basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

ELECTRICAL TECHNOLOGY: DIGITAL ELECTRONICS

MAY/JUNE 2026

MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 14 pages.

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INSTRUCTIONS TO THE MARKERS

1. All questions with multiple answers imply that any relevant, acceptable answer should be considered.

2. Calculations:

   2.1 All calculations must show the formulae.

   2.2 Substitution of values must be done correctly.

   2.3 All answers MUST contain the correct unit to be considered.

   2.4 Alternative methods must be considered, provided that the correct answer is obtained.

   2.5 Where an incorrect answer could be carried over to the next step, the first answer will be deemed incorrect. However, should the incorrect answer be carried over correctly, the marker has to re-calculate the values, using the incorrect answer from the first calculation. If correctly used, the candidate should receive the full marks for subsequent calculations.

3. This marking guideline is only a guide with model answers. Alternative interpretations must be considered and marked on merit. However, this principle should be applied consistently throughout the marking session at ALL marking centres.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

1.1 B ✓ (1)

1.2 C ✓ (1)

1.3 D ✓ (1)

1.4 A ✓ (1)

1.5 D ✓ (1)

1.6 A ✓ (1)

1.7 B ✓ (1)

1.8 C ✓ (1)

1.9 B ✓ (1)

1.10 A ✓ (1)

1.11 C ✓ (1)

1.12 D ✓ (1)

1.13 D ✓ (1)

1.14 D ✓ (1)

1.15 D ✓ (1)

[15]

QUESTION 2: OCCUPATIONAL HEALTH AND SAFETY

2.1 It is an unsafe act. ✓ (1)

2.2 Any person who employs or provides work for any person ✓ and remunerates that person. ✓ (2)

2.3 It is when an attempt is made to numerically determine the probability of various adverse events ✓ and the likely extent of the losses if a particular event takes place. ✓ (2)

2.4 Human rights ensure that human dignity is not infringed ✓ and that everyone is treated with respect, have equal opportunities ✓ and are not exploited in the workplace. (2)

2.5 When the employee feels personally responsible for his/her job performance, he/she shows up on time, ✓ puts in his/her best effort ✓ and completes projects to the best of his/her ability keeping production high. ✓ (3)
[10]

QUESTION 3: SWITCHING CIRCUITS

3.1 A *dual voltage supply* means a power source that can simultaneously ✓ provide two different voltage levels, typically a positive and a negative voltage. ✓ (2)

3.2 3.2.1 C_2 blocks any unwanted signals ✓ (switch bounce) from the supply that might affect the IC's operation. (1)

3.2.2 (a)
- When S_1 is pressed it connects trigger pin 2 to 0 V. ✓
- The voltage at pin 2 drops below ⅓ of the supply ✓
- This changes the output to high, switching the LED on. ✓ (3)

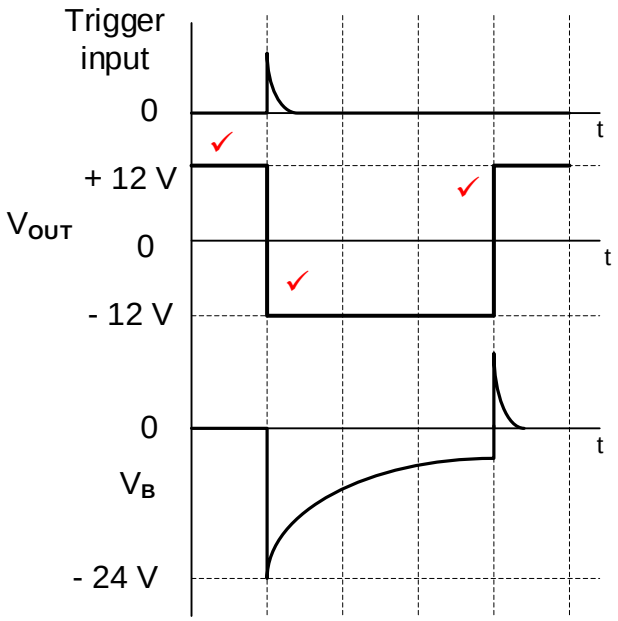
3.2.2 (b) When S_2 is pressed it connects pin 4 to ground (0 V) ✓ resetting the circuit ✓changing the output from high to low. (2)

3.2.3 The threshold pin 6 is connected to ground, ✓ keeping its voltage at 0 V preventing the circuit to reset. ✓ (2)

3.3 3.3.1 $-V_{REF}$ holds the op-amp's inverting input low ✓ and the output at $+V_{SAT}$.✓
Provides a reference voltage for comparison. (2)

3.3.2 The voltage at point B will be 0 V, ✓ because there is no current flowing ✓ through the resistor when the capacitor is fully charged, therefore 0 V across resistor R_2. (2)

3.3.3



✓ Orientation

(4)

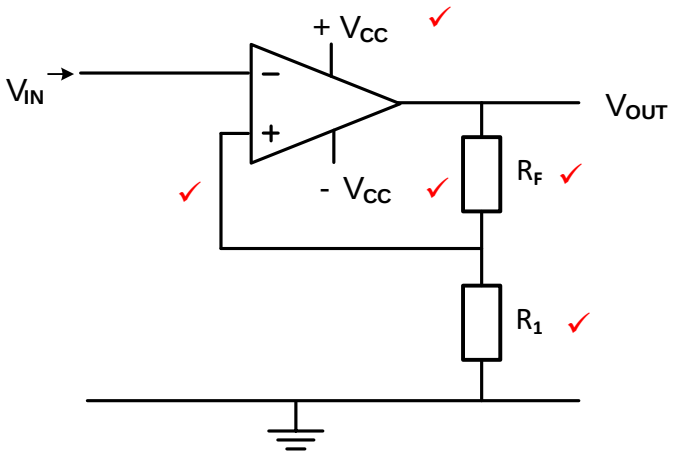
3.4
- A monostable multivibrator requires an external trigger input that changes its output state ✓ for a time period ✓ determined by its RC time constant.
- An astable multivibrator changes its output continuously between two states ✓ without the need of an external trigger input. ✓

(4)

3.5 3.5.1 Inverting ✓ Schmitt trigger.
When the input is higher than the upper trigger level, the output is at $-V_{SAT}$ ✓ and as soon as the input falls below the lower trigger level the output swings to $+V_{SAT}$. ✓

(3)

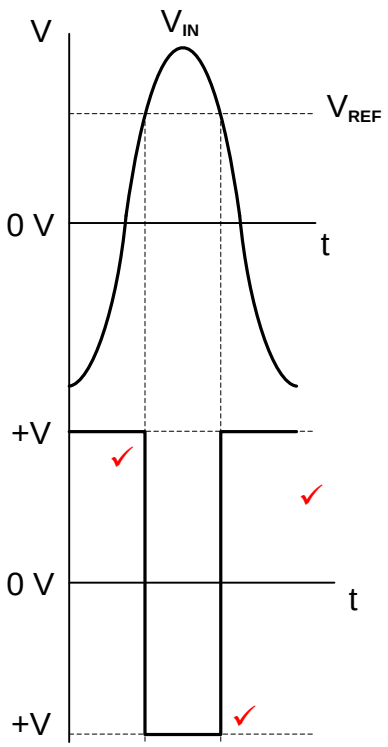
3.5.2



(5)

3.6 3.6.1 R_1 & R_2 sets up the reference voltage ✓ against which the input voltage is compared. ✓ (2)

3.6.2



NOTE:
1 mark for each correct trigger point = 2
1 mark for the correct orientation (3)

3.7 3.7.1 Because $R_1 = R_2 = R_3$ ✓

$$A_V = -\frac{R_F}{R_{IN}} \quad ✓$$

$$= -\frac{330\,000}{22\,000} \quad ✓$$

$$= -15$$ (3)

3.7.2

$$V_{OUT} = -\left(V_1 \times \frac{R_F}{R_1} + V_2 \times \frac{R_F}{R_2} + V_3 \times \frac{R_F}{R_3}\right) \quad ✓$$

$$= -\left(0{,}1 \times \frac{330\,000}{22\,000} + (-0{,}2) \times \frac{330\,000}{22\,000} + 0{,}3 \times \frac{330\,000}{22\,000}\right) \quad ✓$$

$$= -3\,V \quad ✓$$ (3)

3.7.3

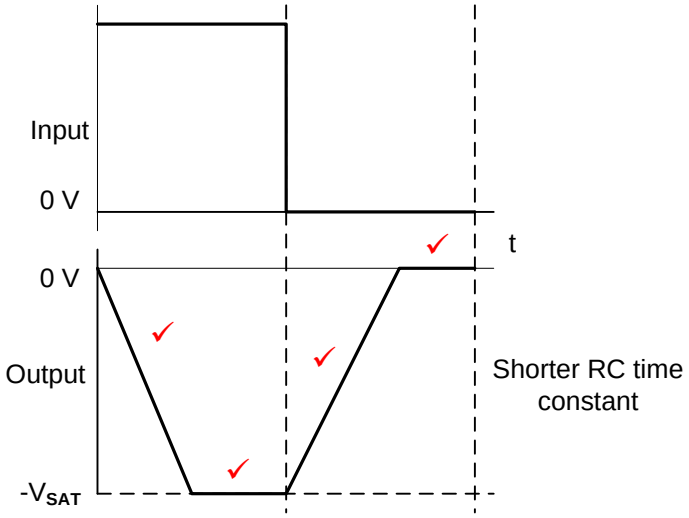
$$V_{OUT} = -\left(V_1 \times \frac{R_F}{R_1} + V_2 \times \frac{R_F}{R_2} + V_3 \times \frac{R_F}{R_3}\right) \quad ✓$$

$$= -\left(0{,}1 \times \frac{330\,000}{22\,000} + (0{,}2) \times \frac{330\,000}{22\,000} + 0{,}3 \times \frac{330\,000}{22\,000}\right) \quad ✓$$

$$= -9\,V \quad ✓$$ (3)

3.8 3.8.1 The op-amp's input draw zero current. ✓
The op-amp's two input terminals always possess the same voltage.✓
When a constant current is fed to the capacitor, it charges at a constant rate. (2)

3.8.2



NOTE:
1 mark for the correct negative slope
1mark for the saturated state on the negative going output.
1 mark for the correct positive slope
1 mark for the saturated state of the positive going output. (4)
[50]

QUESTION 4: SEMICONDUCTOR DEVICES

4.1 A common mode rejection ratio is the ability of a 741 op amp to supress two identical signals on its inputs ✓ in order to have a zero output voltage. ✓ (2)

4.2 4.2.1

$$V_{OUT} = V_{IN} - \frac{R_F}{R_{IN}} \quad ✓$$

$$R_{IN} = -\frac{V_{IN}}{V_{OUT}} \text{x } R_F \quad ✓$$

$$= -\frac{40\text{x}10^{-3}}{-4} \text{x } 1\,000000 \quad ✓$$

$$= 10\ k\Omega$$ (3)

4.2.2 The op amp draws no current on its inverting input terminal because it has an extremely high input resistance. ✓ (1)

4.3 4.3.1 Resistor. ✓ (1)

4.3.2 $V_{OUT} = V_{IN}\left(1 + \frac{R_F}{R_{IN}}\right)$ ✓

$V_{IN} = V_{OUT}\left(\frac{R_{IN}}{R_F + R_{IN}}\right)$

$= 10\left(\frac{20\,000}{100\,000 + 20\,000}\right)$ ✓

$= 1{,}67\,V$ ✓ (3)

4.4 4.4.1 Pin 4-Reset ✓
Pin 5-Control voltage ✓ (2)

4.4.2
- Two comparators ✓
- RS flip flop ✓ (2)

4.4.3 Used in basic timing function for example, turning a light on and off for a certain period of time. ✓ (1)

4.4.4 The transistor T_1 acts as a switch, ✓when activated it allows current flow from the discharge pin to ground.✓ (2)

4.4.5 4.4.5(a) The output of comparator C_1 will be 'high'. ✓ (1)

4.4.5(b) Comparator C_2 will be 'low'.✓ (1)

4.4.5(c) The RS output $\overline{Q}$ of the flip flop will be 'high'.✓ (1)

[20]

QUESTION 5: DIGITAL AND SEQUENTIAL DEVICES

5.1 Common anode ✓ and Common cathode.✓ (2)

5.2 5.2.1 Sinking output. ✓ (1)

5.2.2 There will be no current flow in the circuit,✓ because the emitter must be connected to the positive supply voltage. ✓ (2)

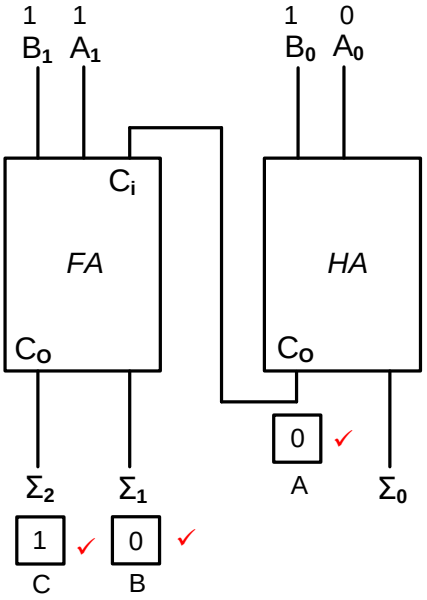
5.3 5.3.1 Encoder. ✓ (1)

5.3.2 It converts data from decimal form to binary.✓ (1)

5.3.3 The pull up resistors ensures that the inputs to the NAND gates remain normally high ✓ when the switches are not activated. (1)

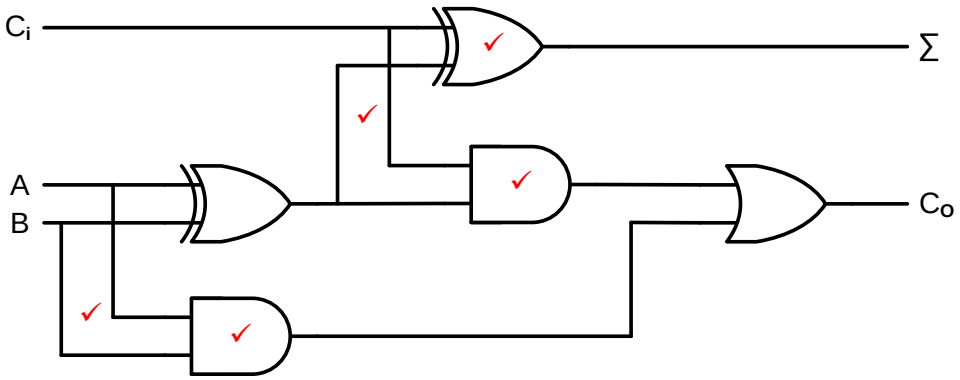
5.3.4 Output A_0 will be a logic '0' ✓and A_1 will be a logic '1'.✓ (2)

5.4 5.4.1



(3)

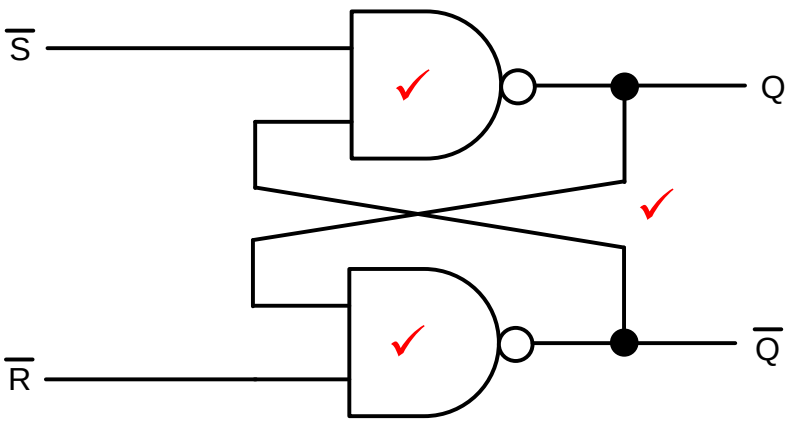
5.4.2



(5)

5.5 5.5.1 Active low RS latch ✓ (1)

5.5.2



(3)

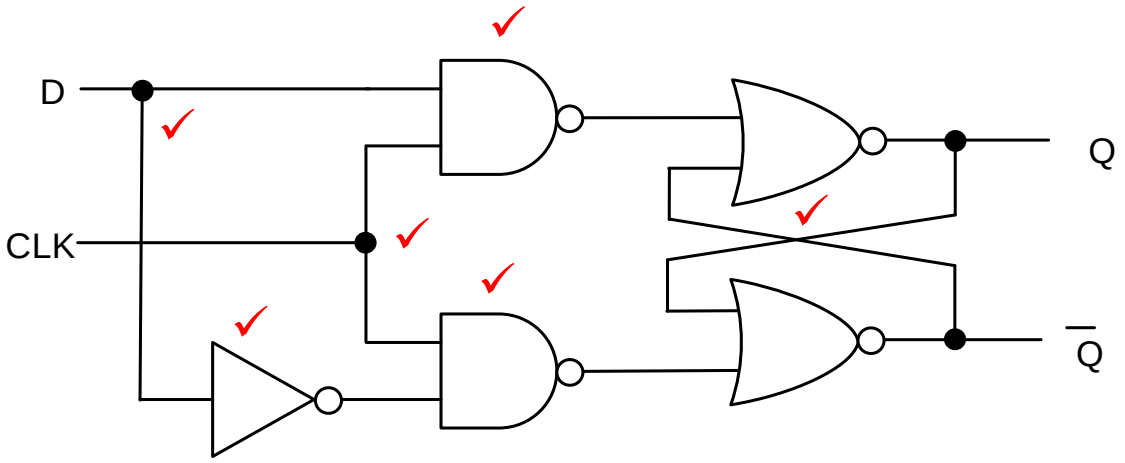
5.5.3

$\overline{S}$	$\overline{R}$	Q	$\overline{Q}$
0	0	Invalid	Invalid
0	1	1	0
1	0	0	1
1	1	No change	No change

✓ ✓ (2)

5.6 Combinational logic circuits use AND, OR and NOT gates (logic gates) ✓ as their basic elements.
Sequential logic circuits rely on the flip-flop ✓ as its basic building element. (2)

5.7



NOTE: 1 mark for each correctly placed gate = 3
1 mark for latch = 1
1 mark for each correct connection = 2 (6)

5.8 5.8.1(a) Gate 1 will be low ✓ (1)

5.8.1(b) Gate 3 will be high ✓ (1)

5.8.2 Gate 7 inverts ✓ the input from the control line. (1)

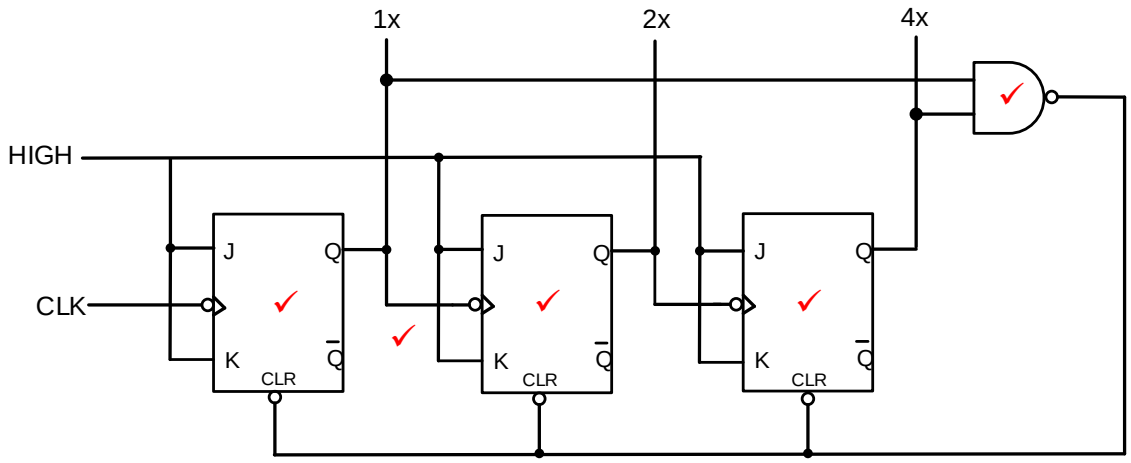
5.8.3 Up counter ✓ (1)

5.8.4 The counter will stop counting ✓ because there will be no change in the outputs (Q and $\bar{Q}$) of the first JK flip-flop ✓ or they will be a zero output on and this will disable the logic gate 3, 4 and 5. ✓ This will lead to a zero output in the second (FF**1**) and the third (FF**2**) flip-flops. ✓ (4)

5.9 5.9.1 Negative edge triggered flip-flop is a flip-flop that reacts to the negative edge of a pulse ✓ which falls from 1 to 0. (1)

5.9.2 Robotics ✓
CNC machines ✓ (2)

5.10

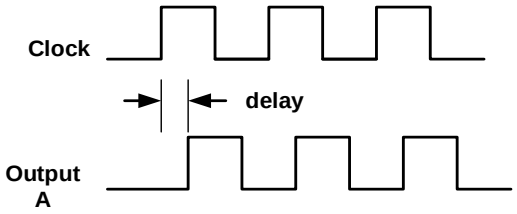


NOTE: 1 mark for each correctly placed symbol = 4
1 mark for correctly placed connections = 1 (5)

5.11 Propagation delay is where the timing signal is delayed ✓ through each flip-flop in the synchronous counter. ✓

OR

NOTE: If the learner only responds with a drawing as shown below, 1 mark will be awarded



(2)

5.12 5.12.1 Serial in-serial out ✓shift register. (1)

5.12.2 Eight clock pulses. ✓ (1)

5.12.3 The bits are clocked into the register one at a time usually from left, ✓ moving through one flip-flop to the right ✓ for every clocked pulse. ✓ (3)

[55]

QUESTION 6: MICROCONTROLLERS

6.1
- Microcontrollers are intended to execute arithmetic and logic operations that make use of data on the chip in the form of the ROM programme. ✓
- The microprocessor moves this data in sequential order from the ROM into the CPU to be processed, ✓ one-instruction-at-a-time, all meticulously controlled by an on-board clock. ✓
- Data is often moved into and out of the RAM for short-term storage, as the process moves through its set sequence. ✓
- The CPU sends its final result to the I/O ports to be communicated out to the 'real world' and to control appliances, when the sequence has ended. ✓ (5)

6.2 6.2.1(a) Accumulator ✓ (1)

6.2.1(b) Control unit ✓ (1)

6.2.1(c) Memory Address Register (MAR) ✓ (1)

6.2.2 (a) To tell the processor what the next instruction is, that needs executing. ✓ and to keep a record of the number of instructions executed, ✓ adding one each time. (2)

6.2.2 (b) To store a copy of the current instruction to be executed. ✓ (1)

6.2.3 First, it fetches instructions and data from memory. ✓ It then decodes ✓ the instructions which are written in binary code, then it executes ✓ the instruction before starting the cycle all over again. (3)

6.3 6.3.1 A = Transmitter ✓
B = Receiver ✓ (2)

6.3.2 Data is transmitted in the form of bits, one after the other, as a series of pulses. ✓ (1)

6.3.3 Reduced speed of data transfer. ✓
Requires parallel-to-serial converter at the transmitter side and serial-to-parallel converter at the receiver side. ✓ (2)

6.4 6.4.1
- Reliable for high-speed serial communication ✓
- Uses less wires than parallel communication ✓
- Useful for communicating serial data, i.e. text, numbers to a PC from a mouse or keyboard
- Easy and low-cost serial interface connection between two computer systems (2)

6.4.2
- A UART creates the data packet on the transmit side by adding both sync, parity and stop bits to the eight-bit byte. ✓
- The data 'packet' is sent out by the transmission line (Tx) with precise timing. ✓
- The UART samples the Receive line (Rx) on the receiving end and at the same timing rates, picks out the sync and parity bits ✓
- It then produces the data in parallel form at its output. ✓
- The UART protocol data flow consists of one start bit, eight data bits and one parity bit and one stop bit.
- Once the start bit has gone high, the next eight bits are data bits, followed by the parity bit. ✓
- The eight-bit data transfer is complete once the stop bit has gone low. ✓ (6)

6.4.3 I^2C ✓ (1)

6.4.4 The Serial Peripheral Interface bus (SPI) is a:
- Synchronous serial communication data link ✓
- It operates in full duplex. ✓
- It uses separate clock and data lines as well as a select line to choose the device chosen to receive data. ✓ (3)

6.5 6.5.1 A set of rules and regulations ✓ that allow two electronic devices to connect and to exchange data and information ✓ between each other. (2)

6.5.2 Simplex ✓
Duplex ✓ (2)

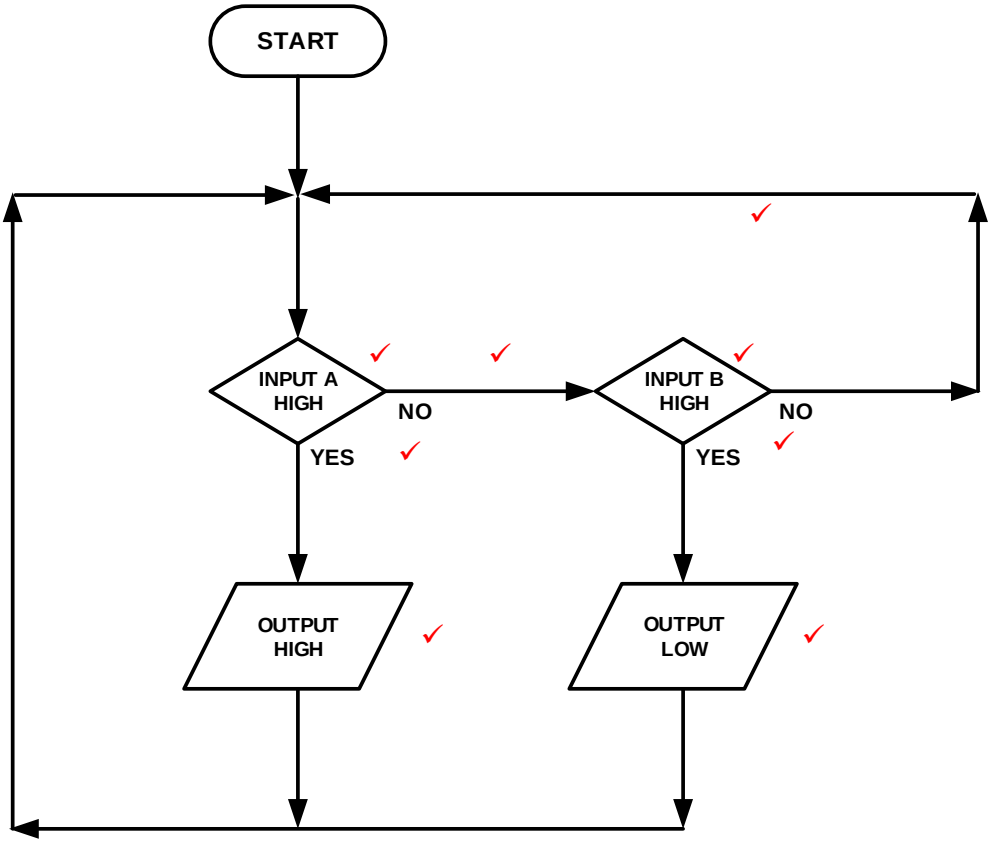
6.5.3 RS-232 ✓
RS-485 ✓ (2)

6.6 The ADC detects a continuously variable (analogue) signal and changes it to a multi-level (digital) signal. ✓ (1)

6.7 6.7.1 A program is a sequence of instructions ✓ that tells a computer how to do a task. ✓ (2)

6.7.2 A flow diagram is a visual representation of the sequence of steps and decisions ✓ needed to perform and complete a process. ✓ (2)

6.8



(8)
[50]

TOTAL: 200

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