higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N3

(8080613)

1 April 2020 (X-paper)
09:00–12:00

This question paper consists of 9 pages and 1 formula sheet.

046Q1A2001

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. Round off all answers to THREE decimals.
6. Use π = 3,142.
7. Work neatly.

SECTION A

QUESTION 1

1.1 Various options are given as possible answers to the following questions. Choose the correct answer and write only the letter (A–D) next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 The forbidden energy gap for an insulator is …

A large.
B nonexistent.
C small.
D overlapping.

1.1.2 The output waveform of a … clipper consists only of the negative half of the input waveform.

A negative series or positive shunt
B positive series or positive shunt
C negative shunt or negative series
D positive shunt or negative shunt

1.1.3 A three-terminal field-effect transistor consists of a …

A gate, anode and source.
B gate, drain and cathode.
C gate, anode and cathode.
D gate, drain and source.

1.1.4 ONE of the following is a significant characteristic of an operational amplifier:

A Low-input impedance
B Low-output impedance
C Low-voltage gain
D Narrow bandwidth

1.1.5 ONE of the following transducers can be used to measure torque:

A Photovoltaic cell
B Thermistor
C Strain gauge
D Photoconductive cell

(5 × 1) (5)

1.2 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (1.2.1–1.2.5) in the ANSWER BOOK.

1.2.1 Response time is the time the meter takes to give an accurate reading.

1.2.2 Kirchhoff's current law is applicable to parallel circuits.

1.2.3 The current is a maximum in a RLC parallel circuit at resonance.

1.2.4 There are more holes than electrons in a P-type material.

1.2.5 Current can flow in both directions in a varactor diode.

(5 × 1) (5)

1.3 Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–H) next to the question number (1.3.1–1.3.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.3.1	Minimum current required to hold the SCR in its conducting state	A	diffusion current
1.3.2	Device that converts a nonelectrical physical quantity to an electrical signal	B	transducer
1.3.3	Measure of degree to which successive measurements differ from one another	C	open loop
1.3.4	Movement of charges of the same type from a high concentration of free charge carriers to a low concentration of free carriers.	D	holding current
1.3.5	Signal of monitored output of amplifier is fed back to the input	E	precision
		F	closed loop
		G	drift current
		H	resolution

(5 × 1) (5)

1.4 Choose ONE term from the list below for each of the following descriptions and write it next to the question number (1.4.1–1.4.5) in the ANSWER BOOK.

Reverse biased; differentiator; leads; negative temperature coefficient; J-FET; forward biased; integrator; positive temperature coefficient; MOSFET; lags

1.4.1 In this transistor the gate terminal is isolated from the channel.

1.4.2 The output voltage of this operational amplifier is related to the rate at which the input voltage changes at that particular instant.

1.4.3 This type of thermistor resistance decreases with the increase in temperature.

1.4.4 This is what the current and the voltage in a parallel RCL circuit does in a resonance circuit.

1.4.5 The depletion layer is small when a PN-junction is in this state.

(5 × 1) (5)

[20]

TOTAL SECTION A: 20

SECTION B

QUESTION 2

2.1 Study the circuit in FIGURE 1 and answer the questions.

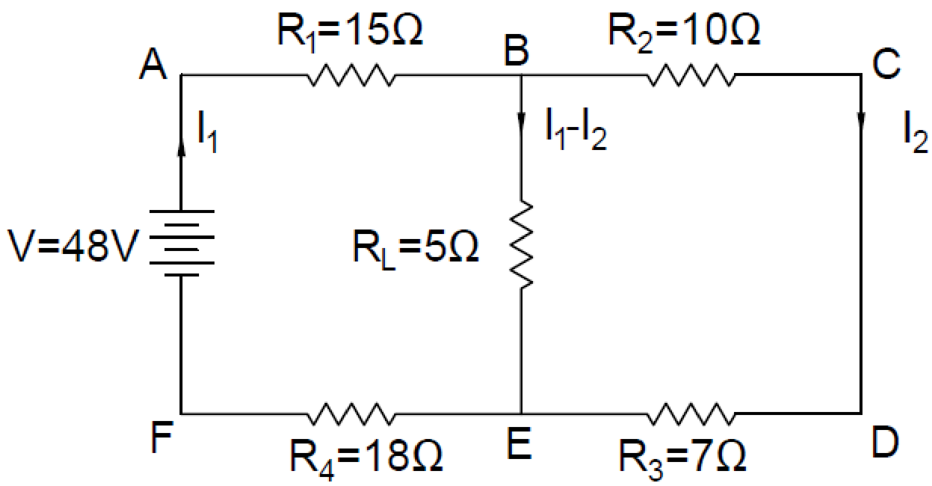

FIGURE 1

2.1.1 Use Kirchhoff's law to determine the current flow through resistor R_L. Consider loops ABEFA and ABCDEFA. (9)

2.1.2 Calculate the power in R_L. (2)

2.2 Study FIGURE 2, which comprises a coil and a capacitor, and answer the questions.

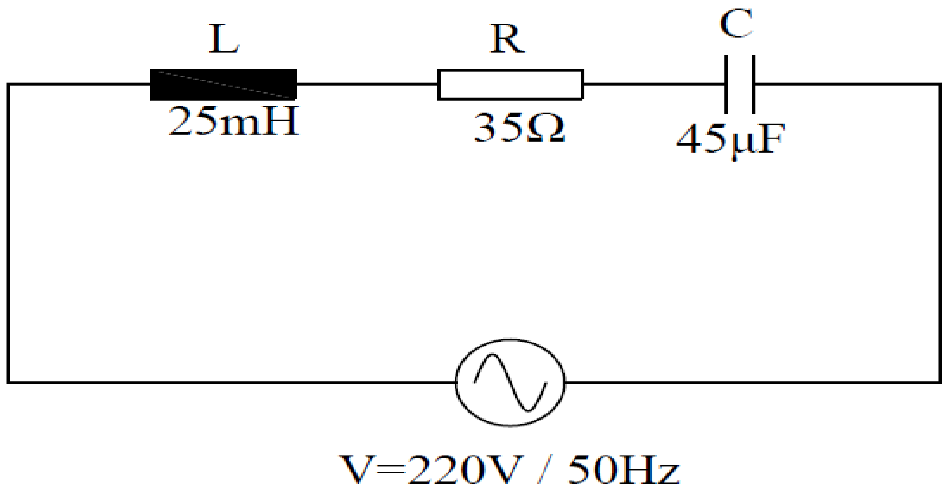

FIGURE 2

Calculate each of the following:

2.2.1 Total impedance of circuit (6)

2.2.2 Total current of circuit (2)

2.2.3 Voltage over coil (4)

2.2.4 Voltage over capacitor (2)
[25]

QUESTION 3

3.1 Draw neat, labelled sketches of each of the following:

3.1.1 Ionic bonds

3.1.2 Covalent bonds

(2 × 2) (4)

3.2 Fermi-levels are a convenient way of indicating the relative distribution of charge carriers in different materials.

Draw neat, labelled fermi-levels of each of the following materials:

3.2.1 P-type material

3.2.2 N-type material

(2 × 2) (4)

3.3 Data sheets provide important parameters of Zener diodes.

Define each of the following parameters you would find on a data sheet:

3.3.1 Zener current (I_Z)

3.3.2 Reference voltage (V_Z)

(2 × 2) (4)

3.4 Describe the working principle of a photo diode. (2)

3.5 Draw a neat, labelled circuit diagram of an inverting operational amplifier. (3)

3.6 Operational amplifiers use different configurations.

State the use of a voltage follower. (1)

3.7 Draw the output waveform of an integrator operational amplifier if a sinusoidal wave is applied to it. (2)

[20]

QUESTION 4

4.1 FIGURE 3 shows a common-emitter amplifier.

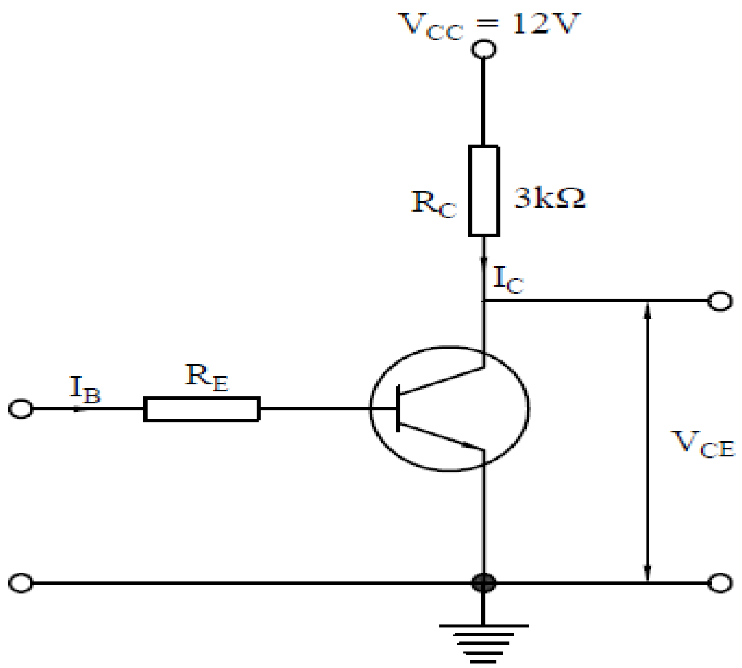

FIGURE 3

4.1.1 Calculate the value of the collector current (I_C). (2)

4.1.2 FIGURE 4 shows a characteristic curve of the common-emitter amplifier.

Copy the curve in the ANSWER BOOK and plot the DC load line of the circuit. Use scale 1V = 1cm and 1mA = 2 cm.

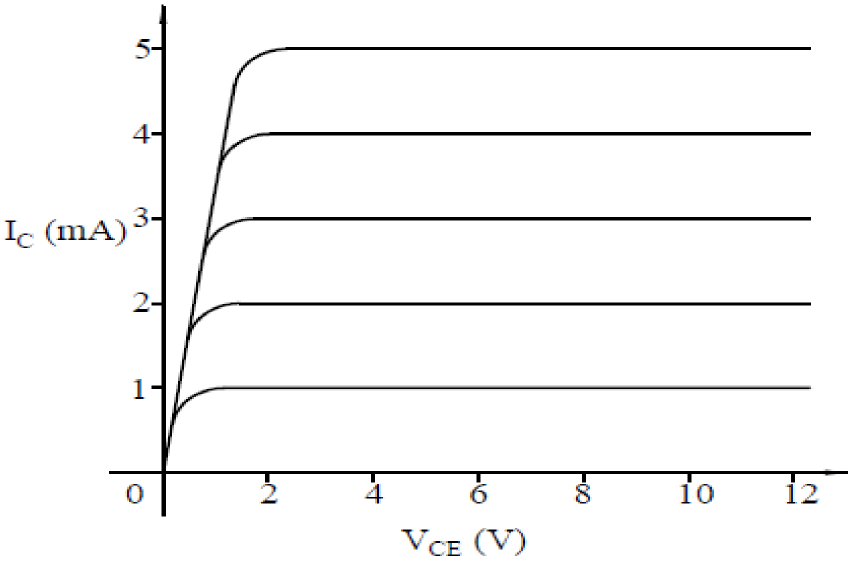

FIGURE 4 (2)

4.2 Make a neat, labelled drawing of an RC-coupled transistor amplifier. (4)

4.3 A field-effect transistor is basically a semiconductor resistor with the value of the resistance being controlled by the potential applied to the control electrode.

Draw each of the following IEC symbols:

4.3.1 P-channel enhanced MOSFET.

4.3.2 N-channel JFET.

(2 × 2) (4)

4.4 Draw a neat, labelled block diagram of a successive approximation digital voltmeter. (6)

4.5 Explain the purpose of the deflection plates in the cathode-ray tube. (2)
[20]

QUESTION 5

5.1 FIGURE 5 below shows a linear variable transformer (LVDT).

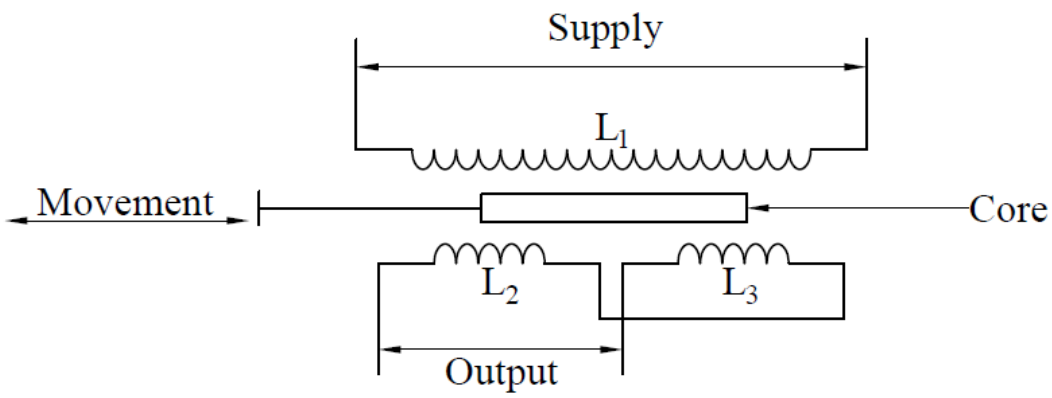

FIGURE 5

5.1.1 Describe the operating principle of the LVDT. (3)

5.1.2 Name TWO applications which use an LVDT. (2)

5.2 Name TWO applications of a piezo-electrical crystal. (2)

5.3 Draw a neat, labelled circuit diagram of a full-wave control SCR circuit to achieve phase control. (4)

5.4 Describe *commutation.* (2)

5.5 Name TWO types of commutation. (2)
[15]

TOTAL SECTION B: 80
GRAND TOTAL: 100

INDUSTRIAL ELECTRONICS N3

FORMULA SHEET

Direct-current theory

$V = I \cdot R$

$P = V \cdot I$

$P = \frac{V^2}{R}$

$P = I^2 \cdot R$

Alternating-current theory

$X_L = 2\pi fL$

$X_C = \frac{1}{2\pi fC}$

$Z = \sqrt{R^2 + (X_L \sim X_C)^2}$

$V_T = \sqrt{V_R^2 + (V_L \sim V_C)^2}$

$I = \frac{V_T}{Z}$

$\theta = \cos^{-1} \frac{R}{Z}$

$V = I \cdot R$

$V = I \cdot X_L$

$V = I \cdot X_C$

$f_r = \frac{1}{2\pi\sqrt{LC}}$

$I_R = \frac{V_T}{R}$

$I_L = \frac{V_T}{X_L}$

$I_C = \frac{V_T}{X_C}$

$I_T = \sqrt{I_R^2 + I_X^2}$

$I_X = I_L \sim I_C$

$\theta = \tan^{-1} \frac{I_X}{I_R}$

$\theta = \cos^{-1} \frac{I_R}{I_T}$

$Z = \frac{V}{I_T}$

$Z_D = \frac{L}{RC}$

$I_T = \frac{V}{Z_D}$

$f_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$

$I_C = I_{RL} \ Sin\theta_L$

$I_T = I_{RL} \ Cos\theta_L$

$I_T = \sqrt{{I_{T_H}}^2 + {I_{T_V}}^2}$

Transistors

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

Transducers

$R = \frac{\rho \cdot l}{a}$

$C = \frac{k \cdot A \cdot E_o}{d}$