higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T770**(E)**(J25)T

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N3

(8080613)

25 July 2018 (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 to THREE decimals.
6. Subsections of questions must be kept together.
7. Use π = 3,142.
8. Write neatly and legibly.

QUESTION 1: DIRECT-CURRENT THEORY

1.1 Briefly describe *negative direction* as applied in Kirchoff's circuits. (2)

1.2 Study FIGURE 1 and calculate the value of (I_1-1_2) current by using Kirchhoff's laws. Use loop ABDA and loop DBCD. (8)

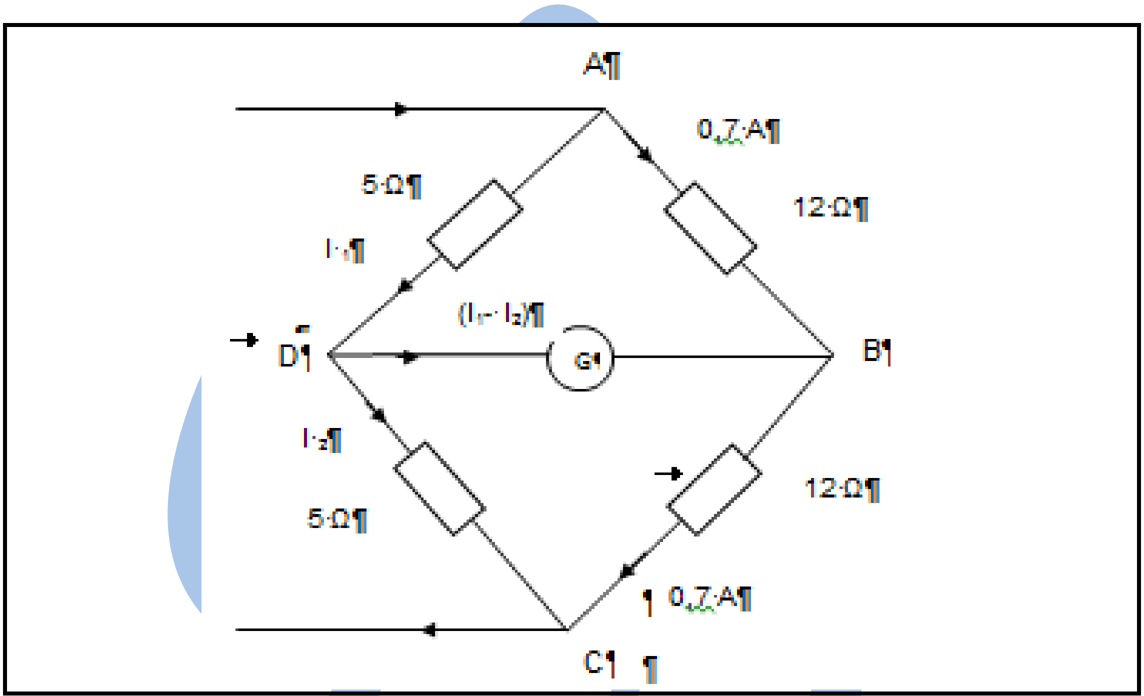

FIGURE 1

[10]

QUESTION 2: ALTERNATING-CURRENT THEORY

Study FIGURE 2 below.

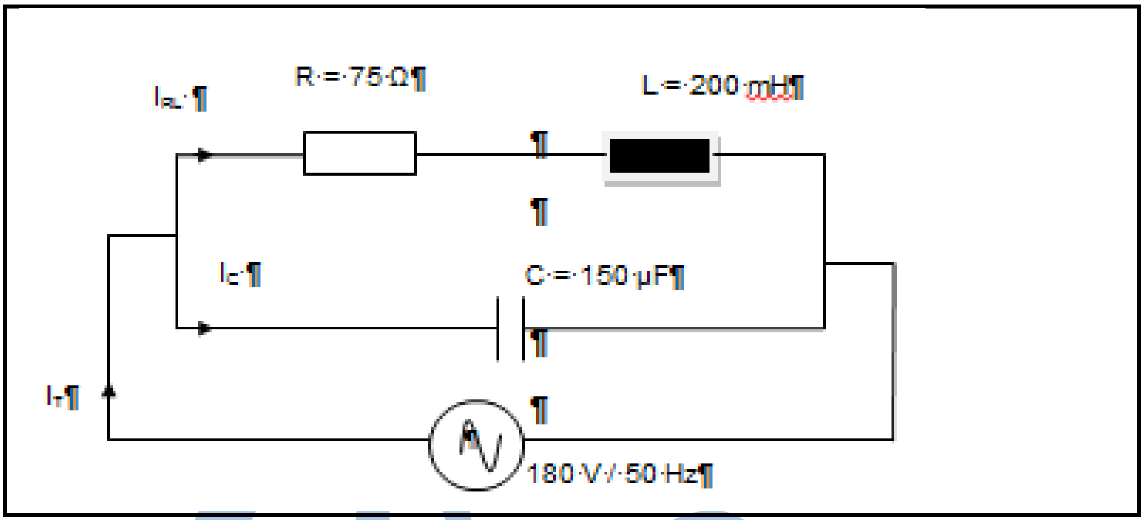

FIGURE 2

Calculate the following using the information from the circuit:

2.1 Phase angle of the inductive branch (6)

2.2 Current I_{RL} (2)

2.3 Current I_C (3)

2.4 Horizontal component of I_{RL} (2)

2.5 Vertical component of I_{RL} (2)

2.6 Horizontal component of I_C (2)

2.7 Vertical component of I_C (2)
[19]

QUESTION 3: SEMICONDUCTOR PHYSICS

3.1 Briefly explain why an atom is considered to be neutrally charged. (2)

3.2 Describe *reverse current (I_R)* as applied to semiconductor diodes. (2)

3.3 Use a labelled sketch, referring to the energy gap and conduction band, to explain why an insulator is not able to conduct electricity. (5)

3.4 Define *positive ion* in terms of atomic theory. (2)

3.5 Identify the circuit in FIGURE 3.

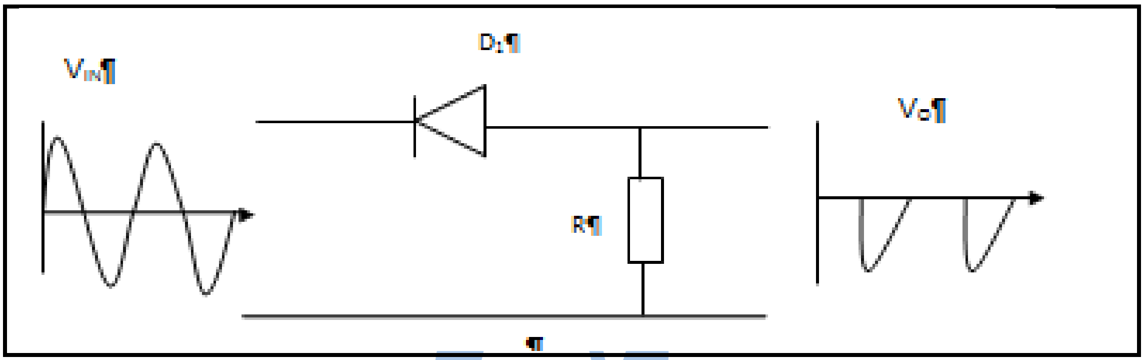

FIGURE 3 (1)

3.6 Briefly explain how the AC input signal in QUESTION 3.6 is converted to a DC output signal. (3)

3.7 Identify the circuit in FIGURE 4. (1)
[16]

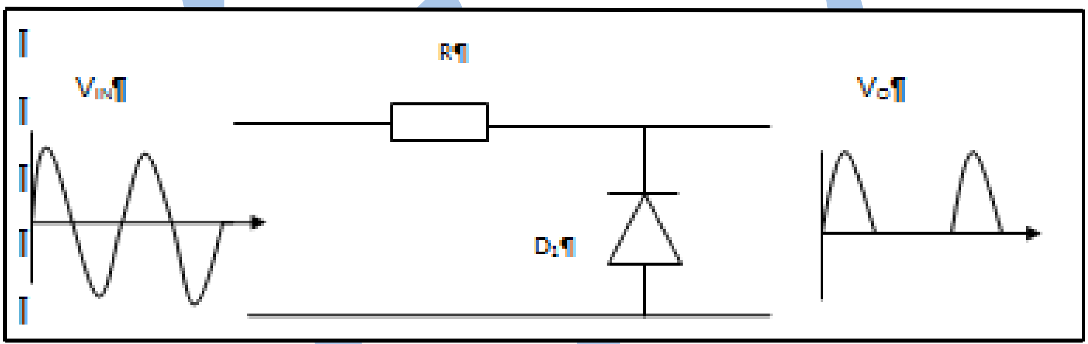

FIGURE 4

QUESTION 4: DIODES AND THEIR APPLICATIONS

Choose the correct word or words from those given in brackets. Write only the word or words next to the question number (4.1–4.5) in the ANSWER BOOK.

4.1 A PN-junction diode conducts in (forward/reverse) direction.

4.2 A zener diode will act as a regulator when operated in (reverse/forward) bias.

4.3 The rectifier stage of a simple power supply consists of (varactor/PN-junction) diodes.

4.4 Whenever a photo diode is not exposed to any light a small current called (drift/dark) current will flow.

4.5 A voltage doubler circuit uses (varactor/PN-junction) diodes to double the input voltage.

(5 × 1) **[5]**

QUESTION 5: TRANSISTORS

Study the circuit in FIGURE 5 below of a transistor used as a switch.

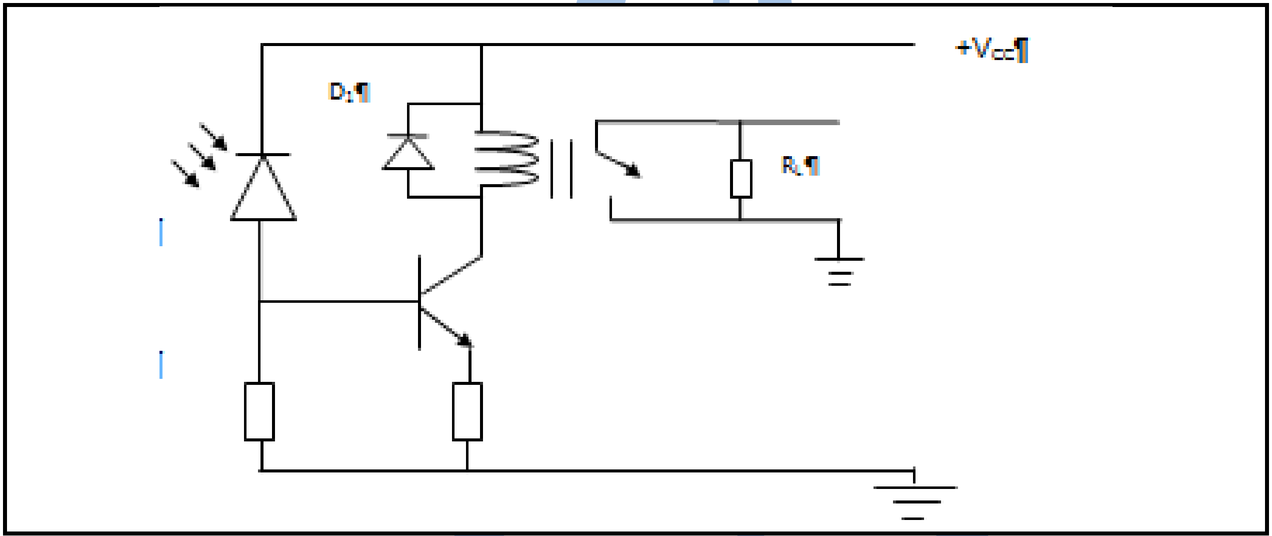

FIGURE 5

5.1 What is required to cause the base current to flow so that the transistor is switched on? (1)

5.2 Briefly describe how the answer in QUESTION 5.1 will cause the transistor to activate the relay in the circuit so that the load is activated. (5)

5.3 State FOUR characteristics of a common-emitter circuit. (4)

5.4 Draw a neat, labelled characteristic curve of an N-channel JFET. (4)

5.5 Briefly explain why a compromise was reached to form Class AB push-pull amplifiers. (4)

[18]

QUESTION 6: SILICON CONTROLLED RECTIFIERS

6.1 Define *holding current* as applied to SCR's. (2)

6.2 Explain how the cycle control method is achieved with SCR's. (5)

6.3 Describe the term *delay angle* as applied to SCR's. (2)

6.4 Describe the term *conduction angle* as applied to SCR's. (2)
[11]

QUESTION 7: OPERATIONAL AMPLIFIERS

7.1 Three different input signals must be combined and a single amplified output must be produced from them.

Draw an Operational Amplifier circuit to use for such a requirement and clearly show the input terminals. (4)

7.2 Draw the output wave of the circuit in QUESTION 7.1 if an AC signal is applied to one of the inputs. (2)
[6]

QUESTION 8: TRANSDUCERS

8.1 With reference to the following formula, briefly describe how the change in length as well as the change in area will affect the resistance of a strain-gauge transducer.

Formula: $R = \dfrac{\rho \cdot l}{a}$ (4)

8.2 With reference to the following formula as applied in capacitive transducers, discuss how the change in each relevant variable will affect 'C'. Ensure that the variables are identified in your discussion.

Formula: $C = \dfrac{k \cdot A \cdot E_0}{d}$ (6)
[10]

QUESTION 9: MEASURING INSTRUMENTS

A sine wave is displayed on the screen of an oscilloscope. The average value of the voltage of this waveform is calculated as 200 mV.

Calculate the following:

9.1 The RMS value of the waveform. (4)

9.2 The peak-to-peak value of the waveform. (1)
[5]

TOTAL: 100

INDUSTRIAL ELECTRONICS N

FORMULA SHEET

DIRECT-CURRENT THEORY

$V = I \cdot R$ $\quad P = V \cdot I$ $\quad P = \dfrac{V^2}{R}$

$P = I^2 \cdot R$

ALTERNATING CURRENT THEORY

$X_L = 2\pi fL$ $\quad X_C = \dfrac{1}{2\pi fC}$ $\quad Z = \sqrt{R^2 + (X_L \sim X_C)^2}$

$V_T = \sqrt{V_R^2 + (V_L \sim V_C)^2}$ $\quad I = \dfrac{V_T}{Z}$ $\quad \theta = \cos^{-1}\dfrac{R}{Z}$

$V = I \cdot R$ $\quad V = I \cdot X_L$ $\quad V = I \cdot X_C$

$f_r = \dfrac{1}{2\pi\sqrt{LC}}$ $\quad I_R = \dfrac{V_T}{R}$ $\quad I_L = \dfrac{V_T}{X_L}$

$I_C = \dfrac{V_T}{X_C}$ $\quad I_T = \sqrt{I_R^2 + I_X^2}$ $\quad I_X = I_L \sim I_C$

$\theta = \tan^{-1}\dfrac{I_X}{I_R}$ $\quad \theta = \cos^{-1}\dfrac{I_R}{I_T}$ $\quad Z = \dfrac{V}{I_T}$

$Z_D = \dfrac{L}{RC}$ $\quad I_T = \dfrac{V}{Z_D}$ $\quad f_r = \dfrac{1}{2\pi}\sqrt{\dfrac{1}{LC} - \dfrac{R^2}{L^2}}$

$I_C = I_{RL}\ Sin\theta_L$ $\quad I_T = I_{RL}\ Cos\theta_L$ $\quad I_T = \sqrt{{I_{T_H}}^2 + {I_{T_V}}^2}$

TRANSISTORS

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

TRANSDUCERS

$R = \dfrac{\rho \cdot l}{a}$ $\quad C = \dfrac{k \cdot A \cdot E_0}{d}$