higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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NOVEMBER EXAMINATION

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N4

(8080164)

17 November 2016 (X-Paper)
09:00–12:00

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

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. Start each question on a NEW page.
5. ALL the calculations must be shown.
6. ALL final answers must be round-off accurately to THREE decimal places.
7. Write neatly and legibly.

QUESTION 1

Use Kirchhoff's method to determine the current flowing through resistor R_L in FIGURE 1 below.

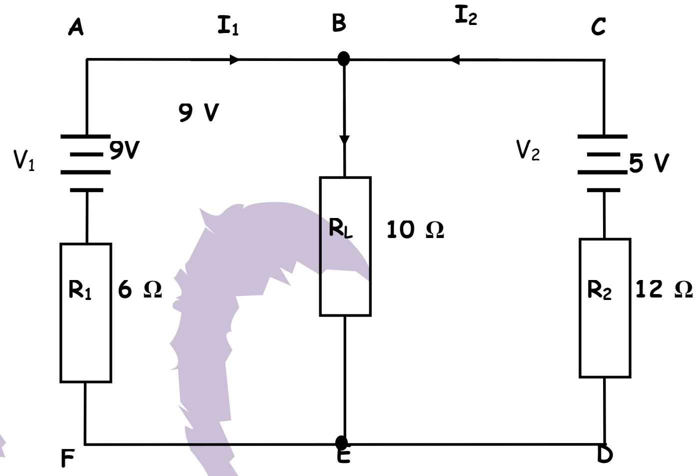

FIGURE 1 **[10]**

QUESTION 2

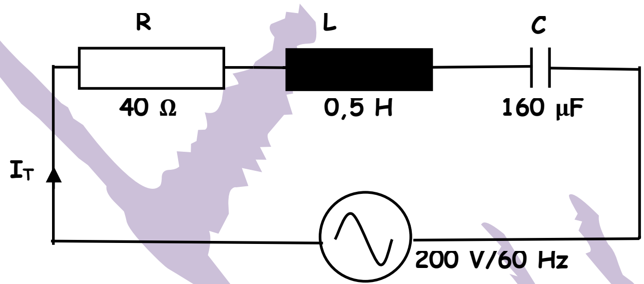

FIGURE 2

Consider FIGURE 2 above and use complex numbers to calculate the following:

2.1 Total impedance of the circuit (4)

2.2 Current flowing in the circuit (2)

2.3 Voltage drop across the inductor (2)

2.4 Voltage drop across the capacitor (2)
[10]

QUESTION 3

3.1 Draw a simple Zener diode voltage regulator circuit and explain how the load can be kept constant. (6)

3.2 The output voltage across the first capacitor of an LC π-filter full-wave rectifier is 100 V DC with a 10 V ripple at a frequency of 100 Hz. If L = 2 H, R = 100 Ω, C_2 = 10 μF and the filter is connected to a 5 kΩ load, calculate the following:

3.2.1 DC output voltage (2)

3.2.2 Ripple output voltage (3)

3.2.3 Ripple factor across the first capacitor (2)

3.2.4 Ripple factor across the second capacitor (2)

[15]

QUESTION 4

4.1 Draw a neat push-pull amplifier circuit which uses two NPN transistors. Clearly show the output waveforms. (5)

4.2 Explain each of the following regions in terms of how the junctions are biased and the uses thereof:

4.3.1 Cut-off region

4.3.2 Active/linear region

4.3.3 Saturation region

(3 × 2) (6)

4.3 Explain, with aid of a labelled circuit diagram, how negative feedback is achieved. (4)

[15]

QUESTION 5

5.1 THREE different input voltages of 2 V, 4 V and 1,2 V and input resistance of 150 kΩ, 200 kΩ and 500 kΩ respectively, must be added by means of a single operational amplifier. A feedback resistor of 300 kΩ is used.

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

5.2 Name FIVE advantages of operational amplifiers. (5)

5.3 Draw the output wave forms of the following operational amplifiers when a 720° input sine wave is used:

5.3.1 Non-inverter

5.3.2 Differentiator

(2 × 2) (4)

[15]

QUESTION 6

6.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (6.1.1–6.1.5) in the ANSWER BOOK.

6.1.1 When the SCR is on, a low resistance exists between the anode and cathode and large currents can flow from the anode to the cathode.

6.1.2 The minimum current needed to keep an SCR on is called a holding current.

6.1.3 When the DIAC switches on the voltage across its terminals increases.

6.1.4 The TRIAC can only fire in one direction.

6.1.5 The LASCR is more sensitive to light when the gate terminal is open. (5 x 1) (5)

6.2 State THREE methods of switching an SCR off. (3)

6.3 Explain with the aid of a block diagram what will happen if the load in the closed-loop system is suddenly decreased. (7)
[15]

QUESTION 7

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

7.2 Explain, with the aid of a neat, labelled circuit diagram, the principle of operation of a light-dependent resistor. (7)
[10]

QUESTION 8

8.1 Draw a neat, labelled block diagram of a function generator. (5)

8.2 Name FIVE sections that the cathode-ray tube is divided into. (5)
[10]

TOTAL: 100

INDUSTRIAL ELECTRONICS N4

FORMULA SHEET

NOTE: Any applicable formula may also be used.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Static current gain $\quad s = \dfrac{I_{out/uit}}{I_{in}}$

Dynamic current gain $\quad = \dfrac{\Delta I_{out/uit}}{\Delta I_{in}}$

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

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

Static voltage gain $\quad = \dfrac{V_{out} / V_{uit}}{V_{in}}$

Dynamic voltage gain $\quad = \dfrac{\Delta V_{out/uit}}{\Delta V_{in}}$

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

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

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

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

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

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

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

Electron charge = 1,6 × 10^{-19} C