Province of the EASTERN CAPE
EDUCATION

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NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2025

ELECTRICAL TECHNOLOGY: DIGITAL ELECTRONICS MARKING GUIDELINE

MARKS: 200

This marking guideline consists of 10 pages.

INSTRUCTIONS TO MARKERS

1. All calculations 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.

   2.6 Markers should consider that learners answers may deviate slightly from the marking guideline depending on how and where in the calculation rounding off was used.

3. This marking guideline is only a guide with model answers.

4. 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 A ✓
1.2 D ✓
1.3 C ✓
1.4 A ✓
1.5 B ✓
1.6 A ✓
1.7 A ✓
1.8 A ✓
1.9 B ✓
1.10 A ✓
1.11 B ✓
1.12 D ✓
1.13 A ✓
1.14 D ✓
1.15 A ✓ **[15]**

QUESTION 2: OCCUPATIONAL HEALTH AND SAFETY

2.1
- The purpose of the Occupational Health and Safety Act is to provide for the health and safety of:
- Persons at work ✓
- Persons in connection with the use of plant and machinery ✓
- The protection of persons against hazards arising out of the activities of other persons at work
- To establish an advisory council for occupational health and safety and related matters. (Any 2 x 1) (2)

2.2 An occurrence of catastrophic proportions, ✓ resulting from the use of machinery, or activities at work. ✓ (2)

2.3 2.3.1 Running could cause you to trip or collide with others. ✓ This could result in injuring with nearby equipment or machinery. ✓ (2)

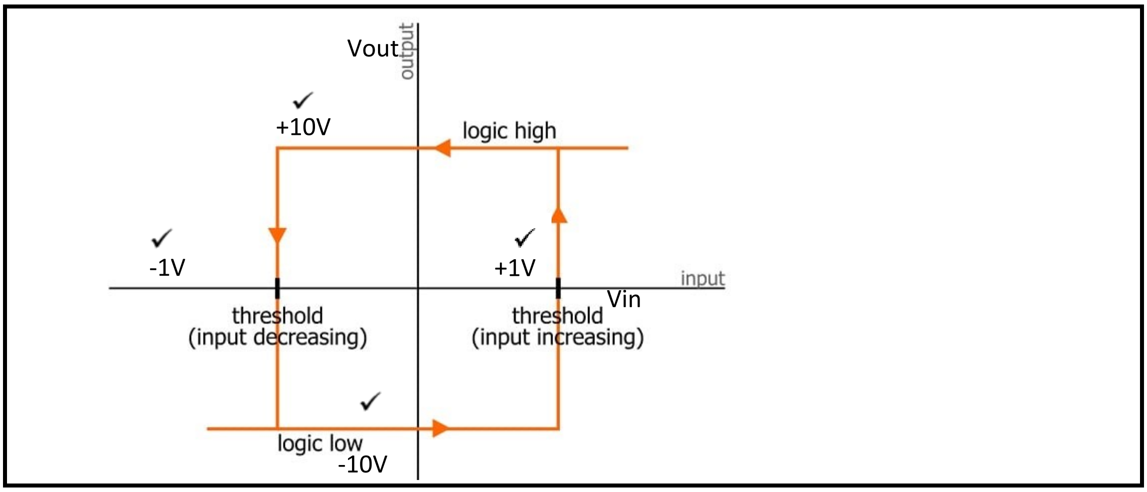
2.3.2 This could cause the outlet to exceed its rated current ✓ and could lead to short circuits, fires or damaged appliances. ✓ (2)

2.4 Faulty tools or equipment ✓
Poor ventilation ✓
Poor or missing guards
Excessive noise
Lack of knowledge of emergency procedures (Any relevant answer) (2)
[10]

QUESTION 3: SWITCHING CIRCUITS

3.1 The time lag between cause and effect. ✓ (1)

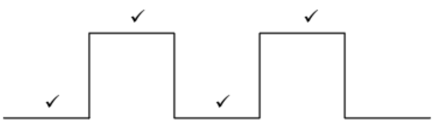
3.2



(4)

3.3 Widely used in the first stages of many radio receivers. ✓
In digital circuitry noise is often introduced into a system via switch bounce which can cause a number of unwanted voltage spikes to appear during switching-on period. ✓
Varying input waveforms, for example a sine wave can be changed into a square or rectangular wave. ✓
A signal can be successfully recovered using a Schmitt trigger even after having suffered severe distortion. ✓ (4)

3.4



(4)

3.5 3.5.1 Mono-stable Multivibrator ✓ (1)

3.5.2 As the switch is activated it pulls pin 2 of the IC to 0 V, ✓ triggering the 555.
This immediately re-sets the circuit, ✓ setting both the Output pin 3 and Discharge pin 7 'high'. ✓ (3)

3.5.3 When triggered, C1 charges through R1 ✓ and the time it takes to reach the threshold voltage (2/3 Vcc) dictates how long the output remains high. ✓ (2)

3.5.4 τ = 1,1 x R x C ✓

τ = 1,1 x 90 000 x 0,0001 ✓

τ = 9,9 seconds ✓ (3)

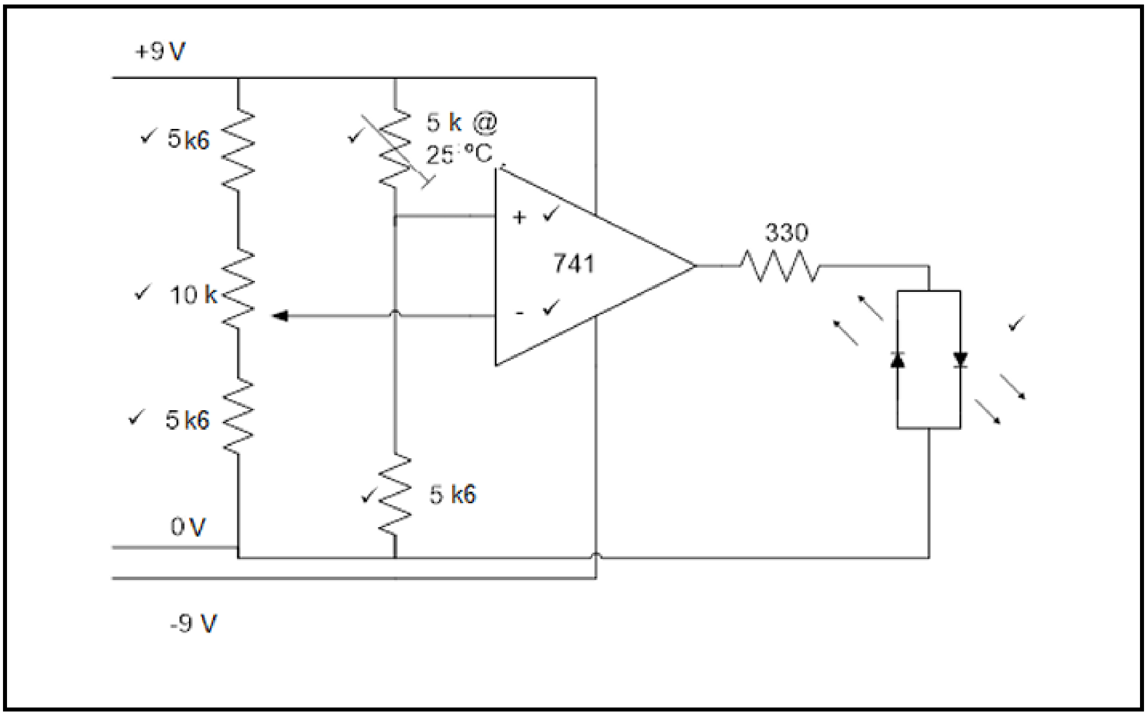
3.5.5 De-bouncing ✓
Varying the time period ✓ (2)

3.6 3.6.1 This means that the time constant (RC) component values are large. ✓ (1)

3.6.2 In this circuit with a long time constant, a square wave would produce a long, slow triangular wave at its output. (1)

3.7 The less light on the LDR, ✓ the higher the resistance. ✓
The more light on the LDR, ✓ the lower the resistance. ✓ (4)

3.8



(8)

3.9 3.9.1 By adding another input resistor to the summing amplifier input. ✓ (1)

3.9.2

$$V_{OUT} = -\left(V_1\frac{R_F}{R_1} + V_2\frac{R_F}{R_2} + V_3\frac{R_F}{R_3}\right) V \checkmark$$
$$3{,}1\ V = -(100\ mV\frac{R_F}{20k} + 200\ mV\frac{R_F}{10k} + 300\ mV\frac{R_F}{50k}\ V \checkmark$$
$$3{,}1\ V = -(5 \times 10^{-6}R_F + 2 \times 10^{-5}R_F + 6 \times 10^{-3}R_F)\ V \checkmark$$
$$3{,}1\ V = 3{,}1 \times 10^{-5}R_F$$
$$R_F = \frac{3{,}1}{3{,}1 \times 10^{-5}}\ \Omega$$
$$R_F = 100\ k\Omega \checkmark$$

(4)

3.9.3 It is negative because the inputs are fed into the inverting input, ✓ which will cause the output to be 180° out of phase. ✓ (2)

3.10 Switch bounce can be eliminated by using a monostable multivibrator circuit to control the output. ✓ (1)

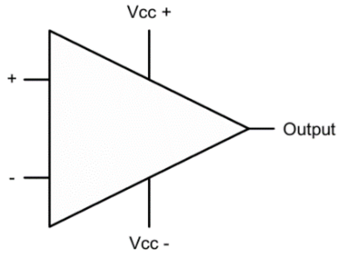
3.11

$$Vout = -(V_1\frac{R1}{Rf} + V_2\frac{R2}{Rf} + V_3\frac{R3}{Rf})\ V$$
$$-2{,}7V = -(150mV\frac{30k}{120k} + 430mV\frac{17k}{120k} + V_3\frac{21k}{120k}) \checkmark$$
$$-2{,}7V = -(0{,}0375 + 0{,}061 + 0{,}175V_3) \checkmark$$
$$-2{,}7V = -(0{,}0985 – 0{,}175V_3) \checkmark$$
$$V_3 = \frac{2{,}6015}{0{,}175}$$
$$V_3 = 14{,}87\ V \checkmark$$

(4)
[50]

QUESTION 4: SEMICONDUCTOR DEVICES

4.1



Drawing correct ✓
Inputs and Output labelled correct ✓
Positive and negative supplies labelled correct ✓ (3)

4.2 Input stage (Differential amplifier) ✓
Intermediate stage (High gain differential amplifier) ✓
Common Collector (Darlington Pair) output stage ✓ (3)

4.3 It is an active low trigger ✓
When the voltage on pin 2 is less than ⅓ of the supply, the output goes high ✓
When the voltage on pin 2 is higher than ⅔ of the supply, the output will go low ✓
If connected to ground, the output will go 'high' and remain 'high' ✓ (4)

4.4 The op-amp should be able to amplify any input of any frequency, from 0 Hz through to radio frequency and higher. ✓ This is not practical and the gain drops at higher frequencies. ✓ This is due to internal capacitances in the op-amp's chip. ✓ (3)

4.5 4.5.1

$$A_V = 1 + \frac{R_F}{R_{IN}} \checkmark$$
$$A_V = 1 + \frac{50\,000}{10\,000} \checkmark$$
$$A_V = 6 \checkmark$$
(3)

4.5.2

$$V_{OUT} = V_{IN} \times \left(1 + \frac{R_F}{R_{IN}}\right) V \checkmark$$
$$V_{OUT} = 1{,}5 \times \left(1 + \frac{50\,000}{10\,000}\right) V \checkmark$$
$$V_{OUT} = 9\ V \checkmark$$
(3)

4.5.3 If the value of the feedback resistor is decreased the gain of the amplifier will decrease causing the output voltage to decrease. ✓ (1)

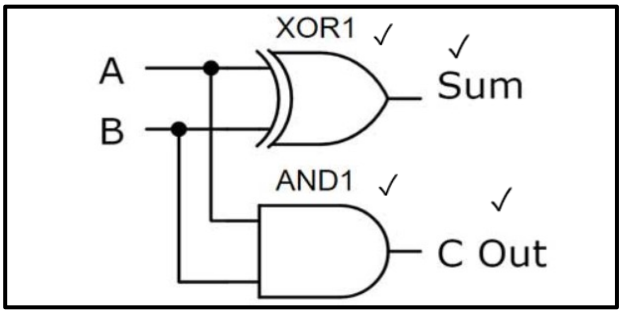
[20]

QUESTION 5: DIGITAL AND SEQUENTIAL DEVICES

5.1 Polarisation ✓ (1)

5.2 The anodes of all 8 LEDs are connected together ✓ on the positive voltage rail ✓ (2)

5.3 5.3.1



(4)

5.3.2

A	B	C Out	Sum
0	0	0 ✓	0
1	0	0 ✓	1
0	1	0 ✓	1
1	1	1 ✓	0

(4)

5.4 5.4.1 D-Type Latch ✓ D Flip-Flop (1)

5.4.2 In this circuit the R input has been replaced by the compliment (inversion) of the S input.
The S input has been renamed to D input. ✓
If the clock input is low, the D-Latch will not respond to an input signal. Once the clock input goes high the output will follow the D input. As the second input is always the inverse of the D input there will thus never be an illegal state. ✓ (2)

5.4.3 Shift Registers ✓
Storage Registers ✓ (2)

5.5 A synchronous counter uses a common clock pulse ✓ that tries to clock all the various JK flip-flops simultaneously. ✓

An asynchronous counter has a clock pulse only on the first JK latch ✓ that serves as the LSB. The output of each JK latch is set as the clock pulse for the next JK latch. ✓ (4)

5.6 Serial-in: Parallel-out shift register (SIPO) ✓
Serial-in: Serial-out shift register (SISO) ✓
Parallel-in: Parallel-out shift register (PIPO) (2)

5.7 All four bits of the input will simultaneously ✓ be loaded to the input of all the flip-flops. ✓
After one clock pulse each flip-flop will shift its input to its output. ✓
This process will repeat itself for four clock pulses ✓ so that the complete 4-bit input is available at the output. (4)

5.8 An encoder is designed to accept input data in decimal form ✓ and to convert this information into its binary form. ✓

A decoder is designed to convert a binary code into a recognizable decimal form, ✓ either as a digit or as a character. ✓ (4)

5.9 Frequency divider ✓
Decade counter ✓
Binary coded decimal counter ✓ (3)

5.10 They are slower ✓ due to the propagation delay through the additional gates in the system. ✓ (2)

5.11 5.11.1 Encoder ✓ (1)

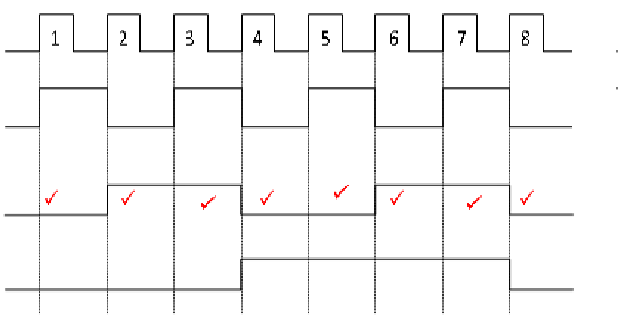
5.11.2

INPUTS	OUTPUTS ✓	
	A_1	A_0
0	0	0 ✓
1	0	1 ✓
2	1	0 ✓
3	1	1 ✓

(5)

5.12

5.12.1



NOTE: A mark is allocated for the correct count at each clock pulse e.g. the count at clock pulse 3 should be 011 and at clock pulse 8 the count should be 000. (8)

5.12.2 The circuit in FIGURE 5.12 is synchronous. ✓ (1)
[50]

QUESTION 6: MICROCONTROLLERS

6.1 Microcontrollers are used in industrial control devices:

- Industrial instrumentation ✓
- Monitoring ✓
- Process control
- Cooling systems (Any 2 x 1) (2)

6.2 6.2.1 Microcontroller ✓ (1)

6.2.2 RAM (Random Access memory) ✓ (1)

6.2.3 Read Only Memory ✓ (1)

6.3 The Current Instruction Register (CIR) splits the instruction into two parts. ✓ One part is decoded by the control unit ready for execution, ✓ the other part is the address of the data stored that needs to be used together with that instruction. ✓ (3)

6.4 6.4.1 –200 mV = 1 ✓
200 mV = 0 ✓ (2)

6.4.2 To connect the following to the main frame:
Point of sale terminals ✓
Metering instruments ✓
Large special automated machines ✓ (3)

6.4.3 Simplex data communication is where all data and information travels in only one direction ✓ from transmitter to receiver. ✓

Half duplex communication is where the two devices take turn in communicating, ✓ one after the other. ✓ (4)

6.5 6.5.1

- Control bus ✓
- Data bus ✓
- Address bus ✓ (3)

6.5.2

- Supports a higher data transfer rate. ✓
- The sender and the receiver use the same clock pulse. ✓ (2)

6.5.3

- Requires more communication lines. ✓
- Requires more space. ✓
- Requires larger connections. (2)

6.6 6.6.1 A program is a sequence of instructions ✓ that tell a computer how to do a task. ✓ (2)

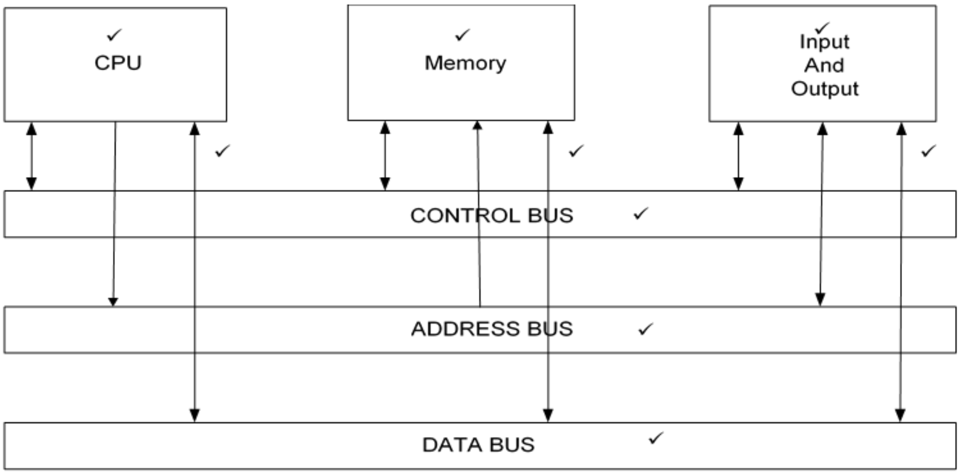
6.6.2 A flowchart is a pictorial version of an algorithm ✓ and illustrates the flow of a program. ✓ (2)

6.6.3 An algorithm is a precise set of procedures to be followed ✓ to solve a problem. ✓ (2)

6.7 In legal data flow the data lines will follow one another after a specific action ✓ and they will not cross one another or move against the other flow. ✓

In illegal data flow the data lines will just end without reaching a function. ✓ The data lines may also move against the flow of other lines or the data lines may cross other data lines. ✓ (4)

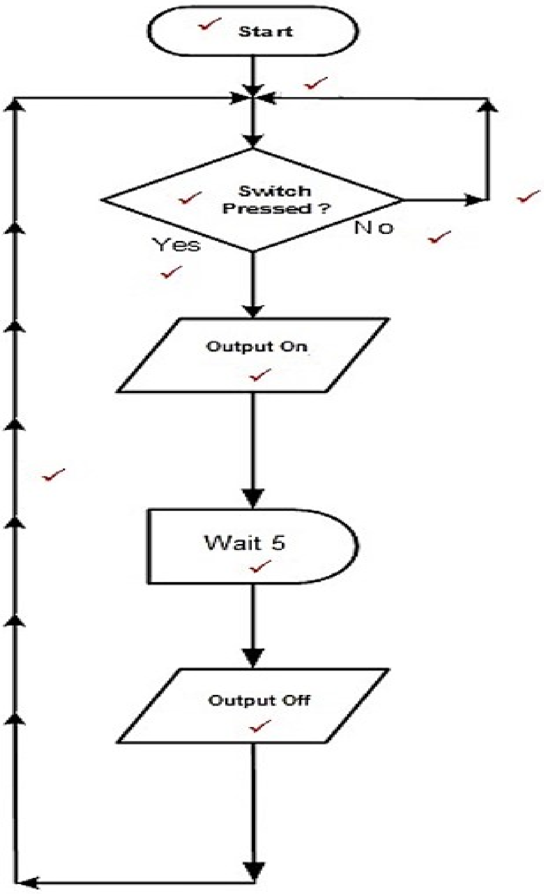
6.8 6.8.1



(9)

6.8.2 Shared boundary ✓ across which two separate components of a computer system exchanges information. ✓ (2)

6.9



(10)
[55]

TOTAL: 200