higher education
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Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T770**(E)**(M29)T

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N3

(8080613)

29 March 2019 (X-Paper)
09:00–12:00

Calculators may be used.

This question paper consists of 7 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. Show ALL calculations.
5. Approximate ALL final answers accurately to THREE decimal places.
6. Keep subsections of questions together.
7. Use $\pi = 3{,}142$
8. Write neatly and legibly.

SECTION A

QUESTION 1

Choose the correct word from those given in brackets. Write only the word next to the question number (1.1–1.10) in the ANSWER BOOK.

1.1 A series RLC circuit becomes (inductive/resistive) at resonance.

1.2 A silicon atom has (two/four) valence electrons.

1.3 The impedance of a parallel RLC circuit at resonance is called (inductive/dynamic) impedance.

1.4 The type of doping used to form the N-type material in atoms is called (acceptor/donor) doping.

1.5 The common base amplifier has a (low/high) input impedance.

1.6 The J-FET can only be operated in (enhancement/depletion) mode.

1.7 The resistance of a (PTC/NTC) thermistor is inversely proportional to the temperature.

1.8 In measuring instruments, the other name for human errors is (systematic/gross) errors.

1.9 A BJT operates as an amplifier in the (saturation/active) region.

1.10 Line commutation is applied to (DC/AC) power supply.

(10 × 1) **[10]**

TOTAL SECTION A: 10

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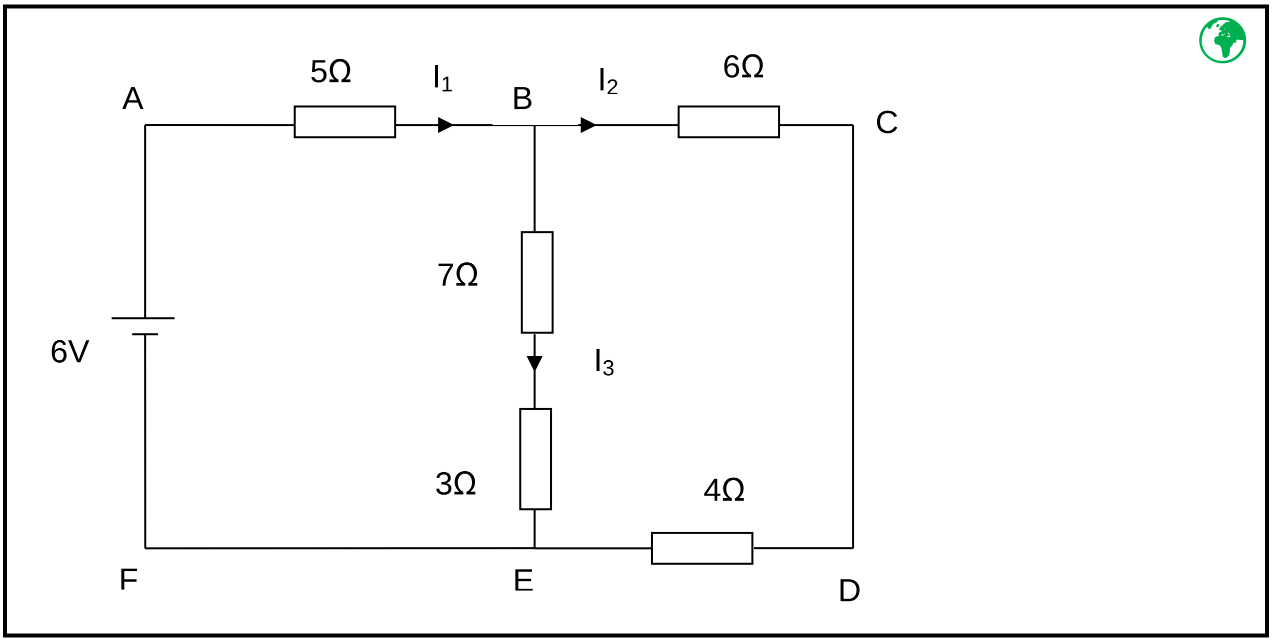
SECTION B

QUESTION 2

Study FIGURE 1 below and calculate the voltage across the 7 Ω resistor by using Kirchoff's laws. Use only Loop ABEFA and Loop CDEBC.



[12]

FIGURE 1

QUESTION 3

3.1 Refer to FIGURE 2 below and answer the questions.

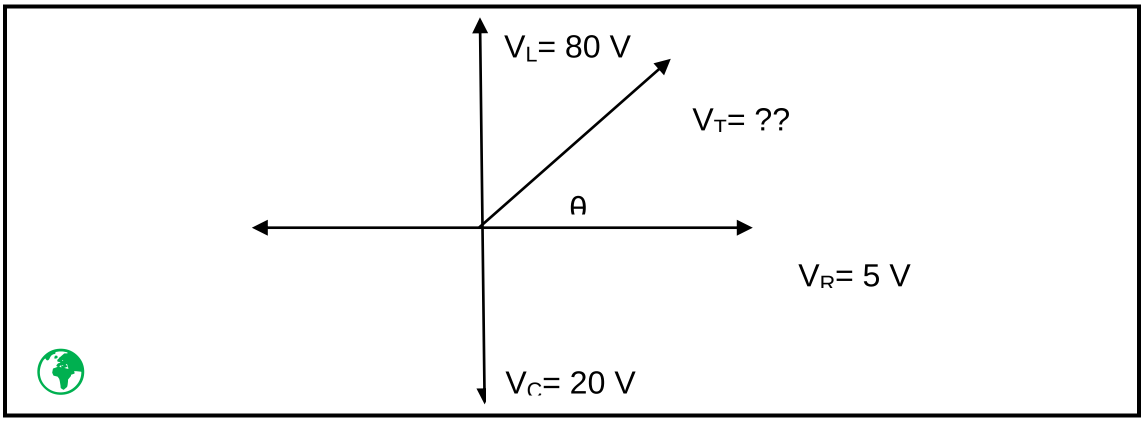


FIGURE 2

3.1.1 Calculate the total voltage of the circuit. (3)

3.1.2 Calculate the phase angle θ. (2)

3.1.3 Draw a neat, labelled circuit diagram of this phasor diagram. (4)

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3.2 Refer to FIGURE 3 below and answer the questions. The current in the circuit is at its maximum and the circuit is resistive.

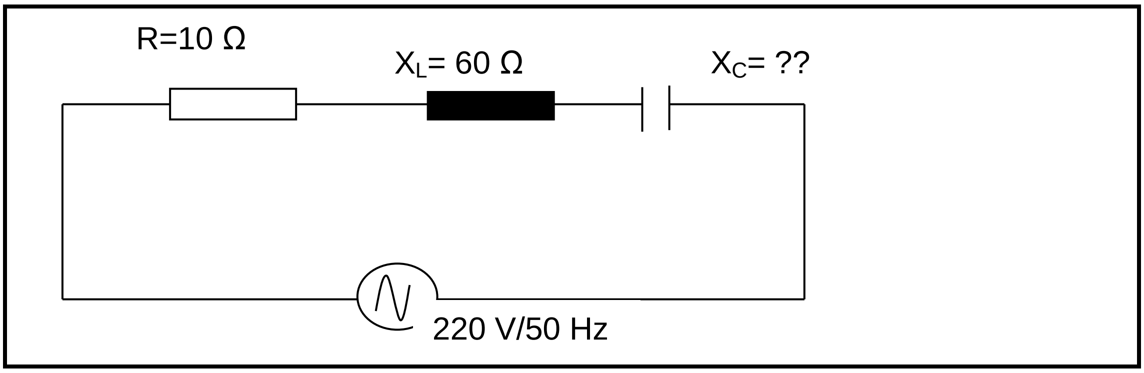

FIGURE 3

3.2.1 Calculate the value of the capacitive reactance. (1)

3.2.2 Calculate the value of the capacitance in µF. (2)

3.2.3 Calculate the value of the inductance in mH. (2)

3.2.4 Calculate the value of the current in the circuit. (1)

3.2.5 Draw a neat, labeled phasor diagram of this circuit. (2)
[17]

QUESTION 4

4.1 Describe the term *positive ion* as applied in atomic theory. (2)

4.2 Define the term *conductor* in terms of atomic theory. (2)

4.3 Draw a neat, labelled diagram to indicate the size of the energy gap in insulator materials as applied in atomic theory. (3)
[7]

QUESTION 5

5.1 Briefly describe the operation of a photo diode when it is exposed to light. (4)

5.2 Draw a neat circuit diagram of a negative series clipper as well as its related input and output waveforms. (4)

5.3 Briefly describe the operation of the circuit in QUESTION 5.2 when the positive signal is applied to the input of the circuit. (4)
[12]

QUESTION 6

6.1 Complete the sentences in the following paragraph by filling in the missing word. Write only the word next to the question number (6.1.1–6.1.4) in the ANSWER BOOK.

In a common emitter amplifier, when the signal to the base increases, the forward bias voltage across the base emitter junction (6.1.1) … and as a result more electrons flow out of the emitter and into the base. As the base current increases, the collector current will (6.1.2) … .This collector current will cause the voltage across R_C to (6.1.3) … and this will cause the voltage V_{CE} to (6.1.4) … (4 × 1) (4)

6.2 Briefly describe the need to combine both Class A and Class B amplifiers together to form Class AB. (2)

6.3 Describe the term *positive feedback* as applied to transistors. (2)
[8]

QUESTION 7

7.1 Name TWO methods of suppressing transients as applied with SCR's. (2)

7.2 Draw a neat block diagram of the full-wave control back to back method of SCR's. (6)

7.3 Describe briefly how the *cycle control* method is achieved with SCR's. (4)

7.4 Draw a neat, labelled block diagram of a frequency counter as applied to measuring instruments. (6)
[18]

QUESTION 8

8.1 You are required to construct an amplifier which will combine THREE different signals to produce a single output.

Draw a neat, labelled circuit using an Op-amp that will be suitable for this task. (4)

8.2 You are required to measure the temperature of a certain environment by using a temperature sensitive transducer. This transducer must be inside a Wheatstone bridge with four resistors. The transducer must respond inversely to the change in temperature.

Draw a neat bridge circuit which is suitable for this task. (7)
[11]

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QUESTION 9

An oscilloscope displays an AC signal with a peak-to-peak voltage of 12 V.

Calculate the following from the signal:

9.1 The peak voltage of the waveform (1)

9.2 The average value of the waveform (2)

9.3 The RMS value of the waveform (2)
[5]

TOTAL SECTION B: 90
GRAND TOTAL: 100

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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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