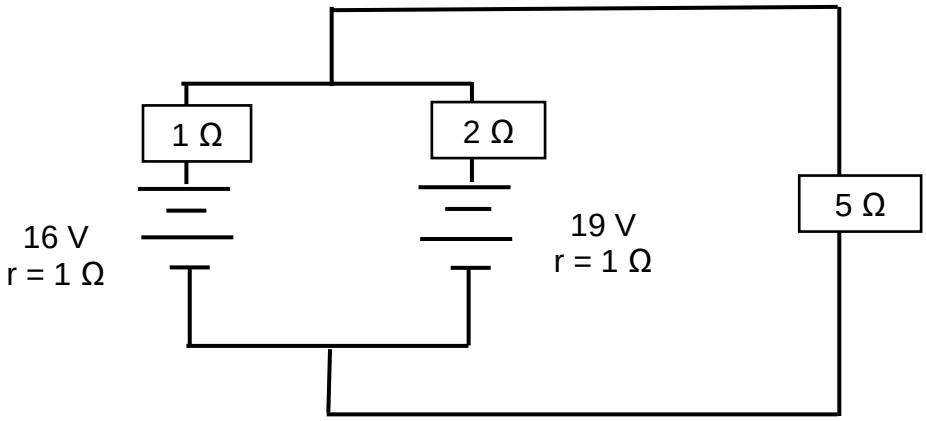


FIGURE 1

Use Kirchhoff's law to determine the voltage drop across a 5 ohms resistor. (10)

1.3 Define *Thevenin's theorem*. (3)

1.4 Define the *maximum power's theorem*. (3)
[20]

QUESTION 2

2.1 Briefly explain the phase relationship between voltage and current due to AC current flowing through each of the following components: resistor, inductor and capacitor. (3 × 2) (6)

2.2 A series resonance network consisting of a resistor of 48 Ω, a capacitor of 3,02 µF and an inductor of 30 mH is connected across a sinusoidal supply voltage, which has a constant output of 12 V at all frequencies.

Calculate the following:

2.2.1 The resonant frequency (2)

2.2.2 The total current at resonance (2)

2.2.3 The voltage across the resistor, inductor and capacitor at resonance (5)

2.2.4 The quality factor (2)

2.2.5 The bandwidth Δf and the edge frequencies f_H and f_L of the circuit (3)
[20]

QUESTION 3

3.1 A silicon diode with saturation current of 12 µA, conducts current of 6 mA at a room temperature of 27 °C.

☆ Calculate the voltage drop across the junction. (5)

3.2 Give TWO differences between the SCR and the TRIAC. (2 × 1) (2)

3.3 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (3.3.1–3.3.5) in the ANSWER BOOK.

3.3.1 The diac switches off when its current flows above the holding current.

3.3.2 The triac is a multilayer three-terminal bi-directional semiconductor device.

3.3.3 The open system represents an amplifier without feedback.

3.3.4 The LASCR is an SCR whose gate is controlled by light energy.

3.3.5 A triac can be used to control AC flow on a half-wave bias.

☆ (5 × 1) (5)

3.4 Explain how LASCR can be used in a circuit to replace an SCR. (3)

[15]

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QUESTION 4

4.1 Choose a/an term/item from COLUMN B that matches a description in COLUMN A. Write only the letter (A–G) next to the question number (4.1.1–4.1.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
4.1.1	Good smoothing action compared to simple capacitor filter at low current (light loads)	A	LC π-filter
4.1.2	Most popular because of its excellent filtering action and high V_{out}	B	Simple capacitor filter
4.1.3	Good regulation and its action is independent of load current	C	RL filter
4.1.4	It is popular because of its low cost, small size, and it improves DC output	D	Series inductor filter
4.1.5	Sudden changes in current are smoothened out and improve filtering action at high load currents across the inductor	E	RCL filter
		F	Choke/LC-input filter
		G	RC π-filter

(5 × 1) (5)

4.2 Give TWO types of a full-wave rectifier. (2)

4.3 A half-wave rectified voltage of 15 V peak is applied across a 300 µF filter capacitor at a frequency of 50 Hz.

Calculate the output DC voltage, if the load resistor takes a current of 110 Ma. (3)

4.4 Draw a neat, labelled circuit diagram of a power supply using the following components:

- A transformer
- A bridge rectifier
- A load resistor
- Two capacitors
- An inductor

(5)

[15]

QUESTION 5

5.1 Define the *gain* of an amplifier. (1)

5.2 An amplifier has the following: Voltage gain (A_V) of 100 and Current gain (A_i) of 10.

5.2.1 Calculate the power gain. (2)

5.2.2 Express all THREE gains in decibels (dB). (3)

5.3 Study FIGURE 2 below and answer the questions that follow:

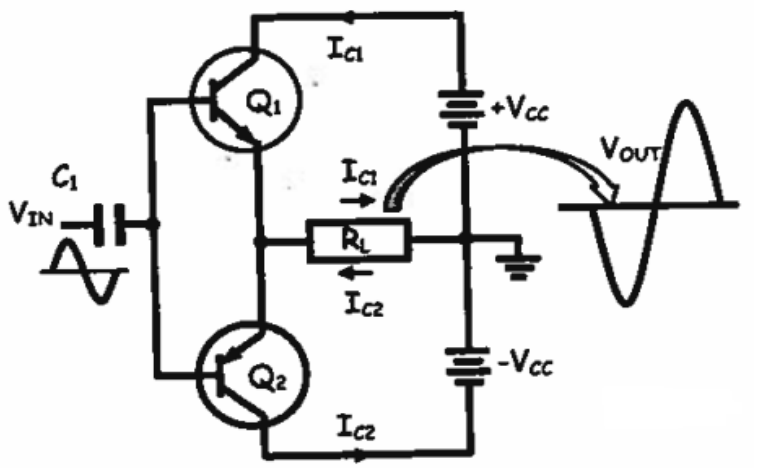


FIGURE 2

5.3.1 What does the above circuit diagram represent? (2)

5.3.2 Explain the operation of the device. (3)

5.4 The input voltage of a non-inverting op-amp is 0,4 V and R_{in} = 1k2Ω and R_f = 10 kΩ. Calculate the output voltage and draw a neat, labelled input and output square waveforms from 0° to 1080°. (4)

[15]

QUESTION 6

6.1 In your own words, what is a strain gauge? (2)

6.2 Explain, with the aid of a neat, labelled circuit diagram, the operation of the linear variable differential transformer. (5)

6.3 Give THREE applications of the transducer mentioned in QUESTION 6.2. (3)

6.4 Define *Liquid Crystal Display*. (2)

6.5 Give THREE applications of an LCD. (3)

[15]

TOTAL: 100

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INDUSTRIAL ELECTRONICS N4

FORMULA SHEET

$$\frac{1}{R_T}=\left(\frac{1}{R_1}+\frac{1}{R_2}+...\frac{1}{R_n}\right)\quad R_T=\frac{R_1R_2}{R_1+R_2}\quad V_2=\frac{R_2}{R_1+R_2}\times\frac{V_T}{1}$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Electron charge/
Elektronlading = 1,6 × 10^{-19} C

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

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