higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T770**(E)**(J29)T

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N3

(8080613)

29 July 2019 (X-Paper)
09:00–12:00

Calculators may be used.

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

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. ALL calculations must be shown.
5. ALL the final answers must be approximated accurately to THREE decimal places.
6. Subsections of questions must be kept together.
7. Use $\pi = 3{,}142$
8. Write neatly and legibly.

SECTION A

QUESTION 1

1.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (1.1.1–1.1.10) in the ANSWER BOOK.

1.1.1 Kirchoff's second law states that the currents entering a point are equal to the current leaving that point.

1.1.2 In a capacitive circuit, current leads the voltage by 90°.

1.1.3 Resonance takes place in an RL circuit.

1.1.4 The nucleus of an atom consists of electrons and protons.

1.1.5 Avalanche breakdown applies to Zener diodes.

1.1.6 In an NPN transistor the holes are the majority charge carriers.

1.1.7 Cyclotronic control is a combination of the phase and the cycle control methods.

1.1.8 Intrinsic materials are sometimes referred to as pure materials.

1.1.9 A Zener diode conducts in both directions.

1.1.10 Sensitivity in measuring instruments refers to the time taken by the meter to provide a reading.

(10 × 1) (10)

1.2 Choose a description from COLUMN B that matches an item in COLUMN A. Write only the letter (A–J) next to the question number (1.2.1–1.2.10) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.2.1	Push-pull amplifier	A	forced commutation
1.2.2	Seven-segment display	B	magnetic field
1.2.3	Clipper	C	digital voltmeter
1.2.4	Piezo-electric transducer	D	dynamic impedance
1.2.5	Continuous balance	E	cathode-ray tube
1.2.6	SCR	F	741 DIL
1.2.7	Parallel RLC circuit	G	light-emitting diode
1.2.8	Operational amplifier	H	ultrasonic cleaning
1.2.9	Oscilloscope	I	class AB
1.2.10	Inductor	J	PN diode

(10)
[20]

TOTAL SECTION A: 20

SECTION B

QUESTION 2

Study FIGURE 1 and calculate the voltage as well as the power across resistor R_1 by using Kirchhoff's laws.

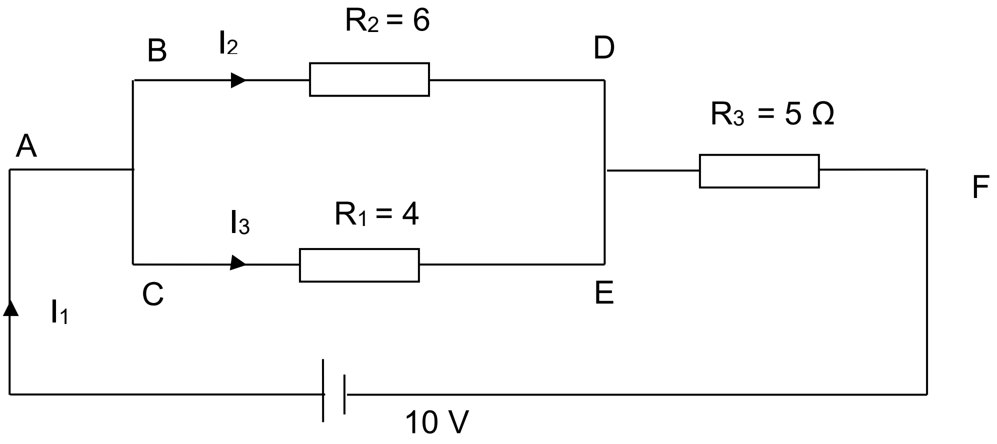

FIGURE 1 **[14]**

QUESTION 3

3.1 Refer to the circuit in FIGURE 2 and do the following calculations:

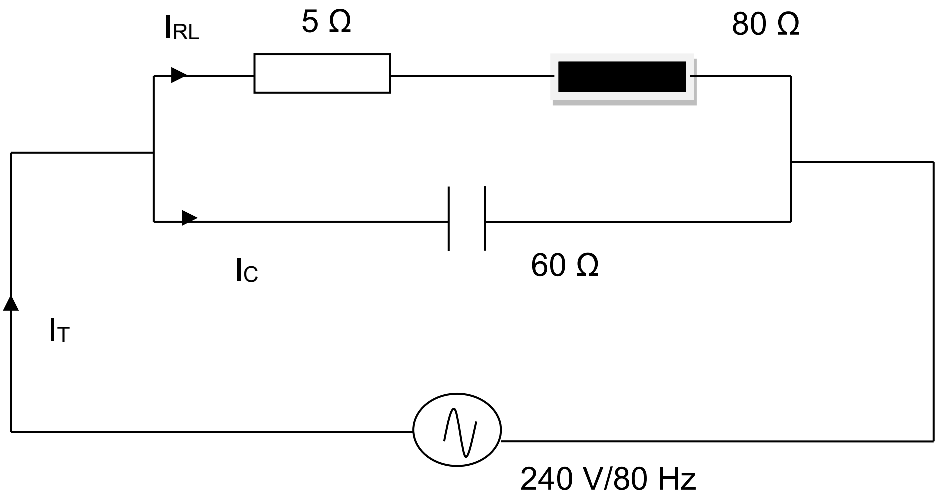

FIGURE 2

3.1.1 The current I_{RL} (3)

3.1.2 The current I_C (2)

3.1.3 The phase angle θ_L of the inductive branch (2)

3.2 If the circuit in FIGURE 2 is considered to be at resonance, calculate the following from the circuit:

3.2.1 The dynamic impedance (4)

3.2.2 The total current in the circuit (2)

3.2.3 The value of the current I_C at resonance (2)
[15]

QUESTION 4

4.1 Draw a neat, labelled circuit of a half-wave voltage doubler. (5)

4.2 Briefly describe the operation of the circuit in QUESTION 4.1 when a positive signal is applied to the input. (3)

4.3 Draw a neat, labelled characteristic curve of a varactor diode. (3)
[11]

QUESTION 5

5.1 State FOUR advantages of using a transistor as a switch instead of a conventional switch. (4)

5.2 Draw a neat, labelled frequency response graph of an RC coupling circuit. (4)
[8]

QUESTION 6

6.1 Draw a neat, labelled circuit diagram of an SCR by using transistors only. (4)

6.2 Briefly describe how the circuit mentioned in QUESTION 6.1 operates when a positive signal is applied on the gate terminal. (4)

6.3 State THREE advantages of an SCR. (3)
[11]

QUESTION 7

7.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (7.1.1–7.1.3) in the ANSWER BOOK.

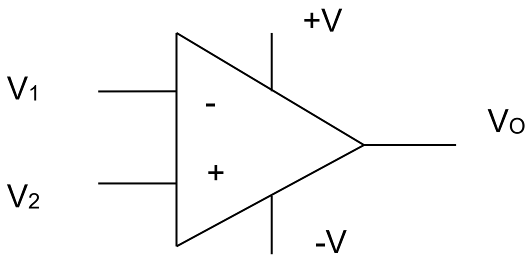

FIGURE 3

7.1.1 In FIGURE 3, if $V_1 > V_2$ then V_O will be positive.

7.1.2 In FIGURE 3, if $V_1 < V_2$ then V_O will be negative.

7.1.3 The operational amplifier can also be called a differential amplifier.
(3 × 1) (3)

7.2 Draw a neat, labelled circuit diagram of an LVDT inductive transducer. (4)

7.3 Describe the operation of the circuit mentioned in QUESTION 7.2, if a force is applied to the core of the circuit. (4)
[11]

QUESTION 8

8.1 Refer to the block diagram of the oscilloscope shown in FIGURE 4 and name the parts labelled in the diagram, by writing only the answer next to the letter (**a**–**i**) in the ANSWER BOOK.

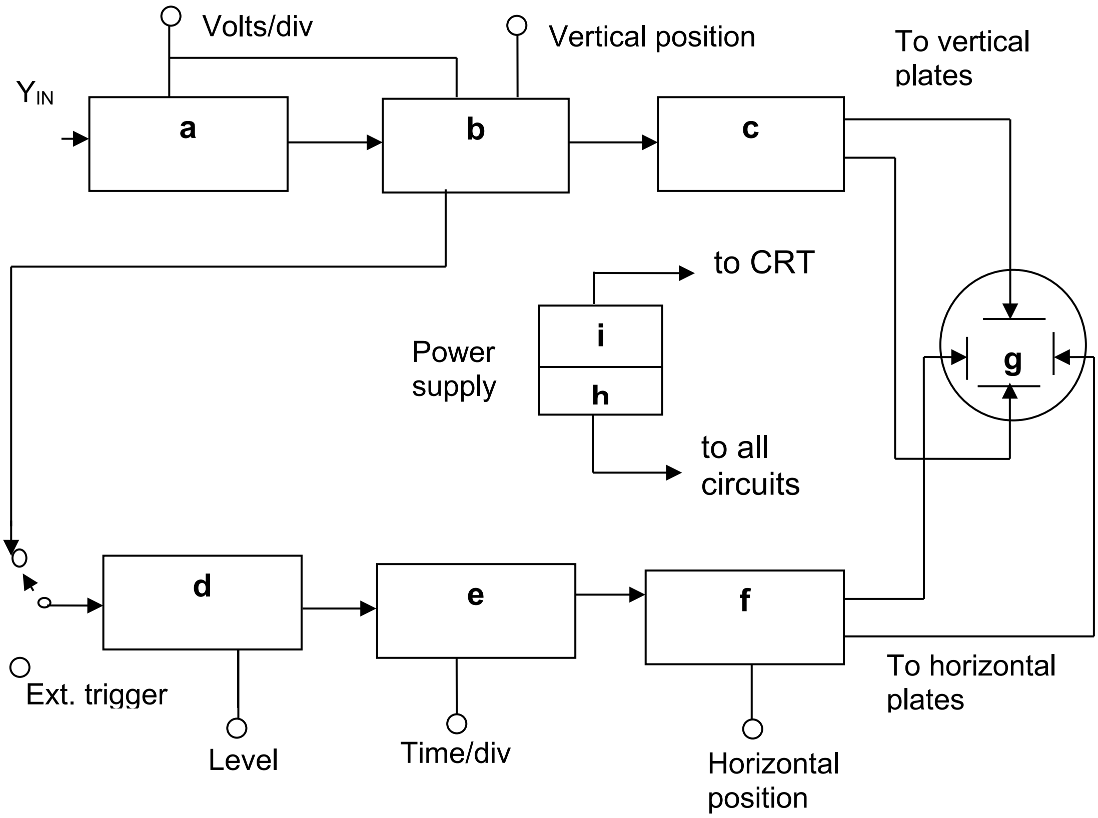

FIGURE 4 (9)

8.2 Describe the function of the part named (**a**) in FIGURE 4. (1)
[10]

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

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