higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T770**(E)**(N30)T

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N3

(8080613)

30 November 2018 (X-Paper)
09:00–12:00

Calculators may be used.

This question paper consists of 7 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 (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 Resonance can be produced in an R–C circuit.

1.1.2 The nucleus of an atom consists of neutrons and electrons.

1.1.3 A strain gauge transducer can be divided into PTC and NTC materials.

1.1.4 Piezo-electric transducer can be used inside a microphone.

1.1.5 A measuring instrument is a device used to convert non electrical signals into electrical signals.

(5 × 1) (5)

1.2 Choose the correct word(s) from those given in brackets. Write only the word(s) next to the question number (1.2.1–1.2.5) in the ANSWER BOOK.

1.2.1 In a resonant RLC circuit the phase angle will be (90˚/0˚).

1.2.2 The (voltage/current) will lead in a capacitive circuit.

1.2.3 A common emitter amplifier has got a (high/low) voltage gain.

1.2.4 In a (positive/negative) feedback the signal is fedback in antiphase with the input signal.

1.2.5 A Dual (beam/trace) oscilloscope consists of two separate electron guns.

(5 × 1) (5)
[10]

TOTAL SECTION A: 10

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SECTION B

QUESTION 2

Study FIGURE 1 below and answer the following questions about the circuit:

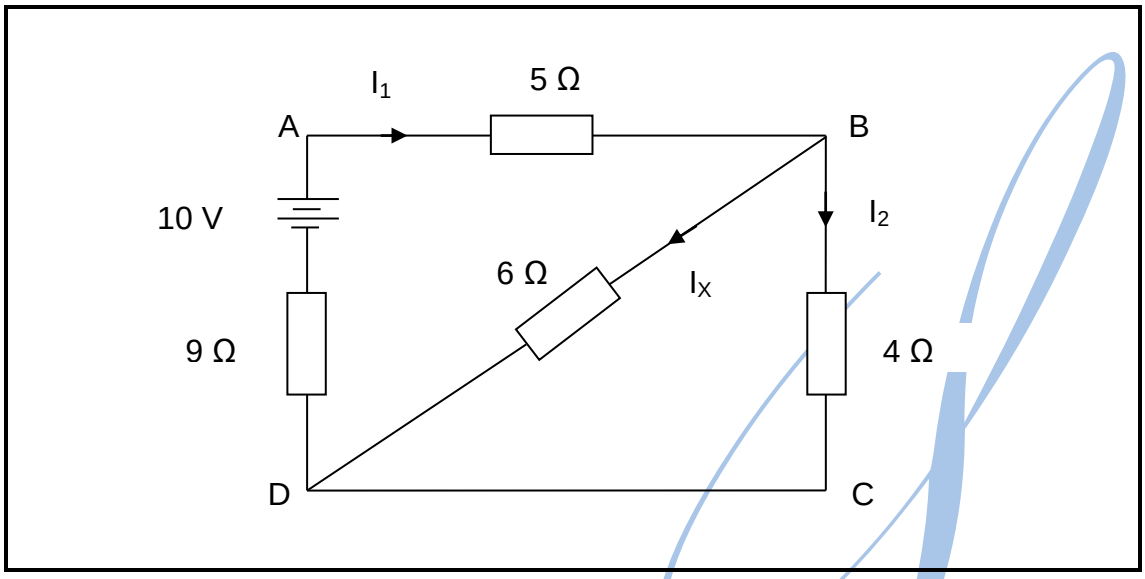

FIGURE 1

2.1 Express the current I_x using other variables. (1)

2.2 Formulate an equation for Loop ABDA and name it equation 1. (1)

2.3 Formulate an equation for Loop DCBD and name it equation 2. (1)

2.4 Calculate the value of the current I_1. (3)

2.5 Calculate the value of the current I_2. (2)

2.6 Calculate the value of the current I_x. (2)

[10]

QUESTION 3

3.1 Refer to FIGURE 2 below and calculate the following from the circuit.

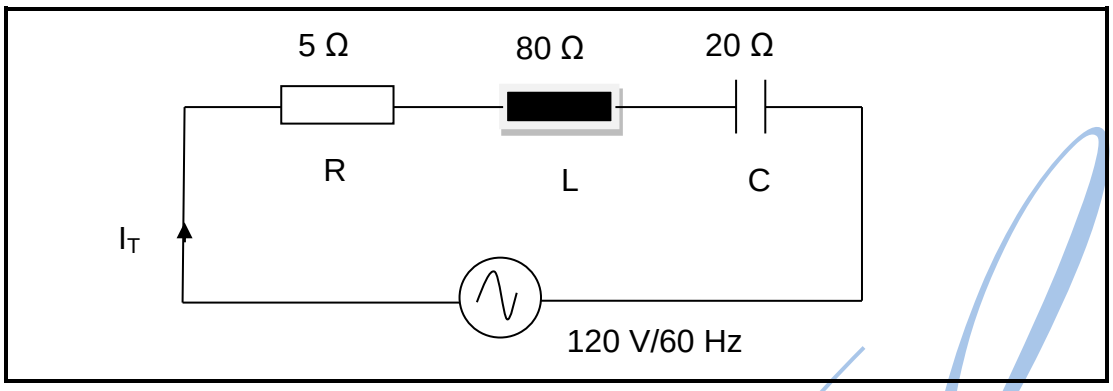

FIGURE 2

3.1.1 The total impedance of the circuit. (3)

3.1.2 The phase angle θ. (2)

3.1.3 The capacitance of the capacitor in µF. (2)

3.1.4 The inductance of the inductor in mH. (2)

3.2 Draw the impedance phasor diagram of the circuit. (4)

3.3 Study FIGURE 3 below and briefly describe the graph in terms of the impedance as well as the resonant frequency. Also state whether the graph reflects a series or parallel resonant circuit.

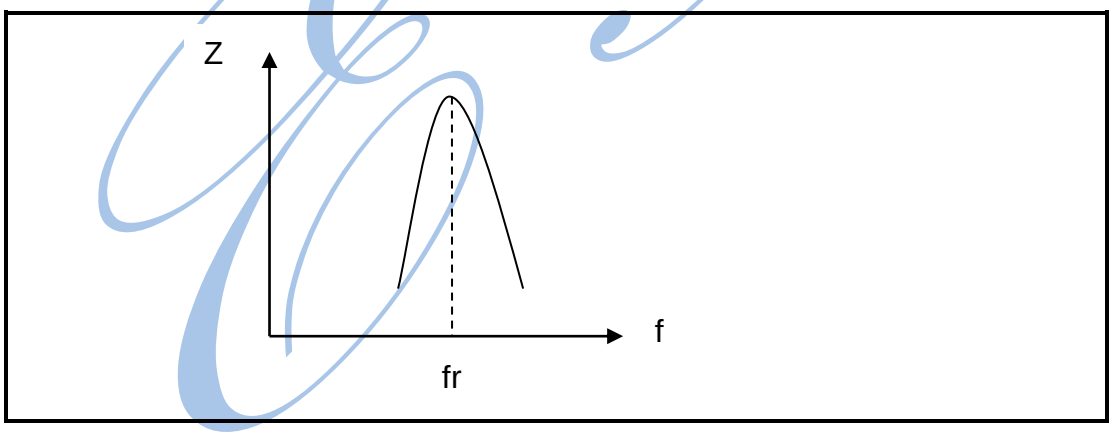

FIGURE 3 (2)

3.4 Study FIGURE 4 below and briefly describe the graph in terms of the current and the resonant frequency. Also state whether the graph reflects a series or parallel resonant circuit.

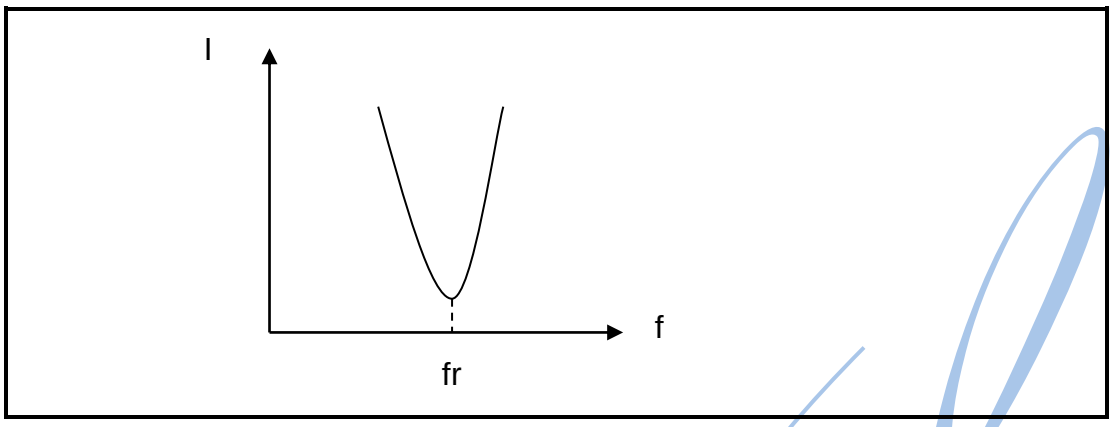

FIGURE 4

(2)
[17]

QUESTION 4

4.1 Briefly describe the term *force of attraction* on an orbiting electron. (2)

4.2 Briefly describe the term *centrifugal force* on an orbiting electron. (2)

4.3 Draw a neat labelled characteristic curve of a silicon diode and clearly indicate the PIV point as well as the forward voltage drop point on the graph. (4)

4.4 Briefly describe the process of *doping* as applied to semiconductors. (3)

4.5 Describe the term *reverse recovery time* as applied to semiconductors. (2)
[13]

QUESTION 5

5.1 Draw a neat circuit of a half wave voltage doubler. (5)

5.2 Draw a neat circuit of an optocoupler configuration which uses a photo diode. (3)
[8]

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QUESTION 6

6.1 Briefly describe the positioning of the Q-point for the following classes of amplification as well as the flow of the output current in each case.

6.1.1 Class A

6.1.2 Class B

6.1.3 Class C

6.1.4 Class AB

(4 × 3) (12)

6.2 Briefly describe why coupling methods of transistors are necessary instead of using a single transistor. (2)

6.3 Describe how those coupling methods in QUESTION 6.2 above are achieved. (2)
[16]

QUESTION 7

7.1 Draw a neat circuit symbol of a P-channel MOSFET and clearly label the terminals. (2)

7.2 Name TWO advantages of field effect transistors. (2)

7.3 Draw a neat Op-Amp circuit which has a gain of unity and clearly indicate its terminals. (3)

7.4 State the use of this circuit in QUESTION 7.3 above. (1)
[8]

QUESTION 8

8.1 Briefly describe the operating principle of the Wheatstone bridge. (4)

8.2 Describe the operating principle of a potentiometer transducer. (2)
[6]

QUESTION 9

9.1 Draw a neat labelled block diagram of a continuous balance DVM. (5)

9.2 Briefly explain the operating principle of this circuit in QUESTION 9.1 above. (7)
[12]

TOTAL SECTION B: 90
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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