



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

**ELECTRONIC CONTROL AND DIGITAL ELECTRONICS
NQF LEVEL 4**

(12041024)

**13 November 2019 (X-Paper)
09:00–12:00**

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

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. Start each section on a NEW page.
 5. Use only a BLACK or BLUE pen.
 6. Write neatly and legibly.
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QUESTION 1

1.1 Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–C) next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 What is frequency selectivity?

- A The frequency at which the capacitive reactance equals the resistance in a low-pass RC-circuit
- B The ability of a circuit to select a specific frequency and reject all other frequencies
- C The range of frequencies that pass from the input to the output of a circuit



1.1.2 What is bandwidth?

- A The frequency at which the capacitive reactance equals the resistance in a low-pass RC-circuit
- B The ability of a circuit to select a specific frequency and reject all other frequencies
- C The range of frequencies that pass from the input to the output of a circuit

1.1.3 What is cut-off frequency?



- A The frequency at which the capacitive reactance equals the resistance in a low-pass RC-circuit
- B The ability of a circuit to select a specific frequency and reject all other frequencies
- C The range of frequencies that pass from the input to the output of a circuit

1.1.4 What is reactive power in an RLC-circuit?

- A The upper and lower cut-off frequencies
- B The rate of energy conversion taken as an average over one or more complete cycles
- C The peak rate of energy storage in the reactive elements of a circuit

1.1.5 What is active power in an RLC-circuit?

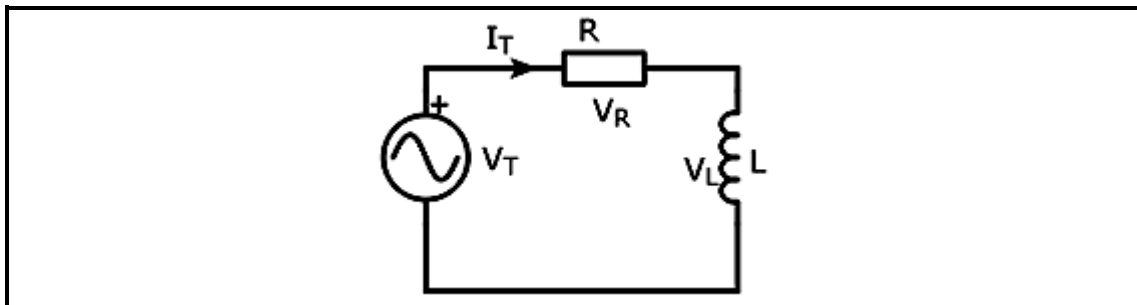


- A The upper and lower cut-off frequencies
- B The rate of energy conversion taken as an average over one or more complete cycles
- C The peak rate of energy storage in the reactive elements of a circuit

(5 × 1)

(5)

- 1.2 The circuit below shows an inductor connected in series with a resistor. The voltage across the inductor (V_L) is 40 V and the voltage across the resistor (V_R) is 30 V. The current flow is 3 A.



- 1.2.1 Calculate the total voltage across the circuit. (3)
- 1.2.2 Calculate the phase angle between the total voltage and the total current. (3)
- 1.2.3 Calculate the impedance of the circuit. (3)
- 1.2.4 Draw the phasor diagram of the circuit. (6)
- [20]**

QUESTION 2

- 2.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (2.1.1–2.1.5) in the ANSWER BOOK.

- 2.1.1 When the capacitor in an LC-oscillator circuit is at maximum, the inductor energy is at minimum. (3)
- 2.1.2 In an LC-oscillator the frequency of the oscillator is proportional to L or C. (3)
- 2.1.3 With undamped oscillation, the amplitude of the oscillations remains constant. (3)
- 2.1.4 A Hartley oscillator is commonly used in radio transmitters. (3)
- 2.1.5 A Colpitts oscillator uses a phase-shift network consisting of two capacitors and one inductor. (5)



(5 × 1) (5)

- 2.2 Name FIVE factors that affect oscillation frequency. (5)

2.3 Explain each of the following:

2.3.1 Amplifier



2.3.2 Oscillator

(2 × 2)

(4)

2.4 Give TWO applications of each of the following multivibrators:

2.4.1 Astable multivibrator

2.4.2 Monostable multivibrator

2.4.3 Bistable multivibrator



(3 × 2)

(6)

2.5 Give the meaning of each of the following power-supplier abbreviations:

2.5.1 SMPS

2.5.2 UPS



(2 × 1)

(2)

2.6 Study the circuit diagram below and answer the questions.

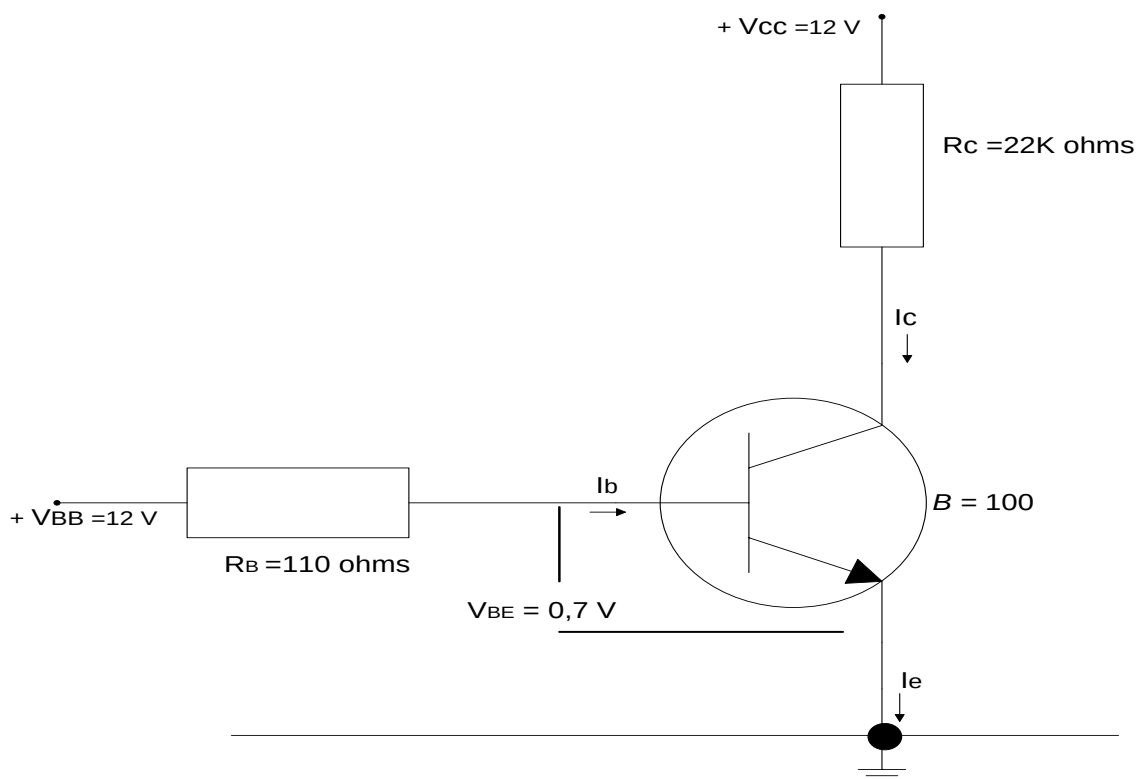


FIGURE 1

- 2.6.1 Determine the saturation current. (3)
- 2.6.2 Determine the cut-off voltage.  (1)
- 2.6.3 Draw the DC load line from the above values. (4)
- [30]**

QUESTION 3

- 3.1 Briefly explain the common problem experienced when using a strip board for the first time. (3)
- 3.2 Name FOUR common faults in relays resulting in a malfunctioning circuit. (4)
- 3.3 Briefly explain each of the following parameter procedures to replace a transistor when using data sheets:
- 3.3.1 Maximum collector-base voltage (V_{CBO})
- 3.3.2  Maximum collector-emitter voltage (V_{CEO})
- 3.3.3 Maximum emitter-base voltage (V_{EBO})
- 3.3.4 Power dissipation (P_D in watts)
- 3.3.5 Gain (H_{FE})
- (5 × 1) (5)
- 3.4 Use the semiconductor technical manual shown in the table below to find the main characteristics of BC640 devices. (6)

Device	Pkg or casing	Polarity	V_{ECO} (min)	I_C (max)	P_D	h_{FE}	$h_{FE}@I_C$		& V_{CE}	V_{CE} (sat)	@ I_C	F_T min	$F_T(typ)$ @ I_C	
2N2218	TO-39	NPN	30	0,8	0,8	20		500	10	0,4	150	250		20
2N2222	TO-18	NPN	30	0,8	0,5	30		500	10	0,4	150	250		20
2N2905	TO-39	PNP	40	0,6	0,6	30		500	10	0,4	150	200		50
BC109	TO-18	NPN	25	0,2	0,6	200	800	2	5	0,6	100	150	3	10
BC237A	TO-92	NPN	45	0,1	0,35	120	220	2	5	0,6	100	150	3	10
BC640	TO-92	PNP	80	1	1	100	400	100	80	80	500	100		10
2N6038	TO-126	PNP	60	4	40	175	15 000	2	3	2	2			
2N6123	TO-220	NPN	80	4	40	20	80	1,5	2	1,5	1,5	2,5		10

- 3.5 What is an *optocoupler*?  (2)
- [20]**

QUESTION 4

4.1 Convert each of the following as indicated:

4.1.1 00110100_{BCD} to decimal (1)

4.1.2 0000_{BCD} to XS-3 (1)

4.1.3 510 to 2421BCD code (1)

4.2.1 Make a neat labelled diagram of a four-stage serial-in-serial-out shift register using D-type flip-flops. (6)

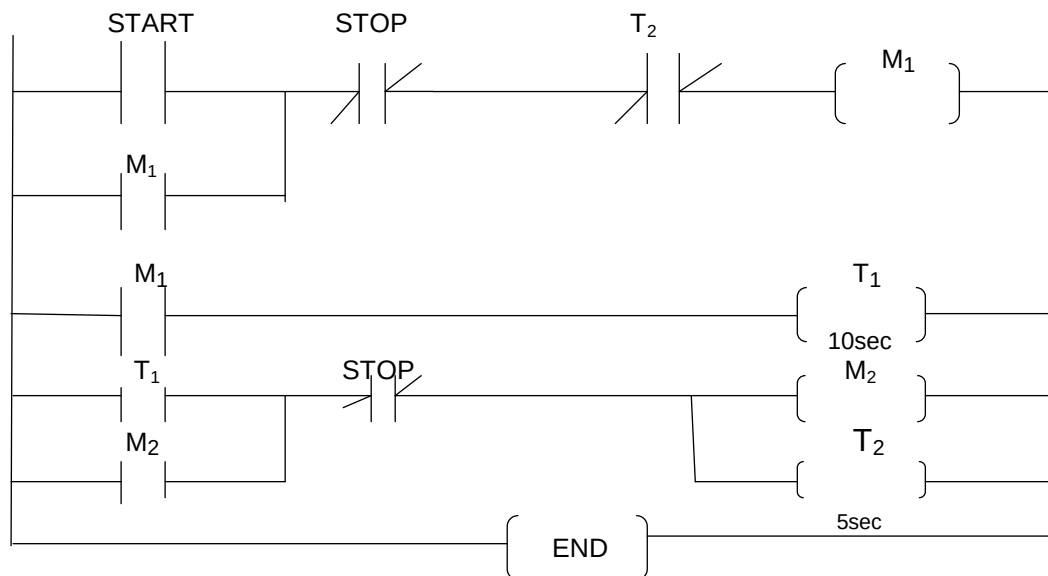
4.2.2 Explain the operation of the shift register in 4.2.1. (6)

[15]

QUESTION 5

5.1 Draw a labelled ladder diagram that will simultaneously switch two lights ON when activated and automatically switch one light OFF ten minutes later. The second light must remain ON until manually de-activated. (7)

5.2



Give a detailed description of the operating principle of the ladder logic illustrated above and list any practical application of the described ladder

(8)
[15]

TOTAL: 100

FORMULA SHEET

AC-THEORY

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

$$X_L = 2\pi fL$$

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

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

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

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

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

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

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

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

$$C_t = \frac{c_1 \times c_2}{c_1 + c_2}$$

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

FUNDAMENTALS OF ELECTRONICS

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

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

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

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