higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N3

(8080613)

27 July 2021 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 8 pages, 1 formula sheet and 1 answer sheet.

046Q1G2127

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
INDUSTRIAL ELECTRONICS N3
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 section on a new page.
5. Only use a black or blue pen.
6. All the final answers must be approximated accurately to THREE decimal places.
7. Use π = 3,142.
8. Write neatly and legibly.

SECTION A

QUESTION 1

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 (1.1–1.5) in the ANSWER BOOK.

1.1 A circuit that provides an entirely positive or negative output voltage when an AC input voltage is applied is called a(n) …

A half-wave rectifier.
B full-wave rectifier.
C filter capacitor.
D Zener diode.

1.2 Which of the following is a disadvantage of using a bridge rectifier rather than a two-diode full-wave rectifier?

A The bridge rectifier requires a centre tapped transformer
B Total volt drop in diodes is double, leading to more losses
C The output waveform has ripples
D It has a lower degree of reliability

1.3 What diodes are doped with elements such as gallium, arsenic, and phosphorus and emit different colours of light?

A LEDs
B Photoconductors
C Photoresistors
D Photocells

1.4 What diode is optimised for operation in the breakdown region and is often used as a voltage regulator?

A Silicon rectifier
B Light emitting
C Zener
D Tunnel

1.5 Semiconductors with other atoms mixed in are called …

A intrinsic semiconductors.
B extrinsic semiconductors.
C pure semiconductors.
D covalent semiconductors.

(5 × 1) **[5]**

QUESTION 2

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (2.1–2.5) in the ANSWER BOOK.

2.1 A semiconductor is a material that is neither a good conductor nor a good insulator.

2.2 The semiconductor element, carbon, is mainly used in the production of diodes.

2.3 FETs may be used as both analogue and logical switches.

2.4 Electrostatic fields are used to position the electron beam of an oscilloscope.

2.5 To turn an SCR off, simply remove the gate voltage.

(5 × 1) **[5]**

QUESTION 3

Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–J) next to the question number (3.1–3.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
3.1	Specially fabricated diode with a proper impurity concentration profile and operated under reverse-biased to give a variable junction capacitance.	A	drift current
		B	varactor
		C	breakdown voltage
3.2	Maximum energy that an electron in a metal has at absolute zero temperature.	D	zener diode
3.3	Steady flow of electrons in one direction caused by an applied electric field constitutes an electric current.	E	operational amplifier
		F	fermi level
3.4	Reverse voltage at which a p-n junction breaks down with a sudden rise in reverse current.	G	collector-emitter voltage
		H	light emitting diode
3.5	Multi-stage, very high gain, direct-coupled, negative-feedback device that uses voltage shunt feedback to provide a stabilised voltage gain.	I	diffusion current
		J	forward voltage

(5 × 1) **[5]**

QUESTION 4

Give ONE word or term for each of the following descriptions by choosing a word or a term from the list below. Write only the word or term next to the question number (4.1–4.5) in the ANSWER BOOK.

free electrons; three; negative; N-type; common emitter; holes; zero; four; common base; P-type, positive, two

4.1 For current to flow through a diode, the positive terminal of the power supply must be connected to the … material.

4.2 The most commonly used transistor arrangement is a … arrangement.

4.3 An SCR has … PN junctions.

4.4 A semiconductor has …. temperature coefficient of resistance.

4.5 Addition of pentavalent impurity to a semiconductor creates many … .

(5 × 1) **[5]**

TOTAL SECTION A: 20

SECTION B

QUESTION 5

FIGURE 1 below shows a series-parallel DC circuit consisting only of resistors and a power supply. Use Kirchhoff's laws to answer the questions that follow.

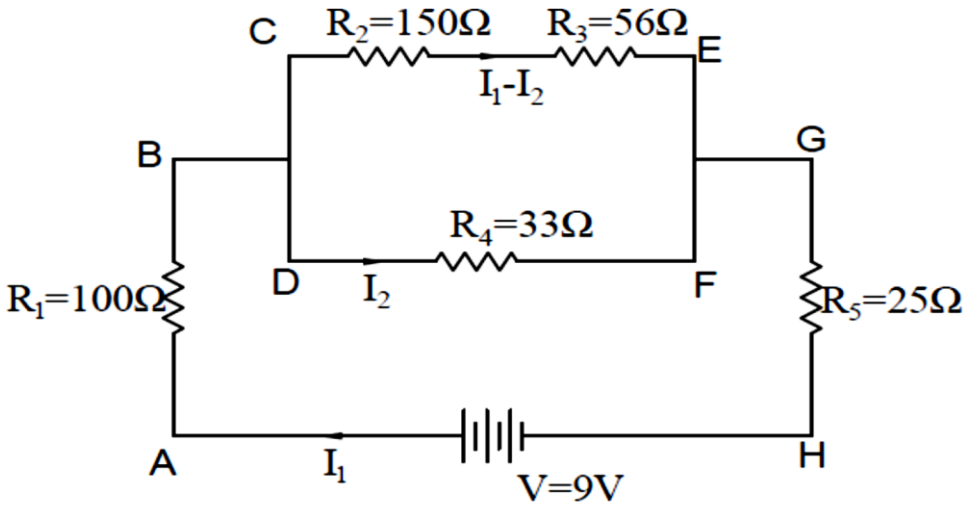

FIGURE 1

5.1 Determine the equation for loop 1 (ABDFGH) (2)

5.2 Determine the equation for loop 1 (ABCEGH) (2)

5.3 Determine the unknown currents I_1, I_2 and (I_1-I_2) (8)

[12]

QUESTION 6

FIGURE 2 below shows a parallel RLC circuit. Referring to the circuit, answer the questions that follow.

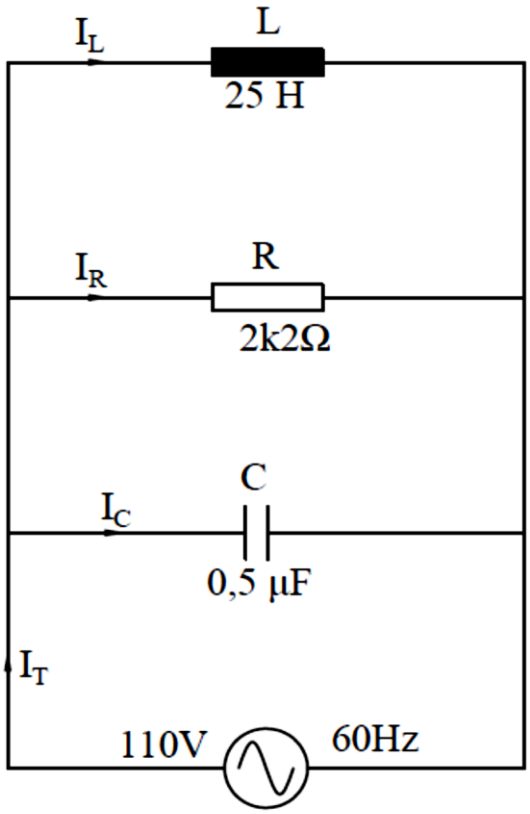

FIGURE 2

6.1 Calculate the current flowing through the inductor. (4)

6.2 Calculate the current flowing through the capacitor. (4)

6.3 Calculate the current flowing through the resistor. (2)

6.4 Calculate the total current. (3)

6.5 Calculate the phase angle. (2)

[15]

QUESTION 7

7.1 Oscilloscopes and televisions require high voltages for the cathode ray tubes to operate. These type of voltages are generated by voltage multipliers.

Draw a neat, labelled circuit diagram of a half-wave voltage doubler. (3)

7.2 Optocouplers are sometimes used as optic switches.

Draw a neat labelled circuit diagram of optocouplers used as switches. (2)

[5]

QUESTION 8

8.1 When a transistor is used as an amplifier, it can be connected in three basic amplifier configurations.

Name FOUR characteristics of a common-base amplifier configuration. (4)

8.2 FIGURE 3 below shows a common emitter amplifier. Refer to FIGURE 3 and answer the questions that follow.

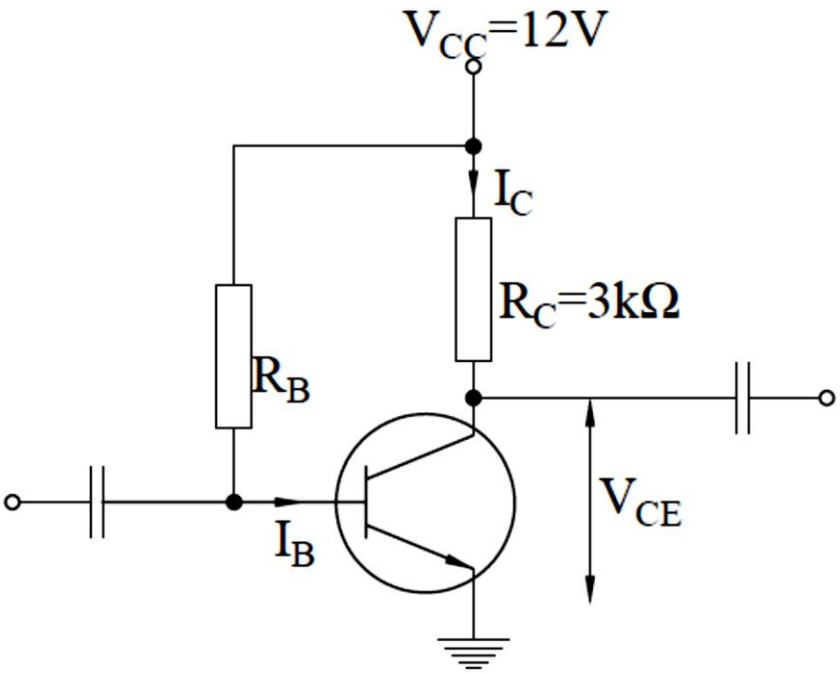

FIGURE 3

8.2.1 Calculate the collector current (I_C). (2)

8.2.2 Use the characteristic curve on the ANSWER SHEET (attached) to draw the load line for the amplifier. (2)

8.2.3 Indicate a suitable Q-point on the DC load line for the amplifier to act as a Class-B amplifier. (1)

8.3 Negative feedback is used to improve the performance of an amplifier.

Name FOUR of these improvements. (4)

8.4 MOSFETs differ from JFETs in the way in which the gate terminal is insulated from the channel. Answer the questions below regarding MOSFETs

8.4.1 Draw the IEC symbol for an N-channel depletion MOSFET.

8.4.2 Draw the IEC symbol for a P-channel enhancement MOSFET.

(2 × 2) (4)

[17]

QUESTION 9

9.1 A frequency counter measures an unknown frequency by counting the number of cycles of the unknown signal.

Draw a neat labelled block diagram of a frequency counter. (4)

9.2 Voltmeters can measure unknown voltages by using different methods.

Describe the operation of the continuous balance. (5)
[9]

QUESTION 10

10.1 Name THREE areas where the potentiometer can be used as a transducer. (3)

10.2 Describe the operating principle of the linear variable differential transformer (LVDT). (2)

10.3 Draw the IEC symbol for a negative temperature coefficient thermistor. (1)

10.4 Name TWO areas of application of a photo voltaic cell. (2)
[8]

QUESTION 11

11.1 Draw a neat labelled circuit diagram of the inverting operational amplifier. (2)

11.2 Draw the output wave form of the integrator if the input is a sine wave. (2)

11.3 Draw a neat, labelled circuit diagram of the non-inverting operational amplifier. (2)
[6]

QUESTION 12

12.1 In full wave control the load current flows in both half cycles.

Draw a neat labelled sketch of a back-to-back full-wave control circuit. (3)

12.2 Phase control is achieved by controlling the time at which the SCR is switched on.

Draw a neat labelled output wave form to illustrate *phase control*. (2)

12.3 Describe the difference between *line commutation* and *forced commutation*. (2)

12.4 Name ONE method to suppress transients. (1)
[8]

TOTAL SECTION B: 80
GRAND TOTAL: 100

INDUSTRIAL ELECTRONICS N3

FORMULA SHEET

Direct-current theory

$V = I \cdot R$ $\quad P = V \cdot I$ $\quad P = \frac{V^2}{R}$

$P = I^2 \cdot R$

Alternating-current theory

$X_L = 2\pi fL$ $\quad X_C = \frac{1}{2\pi fC}$ $\quad Z = \sqrt{R^2 + (X_L \sim X_C)^2}$

$V_T = \sqrt{V_R^2 + (V_L \sim V_C)^2}$ $\quad I = \frac{V_T}{Z}$ $\quad \theta = \cos^{-1}\frac{R}{Z}$

$V = I \cdot R$ $\quad V = I \cdot X_L$ $\quad V = I \cdot X_C$

$f_r = \frac{1}{2\pi\sqrt{LC}}$ $\quad I_R = \frac{V_T}{R}$ $\quad I_L = \frac{V_T}{X_L}$

$I_C = \frac{V_T}{X_C}$ $\quad I_T = \sqrt{I_R^2 + I_X^2}$ $\quad I_X = I_L \sim I_C$

$\theta = \tan^{-1}\frac{I_X}{I_R}$ $\quad \theta = \cos^{-1}\frac{I_R}{I_T}$ $\quad Z = \frac{V}{I_T}$

$Z_D = \frac{L}{RC}$ $\quad I_T = \frac{V}{Z_D}$ $\quad f_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$

$I_C = I_{RL}\ Sin\theta_L$ $\quad I_T = I_{RL}\ Cos\theta_L$ $\quad I_T = \sqrt{{I_{T_H}}^2 + {I_{T_V}}^2}$

Transistors

$I_C = \frac{V_{CC}}{R_L}$

Transducers

$R = \frac{\rho \cdot l}{a}$ $\quad C = \frac{k \cdot A \cdot E_o}{d}$

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EXAMINATION NUMBER: | | | | | | | | | | | | | |