higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T780**(E)**(N15)T

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

(8080164)

15 November 2017 (X-Paper)
09:00–12:00

This question paper consists of 6 pages and a formula sheet of 2 pages and 1 graph paper.

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

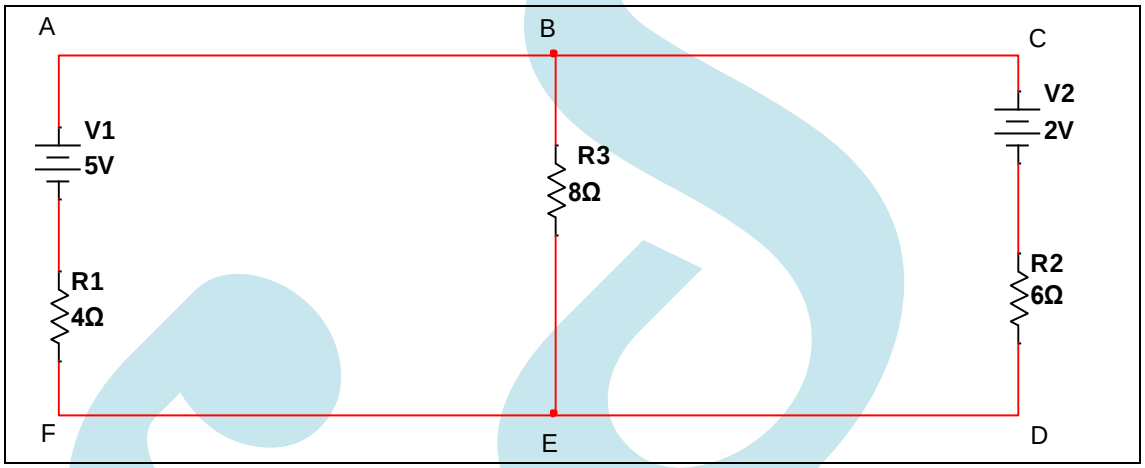
1.1 Explain the following laws of Kirchhoff:

1.1.1 Current law

1.1.2 Voltage law

(2 × 2) (4)

1.2 Consider the following circuit and calculate the current flowing through R_3, using Kirchhoff's laws.



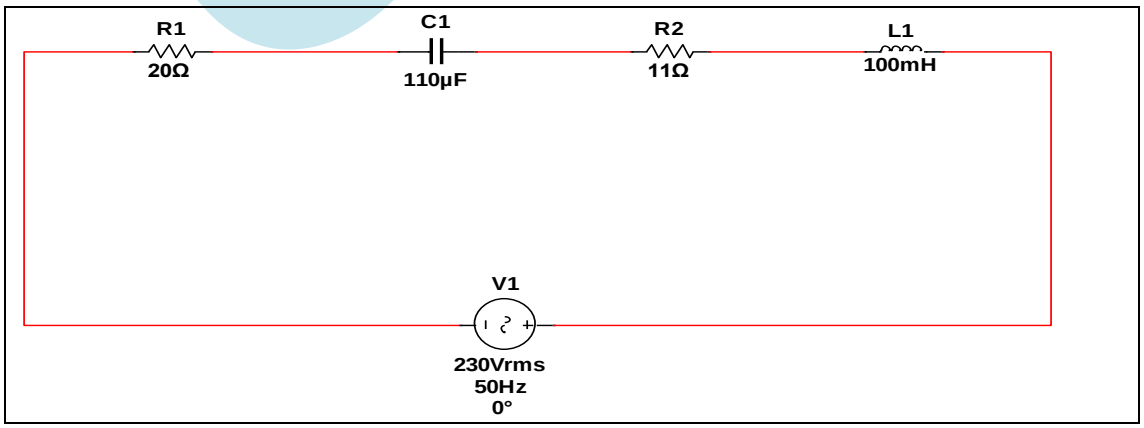
(8)
[12]

QUESTION 2

2.1 An LC circuit resonating at 1 000 kHz has a Q of 100.

Calculate the total bandwidth ΔF and the edge frequencies F_H and F_L. (4)

2.2 Refer to the figure below and calculate I_T (total current) using the j-notation



(6)
[10]

QUESTION 3

3.1 Draw a forward and reverse characteristic curve of silicon and germanium on the same set of axes and show all the labels and voltages. (6)

3.2 Calculate the forward current through a silicon diode when 0,5 V is applied at a temperature of 28 ^{o}C. The saturation current is 1 µA. (3)

3.3 Calculate the amount of current that flows through a Zener diode if V_{zener} = 10 V, the series resistor is 250 Ω and the supply voltage is 15 V. (3)

[12]

QUESTION 4

4.1 Draw a four-diode full-wave bridge rectifier circuit that shows the input and output waveforms. (5)

4.2 A full-wave rectifier circuit has a 100 µF filter capacitor connected to a load of 20 mA and the line frequency is 50 Hz.

Calculate:

4.2.1 Full-wave ripple voltage

4.2.2 DC-filtered voltage if the peak rectified voltage is 10 V

(2 × 3) (6)

[11]

QUESTION 5

5.1 Draw a circuit diagram of a common emitter amplifier and show the input and output waveforms. (5)

5.2 Draw a labelled static emitter characteristic curve of a UJT. (6)

[11]

QUESTION 6

6.1 Name THREE advantages of operational amplifiers. (3)

6.2 Name ONE op-amp that can be used without a feedback. (1)

6.3 Draw a circuit diagram of a non-in amplifier and determine the output voltage in the non-inverting mode of an op-amp with an input voltage of 2 V, a feedback resistance of 10 kΩ and an input resistance of 2 kΩ. (4)

6.4 Calculate the input voltage (V_{in}) if the rate of change of the output voltage for an integrating amplifier is 0,8 V/sec , C = 20 µF and R_{in}= 10 kΩ . (2)
[10]

QUESTION 7

7.1 State whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (7.1.1–7.1.4) in the ANSWER BOOK.

7.1.1 The action of the SCR can be explained in terms of two resistors.

7.1.2 The holding current is the minimum value of the current needed to keep an SCR on.

7.1.3 The diac is a two-terminal device which may be referred to as a bi-directional trigger diode.

7.1.4 LASCR is a three-layer PNP device.

(4 × 1) (4)

7.2 Explain the difference between an *open-loop system* and a *closed-loop system*. (4)
[8]

QUESTION 8

8.1 Name FOUR types of transducers. (4)

8.2 A linear, variable differential transformer is an example of an inductive transducer.

Draw and explain the operational principle of a linear, variable differential transformer. (6)

8.3 Explain the operational principle of photosensitive transducer. (3)
[13]

QUESTION 9

9.1 Differentiate between *electromagnetic deflection* and *electrostatic deflection.* (2)

9.2 Draw a waveform that should appear on an oscilloscope on graph paper on the ADDENDUM (attached). The amplifier gain setting is 0,5 V/div for 1 full cycle of 360^{o}. 8 divisions are counted and the amplitude is 1,5 V.

HINT: Calculate the number of divisions and periods.

Write your EXAMINATION NUMBER on the ADDENDUM, detach it and place it inside your ANSWER BOOK. (6)

9.3 Calculate the frequency from QUESTION 9.2. (2)

9.4 Name THREE basic outputs that can be produced by a function generator. (3)

[13]

TOTAL: 100

INDUSTRIAL ELECTRONICS N4

FORMULA SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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*

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

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

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

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

G.P.-S. 008-0148

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
DEPARTEMENT VAN HOËR ONDERWYS EN OPLEIDING

BOE 8/9

GRAPH PAPER • GRAFIEKPAPIER

(Return this sheet with the other answers)
(Lewer hierdie blad in saam met u antwoordboek)

Examination number
Eksamennommer