



# basic education

Department:  
Basic Education  
**REPUBLIC OF SOUTH AFRICA**

**NATIONAL  
SENIOR CERTIFICATE**

**GRADE 12**

**ELECTRICAL TECHNOLOGY: DIGITAL**

**EXEMPLAR 2018**

**MARKS: 200**

**TIME: 3 hours**

**This question paper consists of 13 pages, a 1-page formula sheet  
and an answer sheet of 3 pages.**

**INSTRUCTIONS AND INFORMATION**

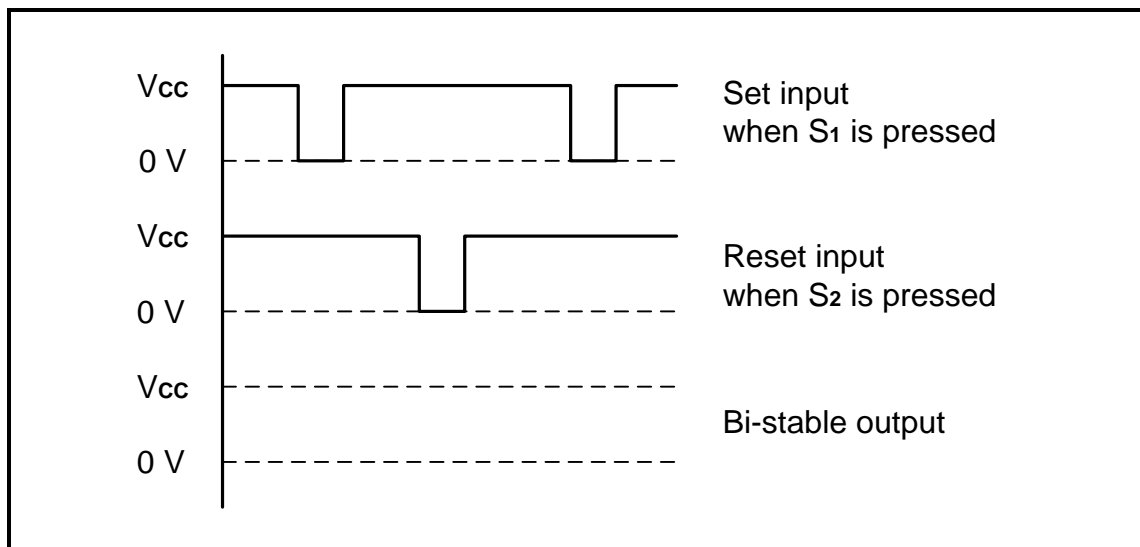
1. This question paper consists of FIVE questions.
2. Answer ALL the questions.
3. Sketches and diagrams must be large, neat and fully labelled.
4. Show ALL calculations and round off answers correctly to TWO decimal places.
5. Number the answers correctly according to the numbering system used in this question paper.
6. You may use a non-programmable calculator.
7. Show the units for ALL answers and calculations.
8. A formula sheet is attached at the end of this question paper.
9. Write neatly and legibly.
10. Use the ADDENDUM provided as per instruction.

**QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY (GENERIC)**

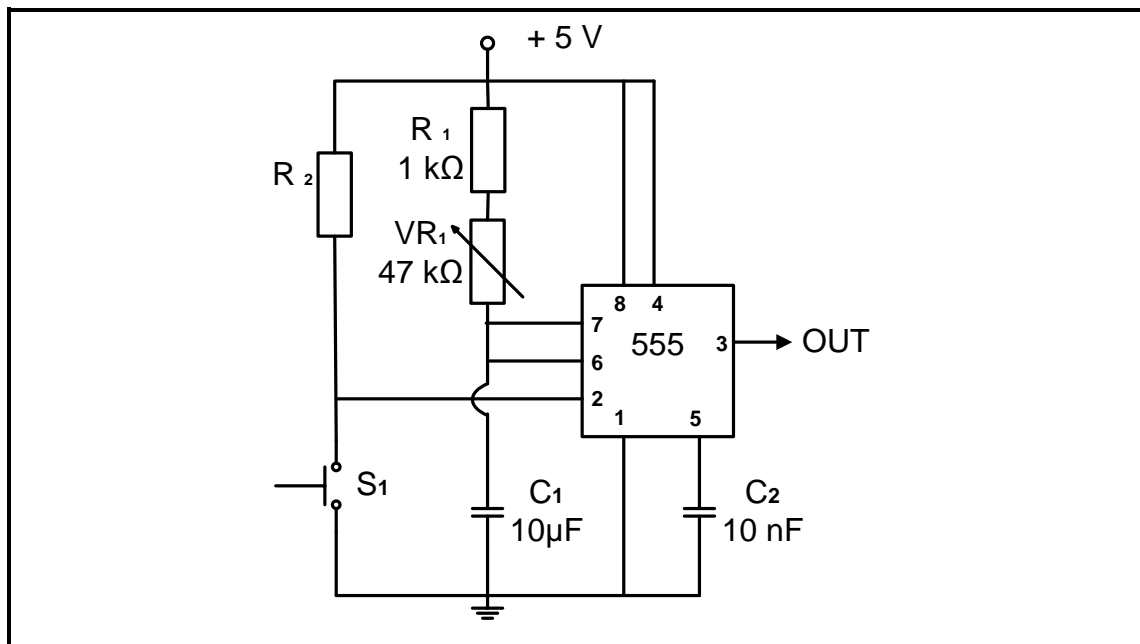
- 1.1 Define the term *workplace* with reference to the Occupational Health and Safety Act, 1993 (Act 85 of 1993) (2)
- 1.2 Name TWO general duties for employees at the workplace. (2)
- 1.3 Explain why 'insufficient ventilation' is an unsafe condition in the workshop. (2)
- 1.4 State TWO functions of a health and safety representative. (2)
- 1.5 Explain *quantitative risk analysis*. (2)

**[10]****QUESTION 2: SWITCHING CIRCUITS**

- 2.1 Draw the output signal of an astable multivibrator. (3)
- 2.2 Define the term *bi-stable multivibrator*. (3)
- 2.3 FIGURE 2.3 below shows the input signals of a bi-stable multivibrator. Draw the output on the addendum provided. (3)

**FIGURE 2.3: INPUT SIGNALS OF A BI-STABLE MULTIVIBRATOR**

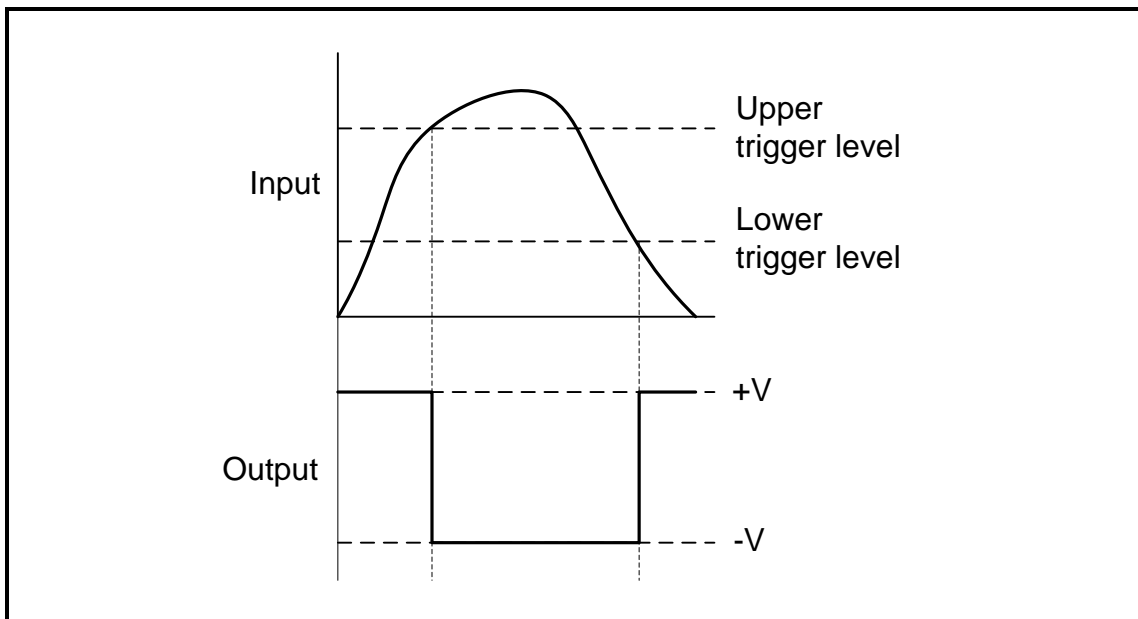
2.4 Refer to FIGURE 2.4 below and answer the questions that follow.



**FIGURE 2.4: MONO-STABLE MULTIVIBRATOR**

- 2.4.1 State ONE application of the mono-stable multivibrator. (1)
- 2.4.2 Explain why resistor R<sub>1</sub> is necessary in the circuit. (3)
- 2.4.3 Explain how an increase in the value of capacitor C<sub>1</sub> will affect the circuit. (2)
- 2.4.4 Describe what will happen in the circuit when switch S<sub>1</sub> is pressed. (5)
- 2.5 State TWO applications other than a temperature sensitive switch of a Schmitt trigger. (2)

- 2.6 Explain the basic operation of a Schmitt trigger with reference to FIGURE 2.6 below.



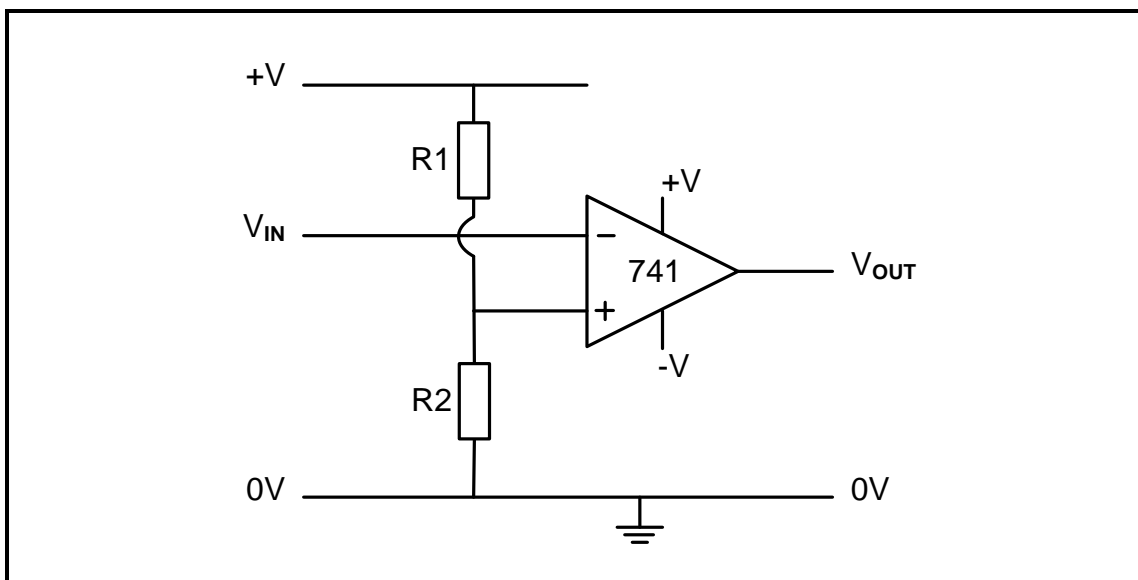
**FIGURE 2.6: INPUT AND OUPUT OF AN INVERTING SCHMITT TRIGGER**

(3)

- 2.7 Draw a fully labelled circuit diagram of a 741 op amp connected as an inverting Schmitt trigger.

(5)

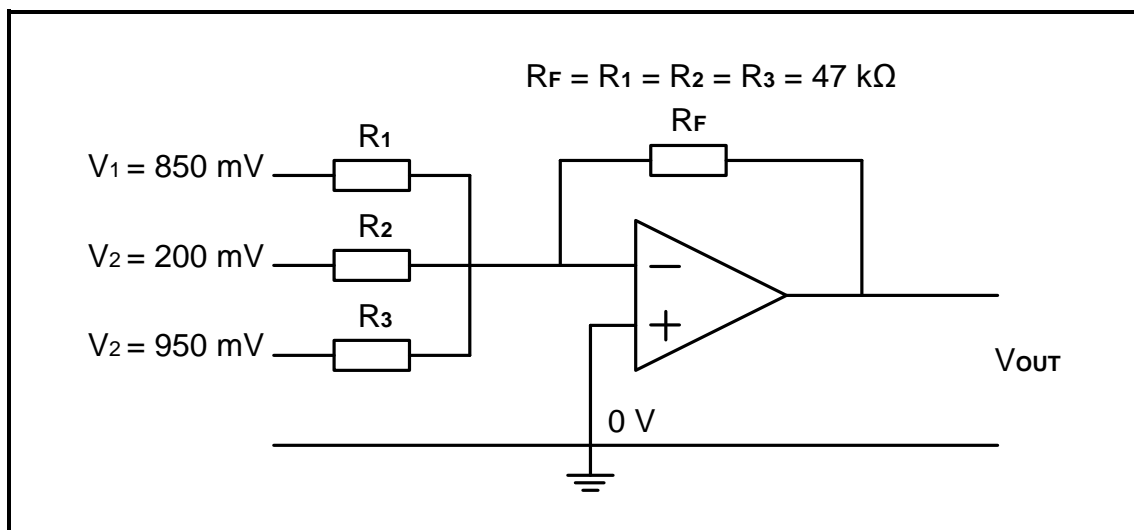
- 2.8 FIGURE 2.8 below shows a 741 op amp as a comparator. Answer the questions that follow.



**FIGURE 2.8: COMPARATOR**

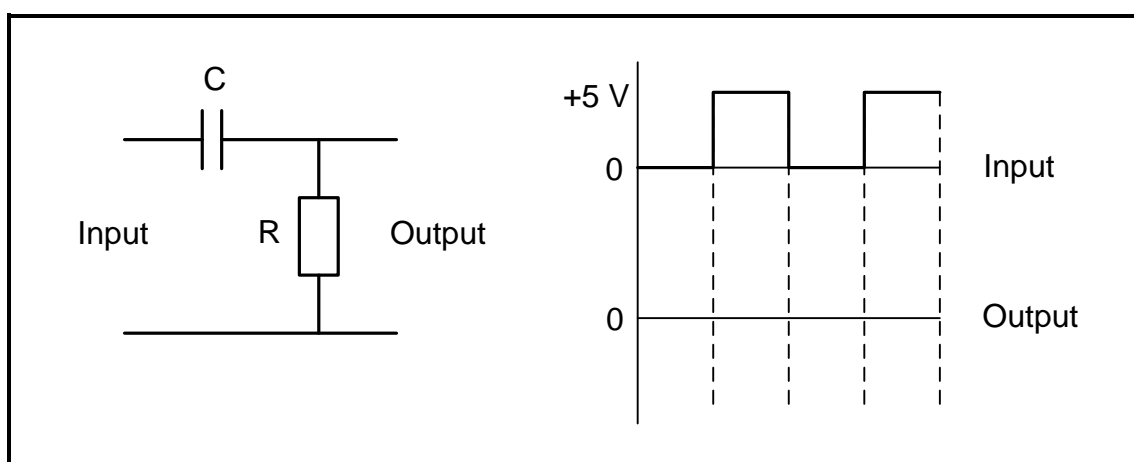
- 2.8.1 State the function of  $R_2$  in the circuit. (1)
- 2.8.2 Describe the operation of the comparator. (6)
- 2.8.3 State how the circuit can be modified to adjust the reference voltage. (1)

2.9 Refer to FIGURE 2.9 below and answer the questions that follow:



**FIGURE 2.9: AMPLIFIER**

- 2.9.1 Identify the amplifier in FIGURE 2.9. (2)
- 2.9.2 Name the type of feedback provided by  $R_F$ . (1)
- 2.9.3 Explain how the gain of this amplifier is determined. (3)
- 2.9.4 Calculate the output voltage of the amplifier. (3)
- 2.10 State the basic function of a differentiator. (2)
- 2.11 FIGURE 2.11 below shows the circuit of a basic passive RC differentiator with its input signal. Answer the questions that follow.



**FIGURE 2.11: RC DIFFERENTIATOR**

- 2.11.1 Draw the output signal with reference to the input signal on the ADDENDUM provided. (3)
- 2.11.2 Explain how a long time constant will influence the output signal. (2)

2.12 Refer to FIGURE 2.12 below and answer the questions that follow.

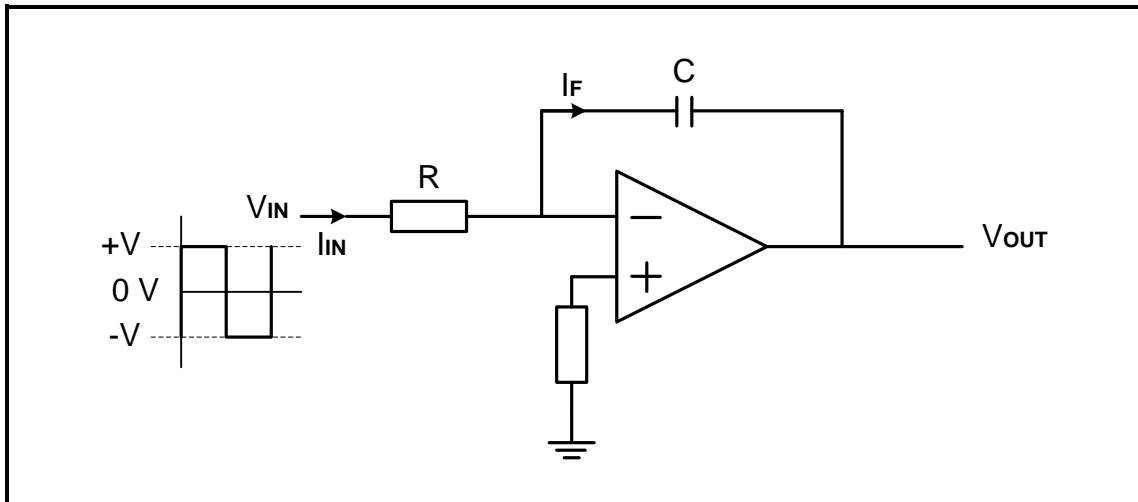


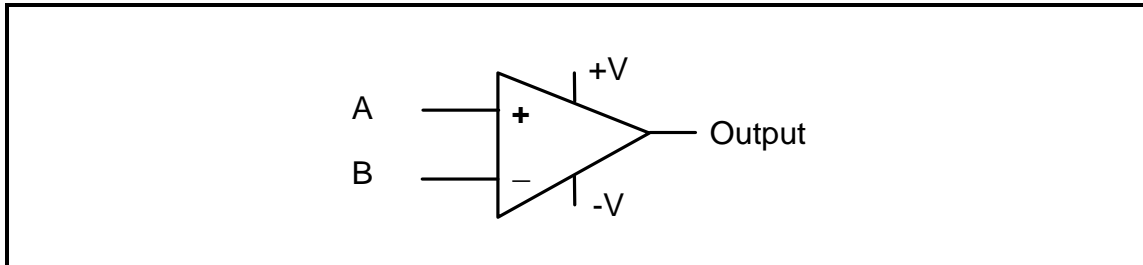
FIGURE 2.12: OP AMP

- 2.12.1 Identify the amplifier. (2)
- 2.12.2 Draw the output signal with reference to the input in FIGURE 2.12 on the addendum provided. (2)
- 2.12.3 Explain how a higher input frequency will affect the output of an integrator. (2)

**[60]**

**QUESTION 3: SEMICONDUCTOR DEVICES (SPECIFIC)**

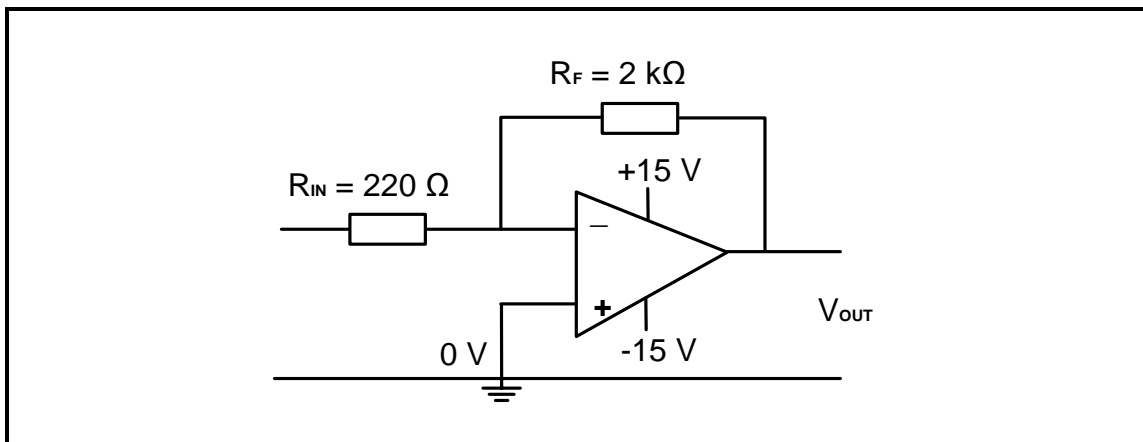
3.1 Refer to FIGURE 3.1 below and answer the questions that follow.



**FIGURE 3.1: 741 OP AMP SYMBOL**

- 3.1.1 Label the inputs **A** and **B**. (2)
- 3.1.2 Name THREE characteristics of an op amp. (3)
- 3.1.3 State ONE operating feature of the 741 op amp as an amplifier, with reference to its gain. (1)
- 3.1.4 Explain why an op amp uses a dual voltage supply. (2)

3.2 Refer to FIGURE 3.2 below and answer the questions that follow.



**FIGURE 3.2: INVERTING OP AMP**

- 3.2.1 Calculate the gain of the op amp. (3)
- 3.2.2 Calculate the output voltage if a 0,55 V signal is applied to the input. (3)
- 3.2.3 Describe what will happen to the output voltage if the value of the feedback resistor is increased to 20 kΩ. (2)
- 3.3 State TWO uses of the 555 IC. (2)



3.4 FIGURE 3.4 below shows the 555 IC. Explain the function of pin 6.

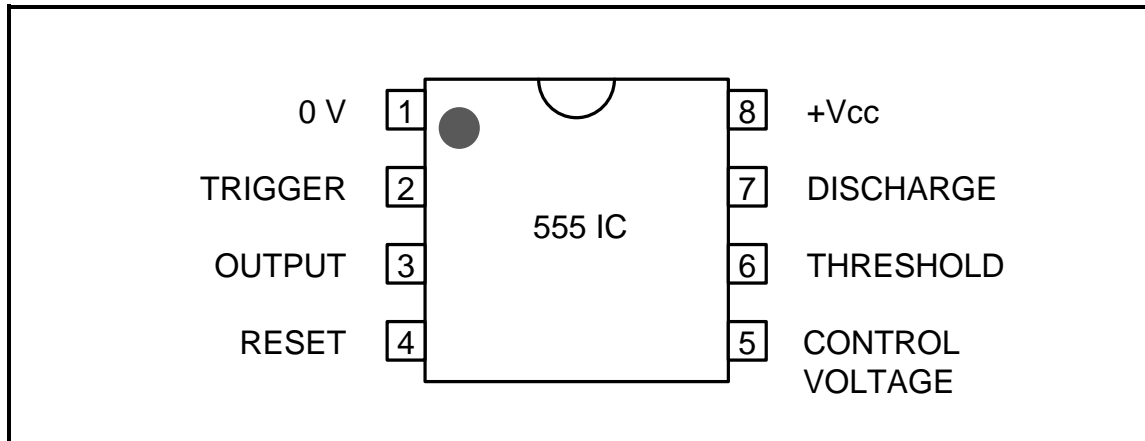


FIGURE 3.4: 555 IC

(2)  
[20]

**QUESTION 4: DIGITAL AND SEQUENTIAL DEVICES (SPECIFIC)**

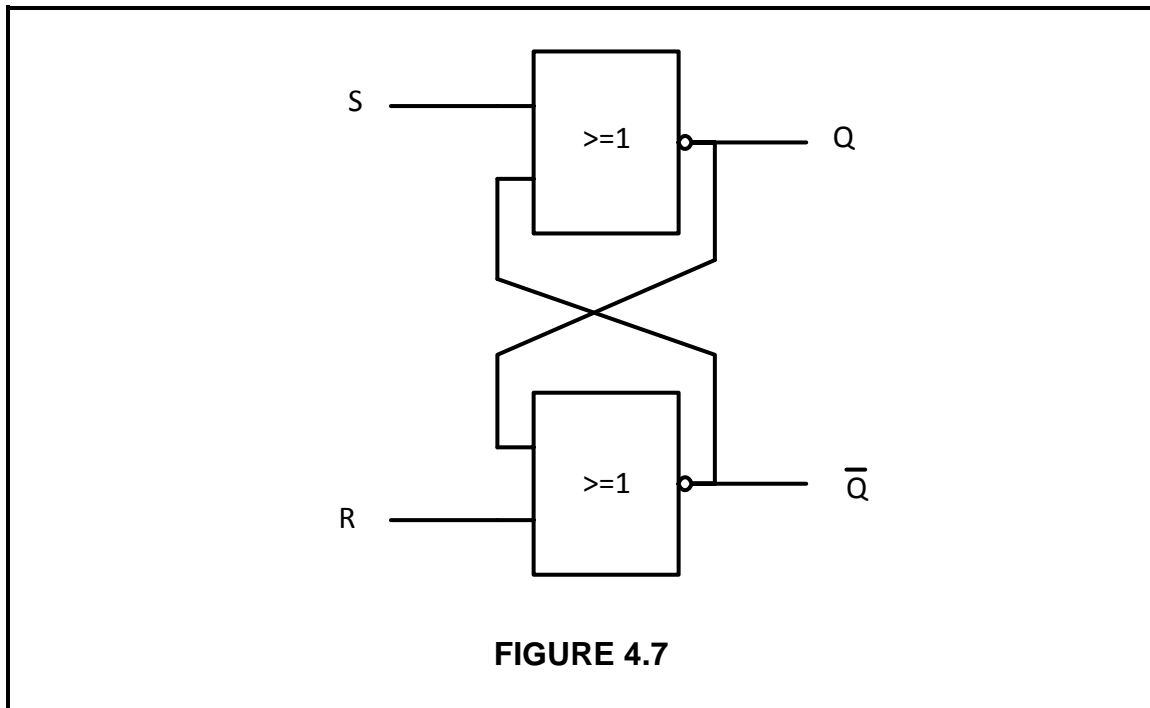
- 4.1 Name ONE type of seven-segment display device that is commonly available, besides the LED seven-segment display. (1)
- 4.2 Explain the difference between a *sinking* and a *sourcing* output with reference to the LED seven-segment display. (4)
- 4.3 Explain the function of a decoder. (2)
- 4.4 TABLE 4.4 represents the truth table of a full adder.

INPUTS			OUTPUTS	
A	B	C	S	C <sub>o</sub>
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

**TABLE 4.4**

- 4.4.1 Extract the Boolean expression from the truth table for the Carry (C<sub>o</sub>). (1)
- 4.4.2 Simplify the Boolean expression in QUESTION 4.4.1 by using Boolean algebra. (4)
- 4.5 Draw the circuit diagram of the full adder using TWO half adders and an OR gate. (6)
- 4.6 Explain the difference between *combinational logic circuits* and *sequential logic circuits* as used in memory elements. (4)

4.7 FIGURE 4.7 below represents an RS latch with the different inputs in the truth table. Complete the truth table for this latch on the ANSWER SHEET provided.



Mode of operation	INPUTS		OUTPUTS	
	S	R	Q	$\bar{Q}$
Illegal	0	0		
Set	0	1		
Reset	1	0		
Hold	1	1		

**TABLE 4.7**

- 4.8 Name TWO types of counters that are commonly used in digital electronics. (2)
- 4.9 With reference to a THREE-stage asynchronous ripple counter:
- 4.9.1 Draw a labelled circuit using JK flip-flops (8)
- 4.9.2 Draw the truth table (6)
- 4.10 Name THREE types of registers that are used in digital electronics circuits. (3)
- 4.11 Draw a neatly labelled sketch of a 4-bit serial-in: serial-out shift register using D-type flip-flops and show ALL the inputs and outputs. (10)
- [55]**

**QUESTION 5: MICROCONTROLLERS (SPECIFIC)**

- 5.1 State TWO uses of a microcontroller in household appliances. (2)
- 5.2 State the main disadvantage of a microcontroller. (2)
- 5.3 Describe the difference between a *microcontroller* and a *microprocessor*. (3)
- 5.4 Explain the difference between discrete logic and *integrated logic*. (4)
- 5.5 5.5.1 Draw a block diagram of a microcontroller (4)
- 5.5.2 State the function of the Central Processing Unit (CPU) as used in microcontrollers (2)
- 5.6 State THREE types of special purpose registers that are used in the (CPU). (3)
- 5.7 With reference to the CPU:
- 5.7.1 Explain the term clock speed (1)
- 5.7.2 Determine the effect that an increase in clock speed has on the CPU (1)
- 5.8 Describe the function of an Analogue to Digital Converter (ADC) as used in microcontrollers. (2)
- 5.9 Illustrate the types of communication protocols using block diagrams with reference to the following:
- 5.9.1 Simplex (2)
- 5.9.2 Duplex (2)
- 5.9.3 half duplex (2)

- 5.10 Complete TABLE 5.10 in the addendum by comparing the characteristics of RS-232 with that of a RS-485 communication protocol. (10)

	RS-232	RS-485
Line configuration		
Maximum cable length		
Maximum data rate		
Typical logic levels		
Mode of operation		

**TABLE 5.10**

- 5.11 With reference to software of microcontrollers define the following terms:
- 5.11.1 Algorithm (2)
- 5.11.2 Program (2)
- 5.11.3 Flow diagram (2)
- 5.12 Draw a flowchart of a mono-stable device that has only one stable state. The program switches the output on and off every 5 seconds and then goes back to its original state. (9)

**[55]**

**TOTAL 200**

**FORMULA SHEET- DIGITAL****SWITCHING CIRCUITS**

1. Gain  $A_V = \frac{V_{out}}{V_{in}} = -\left(\frac{R_f}{R_{in}}\right)$  inverting operational amplifier

2. Gain  $A_V = \frac{V_{out}}{V_{in}} = 1 + \frac{R_f}{R_{in}}$  non-inverting operational amplifier

3.  $V_{OUT} = V_{IN} \times \left(-\frac{R_F}{R_{IN}}\right)$  inverting operational amplifier

4.  $V_{OUT} = -(V_1 + V_2 + V_3)$  summing op amp circuit

5.  $f_r = \frac{1}{2\pi\sqrt{LC}}$  Hartley oscillator

6.  $f = \frac{1}{2\pi\sqrt{6RC}}$  RC phaseshift oscillator

**CENTRE NUMBER:**

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**EXAMINATION NUMBER:**

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**ANSWER SHEETS FOR ELECTRICAL TECHNOLOGY: DIGITAL**

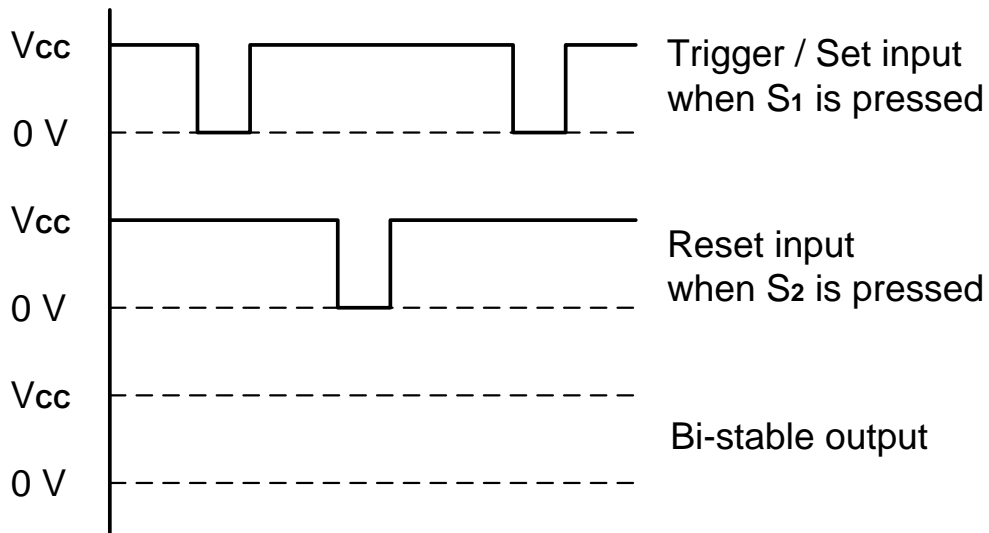
**QUESTION 2: SWITCHING AND CONTROL CIRCUITS**

2.1



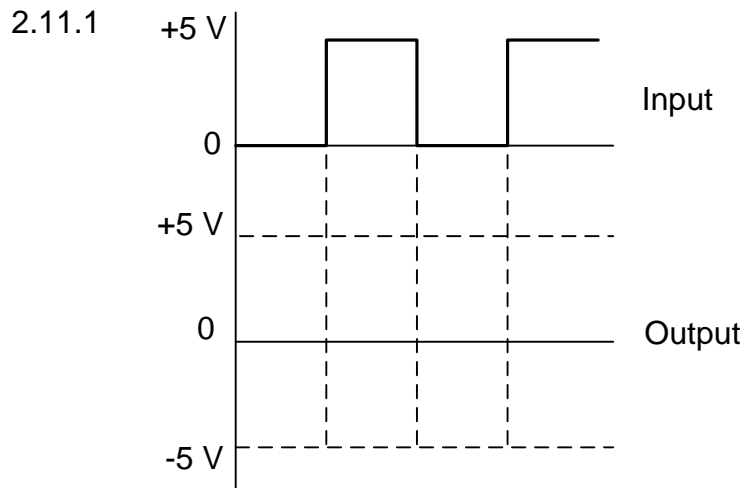
(3)

2.3



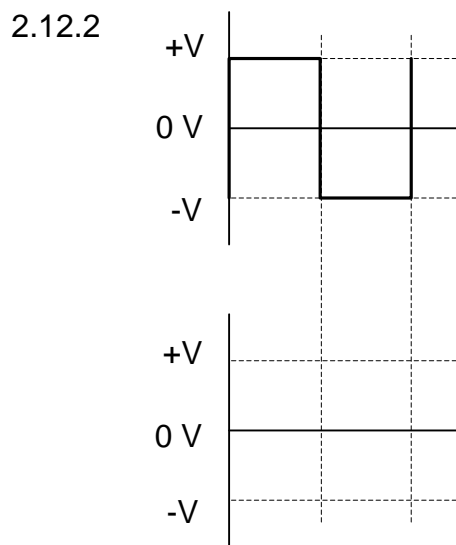
**FIGURE 2.3: INPUT SIGNALS OF A BI-STABLE MULTIVIBRATOR**

(3)



**FIGURE 2.11: RC DIFFERENTIATOR**

(3)



**FIGURE 2.12: OP-AMP**

(2)

**QUESTION 4: DIGITAL AND SEQUENTIAL DEVICES**

4.7

Mode of operation	INPUTS		OUTPUTS	
	S	R	Q	$\bar{Q}$
Illegal	0	0		
Set	0	1		
Reset	1	0		
Hold	1	1		

**TABLE 4.7**

(4)



4.9 4.9.2

CLOCK PULSES	BINARY COUNT SEQUENCE			DECIMAL COUNT
	C	B	A	

**TABLE 4.9**

(6)

**QUESTION 5: MICROCONTROLLERS**

5.10

	RS-232	RS-485
Line configuration		
Maximum cable length		
Maximum data rate		
Typical logic levels		
Mode of operation		

**TABLE 5.10**

(10)