higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T770**(E)**(M28)T

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N3

(8080613)

28 March 2018 (X-Paper)
09:00–12:00

Calculators may be used.

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

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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.

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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 laws are applied to DC circuits.

1.1.2 Kirchoff's second law refers to current.

1.1.3 The reactance of a capacitor increases with an increase in frequency.

1.1.4 The impedance of a parallel RLC circuit is at a minimum at resonance.

1.1.5 Elements with less than four valence electrons are called resistors.

1.1.6 The resistance of a pn-junction diode is high when the diode is forward biased.

1.1.7 LED's are used in seven-segment displays to form the segments.

1.1.8 The application of a transistor as a switch is a manual operation.

1.1.9 Gross errors in measuring instruments are also referred to as human errors.

1.1.10 An SCR is a four-layer semiconductor device.

(10 × 1) (10)

1.2 Choose the correct word or words from those given in brackets. Write only the word or words next to the question number (1.2.1–1.2.10) in the ANSWER BOOK.

1.2.1 The main advantage of an SCR is that it has a (high/low) control power.

1.2.2 Negative feedback is a process used to improve the performance of a circuit by (increasing/reducing) its gain.

1.2.3 Transition capacitance is due to the charge which exists in the depletion layer under a (forward/reverse) bias condition in a pn-diode.

1.2.4 The impedance of a parallel resonant circuit is at its (minimum/maximum) value.

1.2.5 An oscilloscope can be used to calculate the value of the (current/voltage).

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1.2.6 The resistance of an NTC thermistor is (directly/inversely) proportional to temperature.

1.2.7 When both inputs of an operational amplifier are equal, the output will be (one/zero).

1.2.8 (Line/Forced) commutation is applied in SCR's when an AC supply is used.

1.2.9 *Open loop* refers to a system whose output is (monitored/-unmonitored).

1.2.10 (Kirchhoff's/Ohm's) law states that the current entering a point equals the sum of the currents leaving that point.

(10 × 1) (10)
[20]

TOTAL SECTION A: 20

SECTION B

QUESTION 2

Study FIGURE 1 below and calculate the value of the current I_3 in the circuit, by making use of Kirchoff's laws.

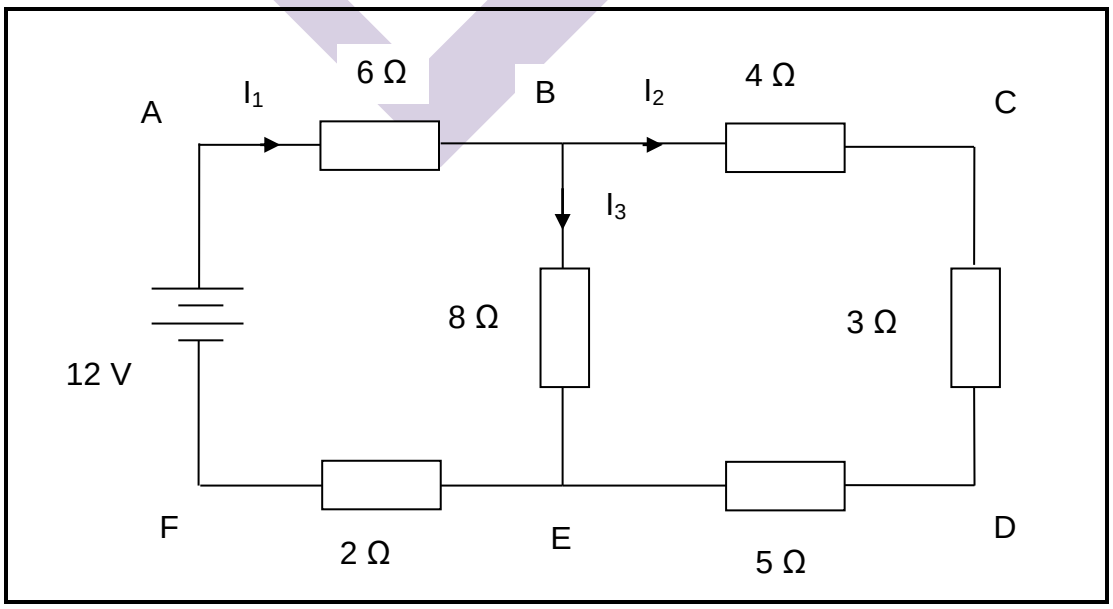


FIGURE 1

[10]

QUESTION 3

3.1 Refer to the circuit in FIGURE 2 below and answer the questions.

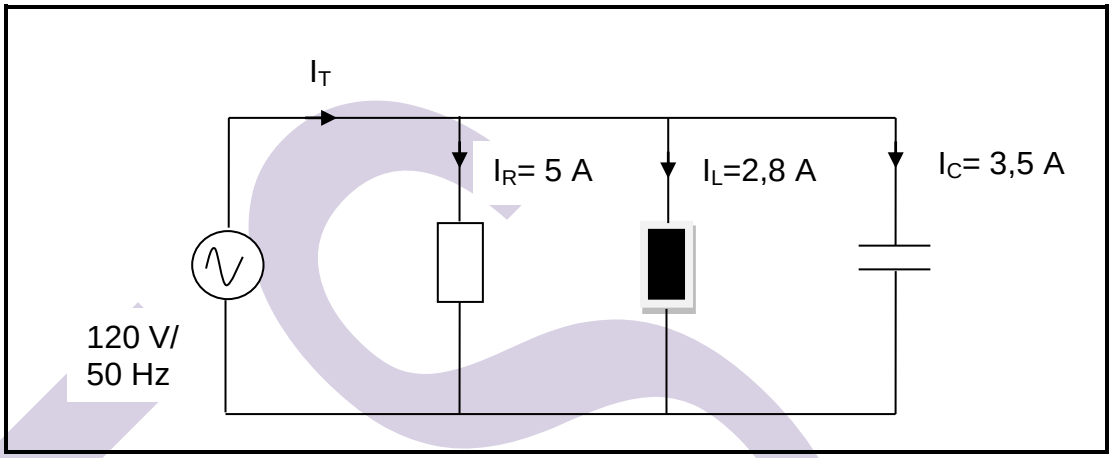


FIGURE 2

Calculate the following from the circuit:

3.1.1 The total current of the circuit (3)

3.1.2 The phase angle θ (2)

3.1.3 The capacitance of the capacitor in µF (4)

3.1.4 The inductance of the inductor in mH (4)

3.1.5 The resistance value of the resistor (2)

3.2 Draw the phasor diagram of the circuit in FIGURE 2. (3)
[18]

QUESTION 4

4.1 Briefly describe the process of acceptor doping as applied to atomic theory. (4)

4.2 Make a neat, labelled sketch to indicate the width of the energy gap of an insulator material. (3)

4.3 Describe the operation of a negative shunt clipper when the positive signal is applied to the circuit. (3)
[10]

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QUESTION 5

5.1 Draw a neat circuit of a shunt positive clipper and indicate the output waveform if an AC signal is applied on the input. (3)

5.2 State the mode of bias in which a varactor diode conducts. (1)

5.3 State the type of diode that you would use to keep the output voltage stable and regulated. (1)

5.4 State the mode that you would use to bias the diode in QUESTION 5.3 above to obtain a constant voltage on the output. (1)

5.5 Draw a neat circuit using the diode in QUESTION 5.3 which will ensure a regulated and stable output voltage. (3)
[9]

QUESTION 6

6.1 State FOUR advantages of *negative feedback* as used with amplifiers. (4)

6.2 Draw a neat circuit diagram of a series voltage regulator which uses an NPN transistor and a Zener diode. (4)

6.3 Explain how an SCR can be turned on by applying a breakover voltage switching-on method. (3)
[11]

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QUESTION 7

7.1 Briefly describe how an LC-filter method is used to *suppress* transients in SCR's. (3)

7.2 Draw a neat circuit which you will use to switch off an SCR. The circuit must use an NPN transistor which will reduce the current to be below the holding point of an SCR. (3)

7.3 Study FIGURE 3 below and answer the questions.

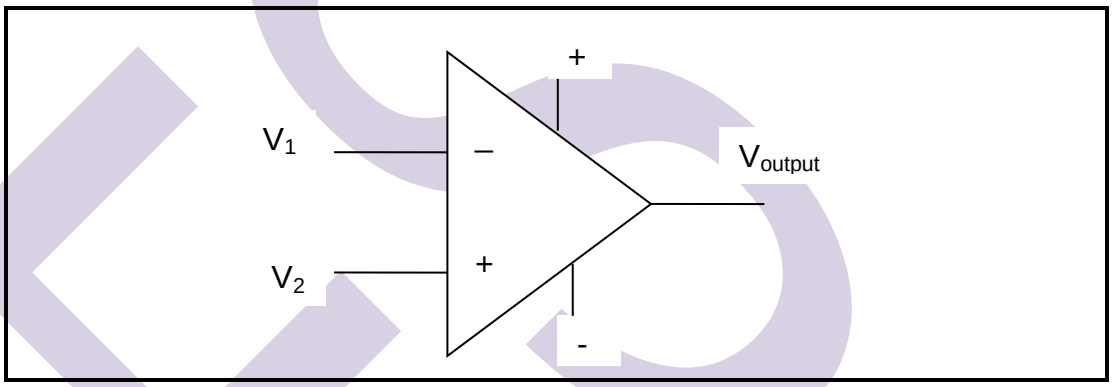


FIGURE 3

State the type of *output* expected in each of the following cases:

7.3.1 If V_1 is greater than V_2

7.3.2 If V_2 is greater than V_1

7.3.3 If V_1 equals V_2

(3 × 2) (6)
[12]

QUESTION 8

The type of dielectric material can affect the capacitance of a capacitor. Refer to FIGURE 4a and FIGURE 4b below and answer the questions with reference to capacitive transducers.

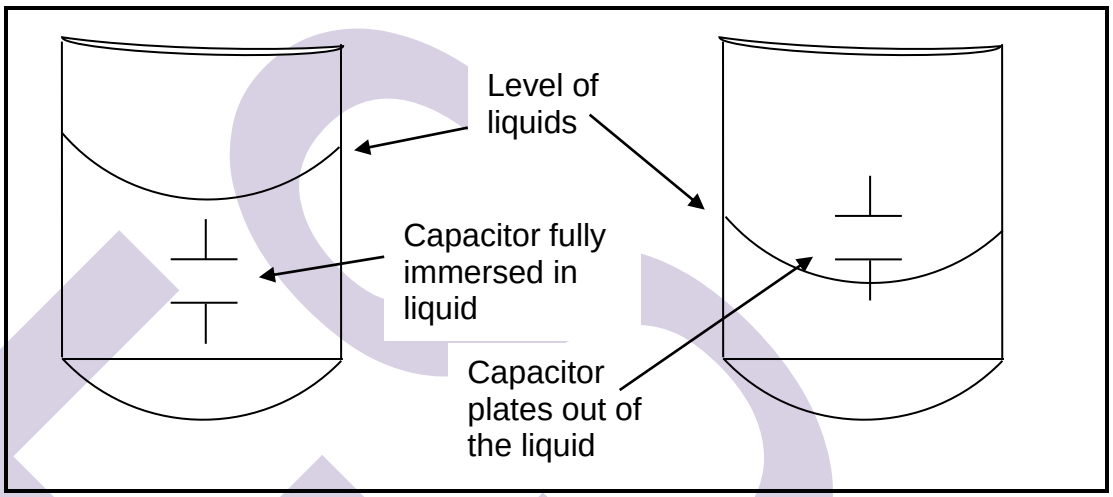


FIGURE 4a **FIGURE 4b**

8.1 Explain the effect which the level of the liquid in FIGURE 4a will have towards the capacitance of the capacitor.

8.2 Explain the effect which the level of the liquid in FIGURE 4b will have towards the capacitance of the capacitor.

(2 × 2) **[4]**

QUESTION 9

An AC waveform is displayed on the screen of an oscilloscope and it shows that it fits into eight blocks from the positive peak to the negative peak. One cycle of this waveform is completed to fit into six blocks horizontally. The peak-to-peak voltage and the period of the waveform are 1,6 V and 60 µs respectively.

Calculate the following:

9.1 The volts/div setting of the oscilloscope

9.2 The time/div setting of the oscilloscope

9.3 The RMS value of the waveform

(3 × 2) **[6]**

TOTAL SECTION B: 80
GRAND TOTAL: 100

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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:

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

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