higher education & training

Department:
Higher Education and Training
**REPUBLIC OF SOUTH AFRICA**

T700(E)(A1)T
**AUGUST EXAMINATION**

NATIONAL CERTIFICATE

# INDUSTRIAL ELECTRONICS N4

(8080164)

**1 August 2014 (Y-Paper)**
**13:00–16:00**



**This question paper consists of 6 pages and a formula sheet of 3 pages.**

# DEPARTMENT OF HIGHER EDUCATION AND TRAINING
# REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
INDUSTRIAL ELECTRONICS N4
TIME: 3 HOURS
MARKS: 100

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**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. Start each answer on a NEW page.
5. ALL the calculations must be shown.
6. ALL the final answers must be approximated accurately to THREE decimal places.
7. Write neatly and legibly.

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## QUESTION 1

Use the Superposition method to calculate the current flowing through a 15 Ω resistor in FIGURE 1 below.

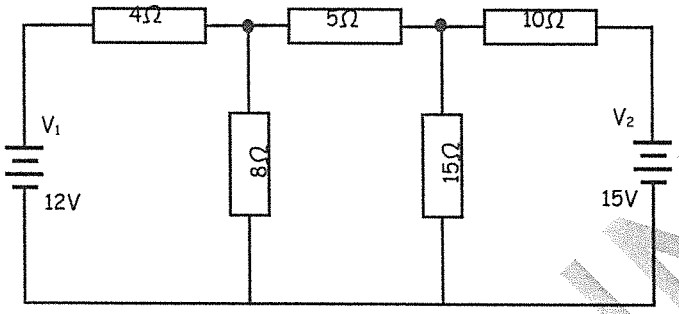


**FIGURE 1** **[10]**

## QUESTION 2

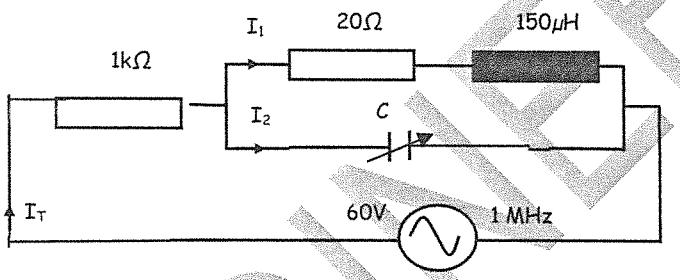


**FIGURE 2**

Consider FIGURE 2 above and calculate the following:

2.1 The value of the capacitor to give resonance (4)

2.2 The dynamic impedance (2)

2.3 The Q-factor of the circuit (2)

2.4 The total resistance of the circuit (2)

**[10]**



 

## QUESTION 3

3.1 The output voltage across the first capacitor of a LC π-filter half-wave rectifier is 120 V DC with an 8 V ripple at a frequency of 110 Hz.

Calculate the output ripple factor of the filter if L = 5 H, R = 200 Ω and $C_2$ = 6 µF. The filter is connected to a 6 kΩ load. (8)

3.2 Calculate the PIV of a half wave rectifier that has an input voltage of 220 Vrms. (2)

3.3 Name TWO advantages and THREE disadvantages of an LC filter. (5)
**[15]**

## QUESTION 4

4.1 Draw a neat sketch showing the basic connection of a CMOS device by means of enhancement of PMOS and NMOS transistors. Also state where it is being widely used. (5)

4.2 Indicate whether the following statements are TRUE or FALSE. Write only 'true' or 'false' next to the question number (4.2.1–4.2.5) in the ANSWER BOOK.

4.2.1 Field Effect Transistors have no offset voltage when used as a switch.

4.2.2 The operation of MOSFET under forward bias is called the enhancement mode.

4.2.3 The depletion mode MOSFET can be operated only with negative gate voltage.

4.2.4 Cross over distortion cannot be eliminated.

4.2.5 Uni-junction transistors can be used in a timing circuit.

(5 x 1) (5)

4.3 Name FIVE points that can be affected by negative feedback to improve the performance of a circuit. (5)
**[15]**

## QUESTION 5

5.1 Draw the functional diagram of an operational amplifier connected as a differentiator. Also draw a 720° input sine wave and its expected output wave form. (5)

5.2 THREE different input voltages of 1,5 V, 2 V and 3 V and input resistance of 100 kΩ, 150 kΩ and 300 kΩ respectively, must be added by means of a single operational amplifier. A feedback resistor of 200 kΩ is used.

Draw a labelled circuit of the operational amplifier and calculate the output voltage. (6)

5.3 Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (5.3.1 – 5.3.2) in the ANSWER BOOK.

5.3.1 … is a mathematical process for determining the rate of change of a function.

A Integration
B Differentiation
C Comparison
D Summing (2)

5.3.2 The operational amplifier of which the gain is always more than one, is the …

A integrator.
B invertor.
C comparator.
D non-invertor. (2)

**[15]**

## QUESTION 6

6.1 Draw a neat, labelled diagram and explain how a diac and a traic can be used to control the speed of a small AC fan motor. (8)

6.2 Demonstrate, with the aid of labelled characteristic curves, the principle of operation of the following thyristors:

6.2.1 Silicon Controlled Rectifier

6.2.2 Diac

(3 x 2) (6)

6.3 What effect will the gate current have on the anode current after an SCR has been turned on? (1)

**[15]**



 

## QUESTION 7

7.1 Discuss, with the aid of a sketch, the operation of a Bourdon tube used to measure angular displacement. (5)

7.2 Name THREE factors which will influence the capacitance of a capacitive transducer. (3)

7.3 What is the function of the compensation gauge in the strain gauge? (2)
**[10]**

## QUESTION 8

8.1 An oscilloscope with a calibrated time base is used to measure the frequency of an oscillator.

If the time/cm control is set at 100 µs/cm and the width of one cycle of the sine wave is 4 cm, calculate the frequency of the oscillator (4)

8.2 Draw a neat, labelled block diagram of a function generator. (6)
**[10]**

**TOTAL: 100**

# INDUSTRIAL ELECTRONICS N4

## FORMULA SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



 

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

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

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

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

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

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

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

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

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



 

*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.*