higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

ELECTRONIC CONTROL AND DIGITAL ELECTRONICS
NQF LEVEL 4

(12041024)

3 December 2020 (X-paper)
09:00–12:00

This question paper consists of 6 pages and 1 formula sheet.

257Q1N2003

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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. Use only a black or blue pen.
5. Write neatly and legibly.

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QUESTION 1

1.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 In an RLC series circuit, the phase difference between the current in the capacitor and the current in the resistor is 0°.

1.1.2 In an RLC series circuit, the phase difference between the current in the inductor and the current in the resistor is 0°.

1.1.3 In an RLC series circuit, the phase difference between the current in the capacitor and voltage across the capacitor is 180°.

1.1.4 Above the resonance frequency, the current in the inductor lags the voltage in an RLC series circuit.

1.1.5 Below the resonance frequency, the current in the capacitor lags the voltage in an RLC series circuit.

(5 × 1) (5)

1.2 Explain what will happen in an RL series circuit if the following happens:

1.2.1 The resistor is open

1.2.2 The inductor is open

1.2.3 A shorted winding on the inductor

(3 × 1) (3)

1.3 A circuit consists of an 80 Ω resistor, a 400 mH inductor and a 47 µF capacitor, all connected in parallel across a 240 V, 50 Hz supply.

Calculate the following:

1.3.1 The current flowing in each branch (10)

1.3.2 The supply current (2)

[20]

QUESTION 2

2.1 Calculate the oscillation frequency of a Colpitts oscillator if the following values are given:

L = 5 µH, C_1 = 0,01 µF and C_2 = 0,002 µF (6)

2.2 Make a drawing of a 555 timer in astable mode. (7)

2.3 Name FOUR factors that affect oscillation frequency. (4)

2.4 State TWO applications of a monostable multivibrator. (2)

2.5 Explain TWO ways in which an SCR (silicon-controlled rectifier) can be turned ON. (2 × 2) (4)

2.6 Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (2.6.1–2.6.5) in the ANSWER BOOK.

2.6.1 In an LC oscillator circuit, when the capacitor is at its maximum, the inductor … is at its minimum.

A energy
B voltage
C power
D current

2.6.2 In an LC oscillator, the frequency of the oscillator is proportional to the …

A capacitance and current.
B inductance or resistance.
C resistance or capacitance.
D inductance or capacitance.

2.6.3 An oscillator produces … oscillations.

A damped
B natural
C undamped
D free-running

2.6.4 A … oscillator is commonly used in radio transmitters.

A Wien bridge
B Hartley
C LC
D Colpitts

2.6.5 A … oscillator uses both positive and negative feedback.

A Wien bridge
B Hartley
C LC
D Colpitts

(5 × 1) (5)

2.7 Draw an IEC symbol of a triac. (2)
[30]

QUESTION 3

3.1 Use the table below from the technical manual of a semiconductor to find the main characteristics of BC237A devices.

Device	P/kg or casing	Lead	Polarity	V_{CB} (max)	I_C (max)	P_D	h_{FE}	V_{CE} max	V_{BE} max
2N2218	TO-39	1	NPN	30	0,8	0,8 W	200 Mn	10	5
2N2222	TO-18	1	NPN	30	0.8	0,5 W	200 Mn	20	5
2N2905	TO-39	10	PNP	40	0,6	0,6 W	120 Mn	30	5
BC109	TO-18	11	NPN	25	0,2	0,6 W	200 Mn	50	5
BC237A	TO-92	11	NPN	45	0,1	0,35 W	200 Mn	50	5
BC640	TO-92	11	PNP	80	1	1 W	240 Mn	80	5
2N6038	TO-126	24	PNP	60	4	40 W	40 Mn	100	5
2N6123	TO-220	24	NPN	80	4	40 W	300 Mn	100	5

TABLE (6)

3.2 A newly appointed trainee electronics technician for PH Engineering is given a PC board by the supervisor to remove and replace a component.

3.2.1 The component to be replaced is an SCR.

State FIVE safety precautions that should be taken when handling SCR components. (5)

3.2.2 Briefly explain how the component from the printed circuit board (PCB) mentioned in QUESTION 3.2.1 must be removed. (4)

3.2.3 Why would the manufacturers of ICs recommend that an IC socket be soldered onto the PCB or veroboard instead of the IC pins? (1)

3.2.4 Briefly explain the requirements of a good low resistance joint of the component of the printed circuit board (PCB). (4)
[20]

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QUESTION 4

4.1 Draw a labelled circuit diagram of a TWO-stage serial-in-parallel-out circuit. (5)

4.2 Explain how to install application software. (8)

4.3 Convert decimal number 5 to a 2421 BCD code. (2)
[15]

QUESTION 5

5.1 Design a labelled ladder diagram that will simultaneously switch ON two lights when activated and automatically switch OFF one light ten minutes later. (8)

Note: The light that is still ON must remain on until manually deactivated.

5.2 Name THREE programming languages used to instruct a PLC. (3)

5.3 State FOUR functions of a microprocessor in a PLC. (4)
[15]

TOTAL: 100

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ELECTRONICS CONTROL AND DIGITAL ELECTRONICS L4

FORMULA SHEET

AC Theory

$$X_C = \frac{1}{2\pi fc}$$

$$X_L = 2\pi fL$$

$$z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\phi = \tan^{-1} \frac{X_L \; X_C}{R}$$

$$I_T = \sqrt{I_R^2 + (I_C - I_L)^2}$$

$$f_c = \frac{1}{2\pi RC}$$

$$f_r = \frac{1}{2\pi\sqrt{RC}}$$

$$Q = \frac{X_L}{R} = \frac{X_C}{R}$$

$$I = \frac{V}{R}$$

$$f_o = \frac{1}{2\pi RC\sqrt{2n}}$$

$$C_t = \frac{C_1 \times C_2}{C_1 + C_2}$$

$$f_o = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}$$

Fundamentals of Electronics

$$B_W = \frac{f_r}{Q}$$

$$\beta = \frac{I_C}{I_B}$$

$$I_B = \frac{V_{BB} - V_{BE}}{R_B}$$

$$I_C - \frac{V_{CC}}{R_C}$$

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