Province of the
EASTERN CAPE
EDUCATION

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NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2025

ELECTRICAL TECHNOLOGY: DIGITAL ELECTRONICS

MARKS: **200**

TIME: **3 hours**

This question paper consists of 16 pages, including a 1-page formula sheet and a 2-page answer sheet.

INSTRUCTIONS AND INFORMATION

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

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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 numbers (1.1 to 1.15) in the ANSWER BOOK, for example 1.16 D.

1.1 The purpose of the Occupational Health and Safety Act is to …

A provide for the health and safety of persons at work.
B provide for the health and safety of persons at home.
C prevent wear and tear on machinery.
D prevent workers from using machinery. (1)

1.2 The function toggle is obtained in an active low JK flip-flop when the inputs are ...

A J = 0 and K = 0
B J = 1 and K = 0
C J = 0 and K = 1
D J = 1 and K = 1 (1)

1.3 The bistable multivibrator has the following characteristics:

A Free running with ONE input
B Free running with TWO inputs
C TWO stable states with TWO inputs
D NO stable states with ONE input (1)

1.4 With reference to a monostable multivibrator, the time an output stays high is determined by:

A The time constant (RC)
B The length of time you push the button
C The magnitude of the supply voltage
D It will stay high indefinitely (1)

1.5 The term *full sequence counter* refers to a counter that …

A counts from 0 to 5.
B runs to its maximum count.
C is interrupted during the count.
D stops counting at 2. (1)

1.6 In which ONE of the following devices is a microcontroller found?

A Laptop
B Transistor radio
C Microwave oven
D Swimming-pool pump (1)

1.7 To prevent infection when treating burns, the following should NOT be done:

A Do not take a pain killer
B Do not pop blisters
C Do not use a sterile gauze or bandage
D Do not hold the burned area under cool running water (1)

1.8 With reference to microcontrollers, a … is an example of an input.

A sensors
B motors
C monitors
D LED display (1)

1.9 Which 741 operational amplifier circuit would amplify an input signal in phase without distorting the output signal?

A Inverting amplifier
B Non-inverting amplifier
C Voltage-following amplifier
D Schmitt-trigger amplifier (1)

1.10 Pulse triggered flip-flop circuits are also referred to as:

A Master/Slave
B Follow my lead
C Simultaneous trigger
D Continuous trigger (1)

1.11 With reference to microcontrollers, identify which ONE is NOT part of the microcontroller:

A Control unit
B Serial port
C Memory
D Arithmetic Logic Unit (1)

1.12 The … is where the timing signal is delayed by a fraction of time through each flip-flop.

A ripple counter
B down counter
C frequency divider
D propagation delay (1)

1.13 The term ‘debugging’ refers to:

A Identify and remove errors
B Find bugs and kill them
C Find bugs and remove them
D All of the above (1)

1.14 With reference to microcontrollers, the term RAM means:

A Read All Memory
B Random Allocation Memory
C Read and Memorise memory
D Random Access Memory (1)

1.15 The maximum supply voltage for a 555 IC is:

A +15 V
B +12 V
C -12 V
D +5 V (1)

[15]

QUESTION 2: OCCUPATIONAL HEALTH AND SAFETY

2.1 Explain the purpose of the Occupational Health and Safety Act. (2)

2.2 Define *major incident* with reference to the Occupational Health and Safety Act, 1993 (Act 85 of 1993). (2)

2.3 Describe why the following are unsafe acts:

2.3.1 Running in the workshop (2)

2.3.2 Overloading electrical outlets with too many appliances (2)

2.4 State TWO unsafe conditions that must be avoided in a workshop. (2)

[10]

QUESTION 3: SWITCHING CIRCUITS

3.1 Define *hysteresis.* (1)

3.2 Draw a fully labelled diagram of a typical hysteresis curve. Use ANSWER SHEET for QUESTION 3.2. (4)

3.3 List FOUR applications of a Schmitt trigger. (4)

3.4 Draw the output waveform of a 555 timer IC used as a Schmitt Trigger. Show at least TWO full cycles. (4)

3.5 With reference to FIGURE 3.5 below, answer the following questions.

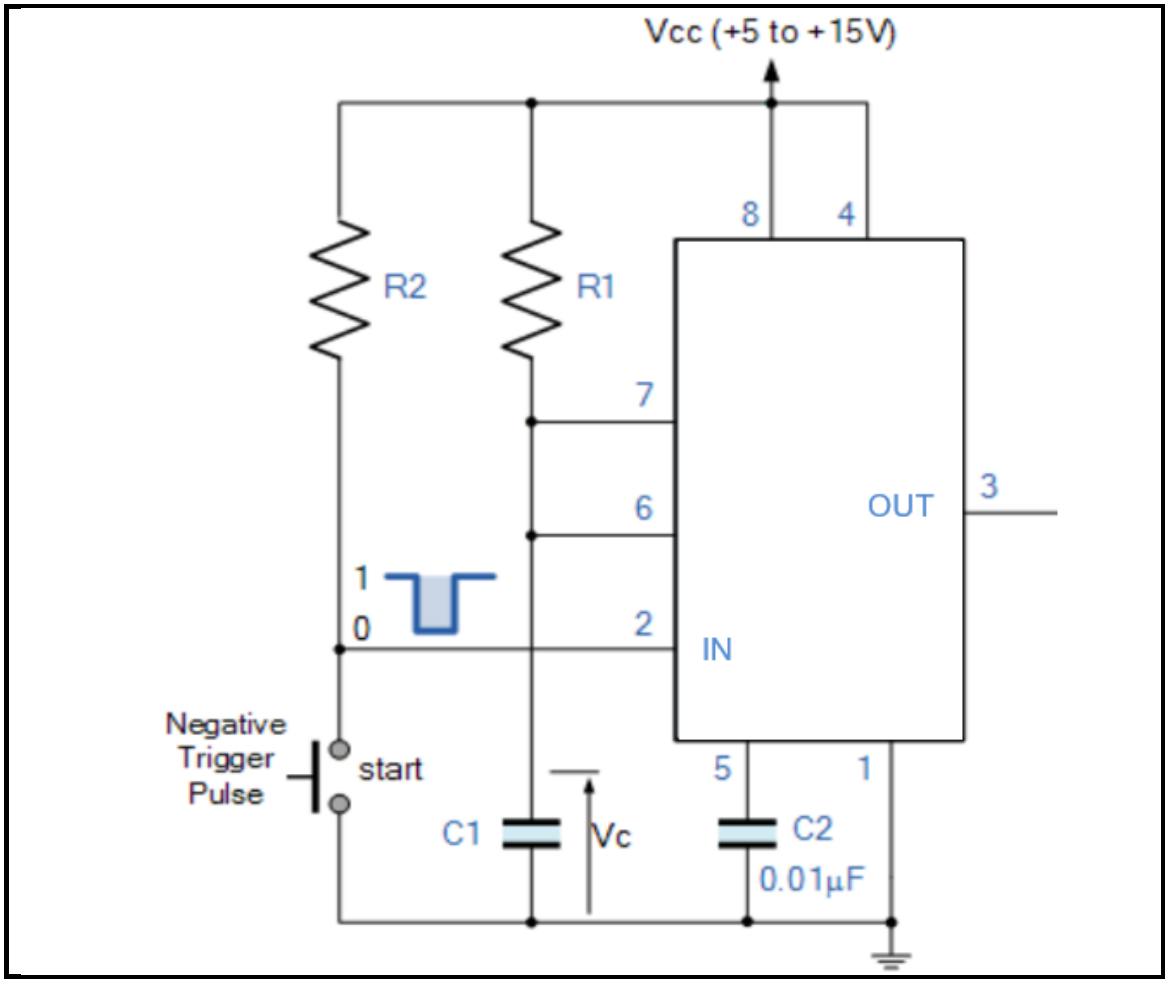


FIGURE 3.5

3.5.1 Identify the circuit in FIGURE 3.3 above. (1)

3.5.2 Describe what happens when the SET switch, S1 is pressed. (3)

3.5.3 Explain the function of C1 in the circuit. (2)

3.5.4 Calculate the time delay of the circuit if it uses a 100 µF capacitor and a 90 KΩ resistor in its timing circuit. (3)

3.5.5 Name TWO applications for the above-mentioned circuit. (2)

3.6 When an active op amp integrator has a very long time constant.

3.6.1 State what this means with regard to the components of the circuit. (1)

3.6.2 What shape of output wave form would be expected from this circuit if it was presented with a square wave? (1)

3.7 Explain the principle of operation of a light dependent resistor (LDR). (4)

3.8 Complete the fully circuit diagram for a temperature sensor using a 741 op amp on the ANSWER SHEET for QUESTION 3.8. (8)

3.9 Refer to FIGURE 3.9 below and answer the questions that follow.

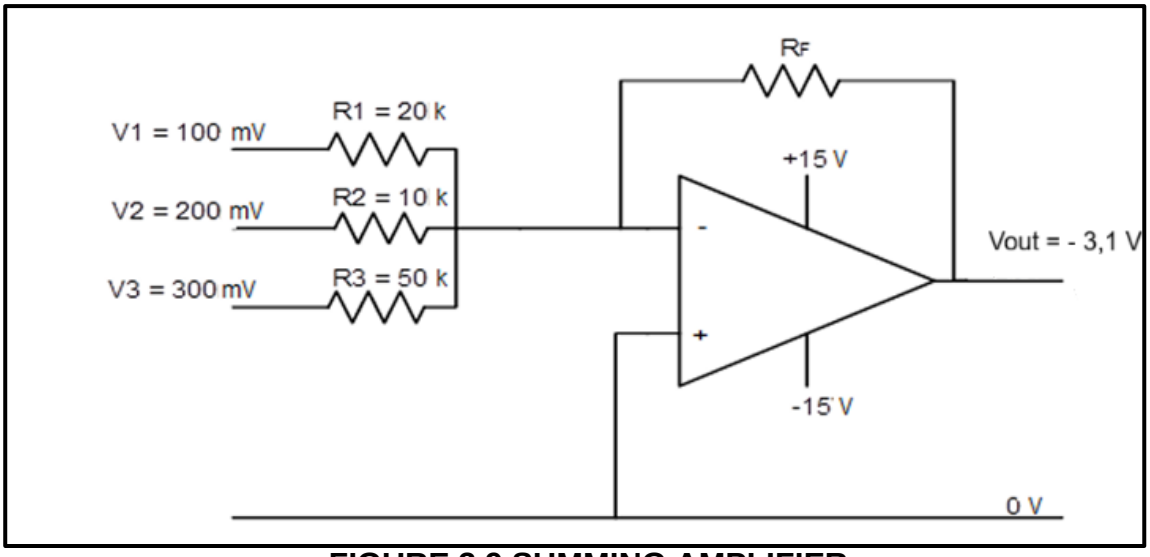


FIGURE 3.9 SUMMING AMPLIFIER

3.9.1 State how an input signal can be added to the summing amplifier. (1)

3.9.2 Calculate the value of the feedback resistor (RF). (4)

3.9.3 State why the output voltage in FIGURE 3.9 is negative. (2)

3.10 Explain how to eliminate switch bounce. (1)

3.11 A summing amplifier has three input resistors with the following values:
R1 = 30 kΩ, R2 = 17 kΩ, R3 = 21 kΩ

The output voltage for this circuit is given as –2,7 V. The known input voltages are: V1 = 150 mV, V2 = 430 mV

Calculate the value of V3 if this circuit has a 120 kΩ feedback resistor. (4)

[50]

QUESTION 4: SEMICONDUCTOR DEVICES

4.1 Draw a neat IEC symbol of the 741 operational amplifier. (3)

4.2 State the THREE stages of a 741 operational amplifier. (3)

4.3 With reference to a 555 timer IC, explain the function of pin 2 (trigger). (4)

4.4 With reference to operational amplifier characteristics, explain the term *bandwidth*. (3)

4.5 FIGURE 4.5 below shows the op amp as a non-inverting amplifier. Answer the questions that follow.

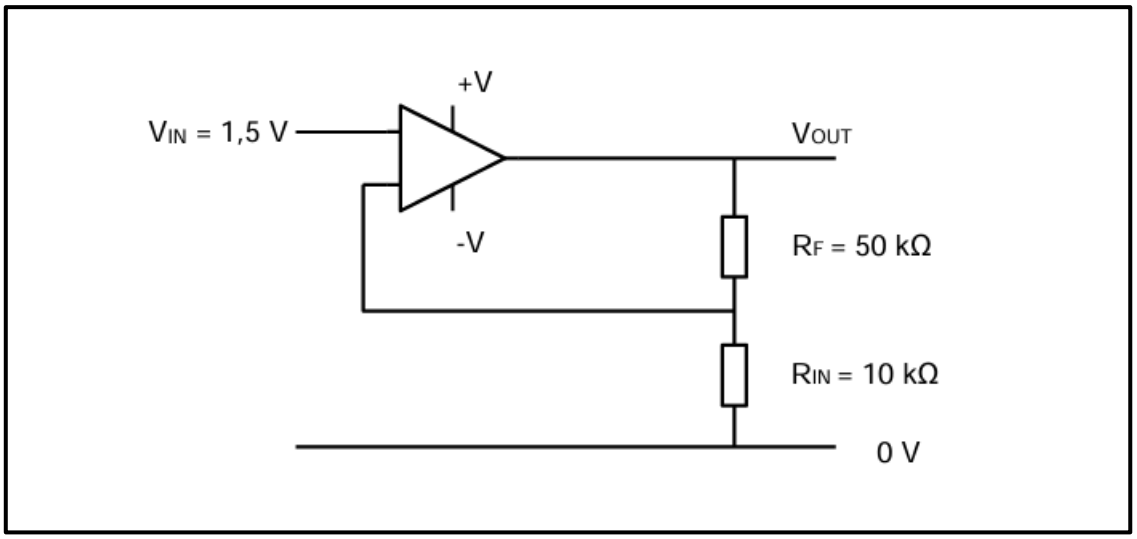


FIGURE 4.5

4.5.1 Calculate the voltage gain in FIGURE 4.5. (3)

4.5.2 Calculate the output voltage. (3)

4.5.3 Describe the effects of decreasing the feedback resistor. (1)

[20]

QUESTION 5: DIGITAL AND SEQUENTIAL DEVICES

5.1 Name the light altering principle that a liquid crystal display relies on. (1)

5.2 Explain the term *common anode* with reference to the seven segment LED display. (2)

5.3 A combinational logic circuit combining an AND-gate with an exclusive OR-gate (XOR) creates the basic circuit for a computer's binary single bit addition, the HALF-ADDER circuit.

5.3.1 Complete the half-adder circuit using the ANSWER SHEET for QUESTION 5.3.1. (4)

5.3.2 Complete the truth table on the ANSWER SHEET for QUESTION 5.3.2. (4)

5.4 FIGURE 5.4 below represents the logic symbol of a flip-flop.

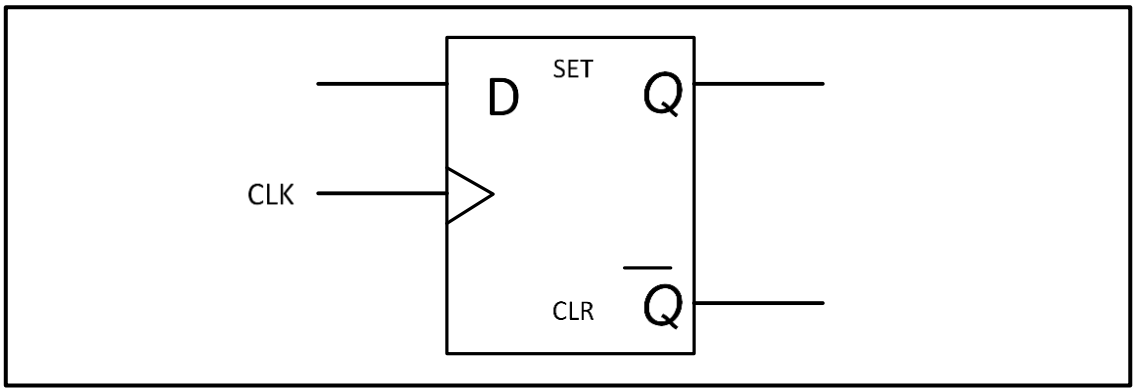


FIGURE 5.4

5.4.1 Identify the flip-flop in FIGURE 5.4. (1)

5.4.2 Explain how the circuit is designed to eliminate any illegal states in the operation of this flip-flop. (2)

5.4.3 Name TWO applications of this type of flip-flop. (2)

5.5 Discuss the difference in working principle between a *synchronous* and an *asynchronous* ripple counter. (4)

5.6 Name TWO types of shift registers, other than the parallel-in-serial-out shift register, that are used in digital electronic circuits. (2)

5.7 Explain how a parallel-in-serial-out shift register (PISO) consisting of four D-type flip-flops will shift a 4-bit input to the output. (4)

5.8 Give the difference between an *encoder* and a *decoder*. (4)

5.9 Name THREE applications of counters. (3)

5.10 Explain the disadvantage of propagation delay. (2)

5.11 With reference to FIGURE 5.11 below, answer the questions to follow.

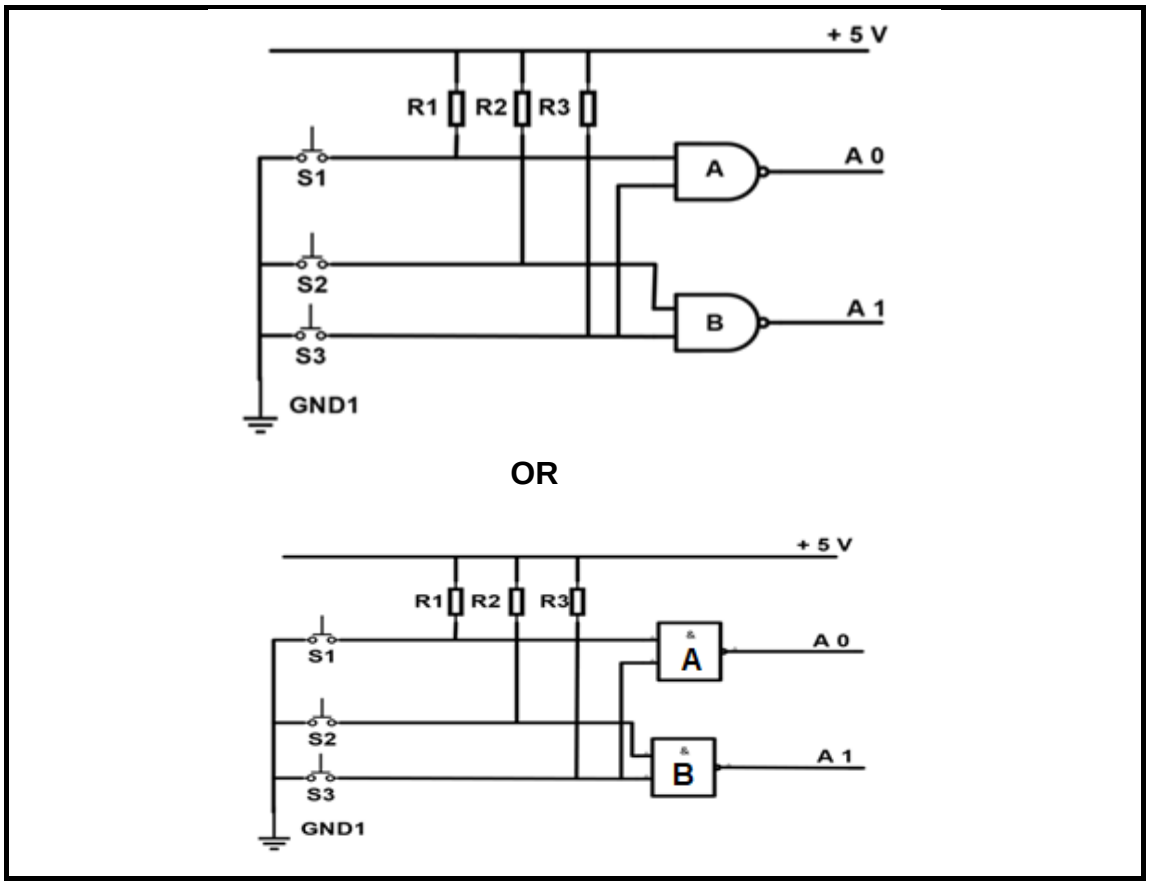


FIGURE 5.11

5.11.1 Identify the circuit in FIGURE 5.11. (1)

5.11.2 Draw a truth table for the circuit in FIGURE 5.11. (5)

5.12 Refer to FIGURE 5.12 below of a three-stage binary counter and answer the questions that follow.

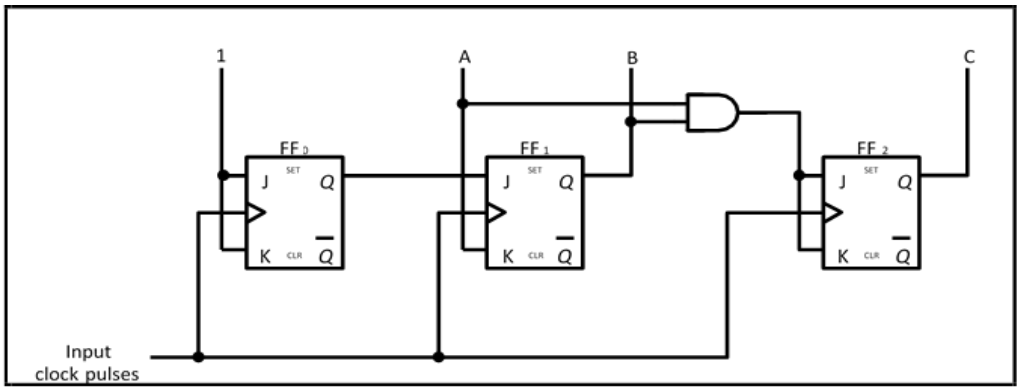


FIGURE 5.12

5.12.1 Complete the timing diagrams for this counter on the ANSWER SHEET for QUESTION 5.12.1. (8)

5.12.2 State whether the circuit in FIGURE 5.4 is synchronous or asynchronous. (1)

[50]

QUESTION 6: MICROCONTROLLERS

6.1 Name TWO uses of a microcontroller in industrial control devices. (2)

6.2 Refer to the block diagram in FIGURE 6.2 below and answer the questions that follow.

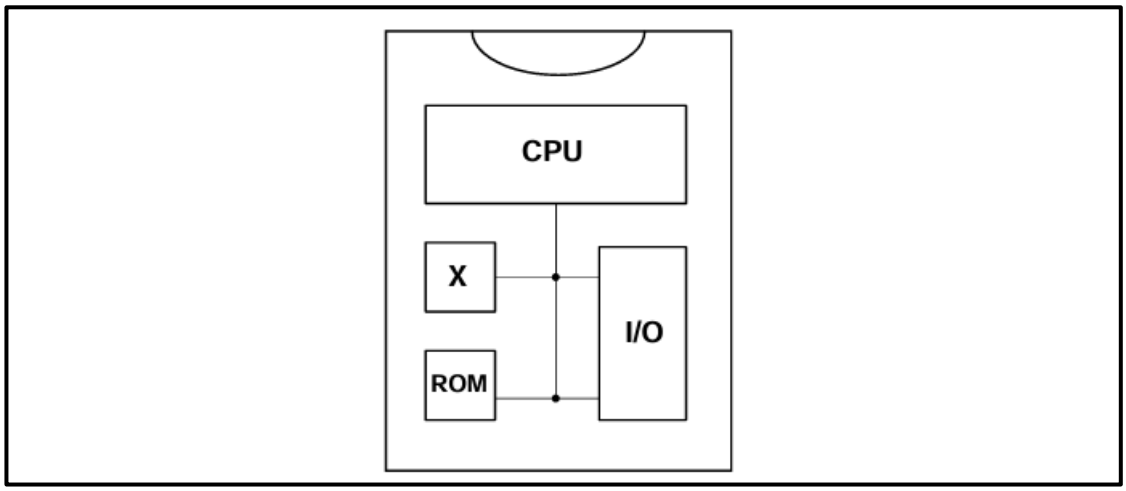


FIGURE 6.2

6.2.1 Identify the block diagram in FIGURE 6.2. (1)

6.2.2 Identify component **X**. (1)

6.2.3 Write out the abbreviation ROM in full. (1)

6.3 Explain the function of a current instruction register (CIR) within the CPU. (3)

6.4 Answer the following questions with reference to RS-485 communication protocol.

6.4.1 State the logic values which is represented by –200 mV and 200 mV. (2)

6.4.2 State THREE applications of the RS-485. (3)

6.4.3 Explain the differences between *simplex communication* and *half duplex communication*. (4)

6.5 Answer the following questions with reference to communication in a microcontroller.

6.5.1 Name the THREE busses that forms part of the system bus in a microcontroller. (3)

6.5.2 State TWO advantages of synchronous communication when compared to asynchronous communication. (2)

6.5.3 State TWO disadvantages of parallel communication when compared to serial communication. (2)

6.6 Refer to software of microcontrollers and explain the following terms:

6.6.1 *Program* (2)

6.6.2 *Flowchart* (2)

6.6.3 *Algorithm* (2)

6.7 Discuss the difference between *legal* and *illegal data flow* within a flow chart. (4)

6.8 Refer to communication in a microcontroller and answer the questions that follow.

6.8.1 Draw the block diagram of a microcontroller, clearly indicating the THREE system buses. (9)

6.8.2 Define the term *interface*. (2)

6.9 Draw a flow diagram for a device that only has one input and one stable state. The program switches the output on and off every 5 seconds and then returns to the original state. (10)

[55]

TOTAL: 200

FORMULA SHEET

SWITCHING CIRCUITS

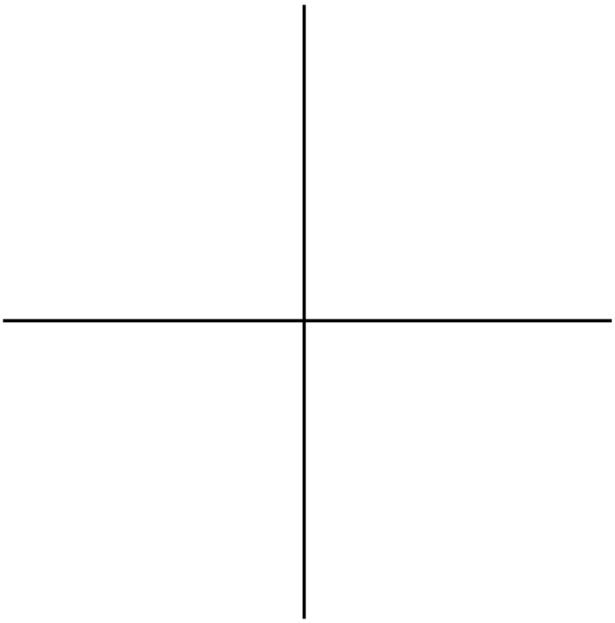
1. $\text{Gain A}_V = \frac{V_{OUT}}{V_{IN}} = -\left(\frac{R_f}{R_{in}}\right)$ inverting operational amplifier
2. $\text{Gain A}_V = \frac{V_{OUT}}{V_{IN}} = 1 + \left(\frac{R_f}{R_{in}}\right)$ non-inverting operational amplifier
3. $V_{OUT} = V_{IN} \times \left(-\frac{R_f}{R_{in}}\right)$ inverting amplifier
4. $V_{OUT} = -(V_1 + V_2 + V_3)$ summing up op amp
5. $f_r = \frac{1}{2\pi\sqrt{LC}}$
6. $f = \frac{1}{2\pi\sqrt{6RC}}$

LEARNER'S NAME: _____

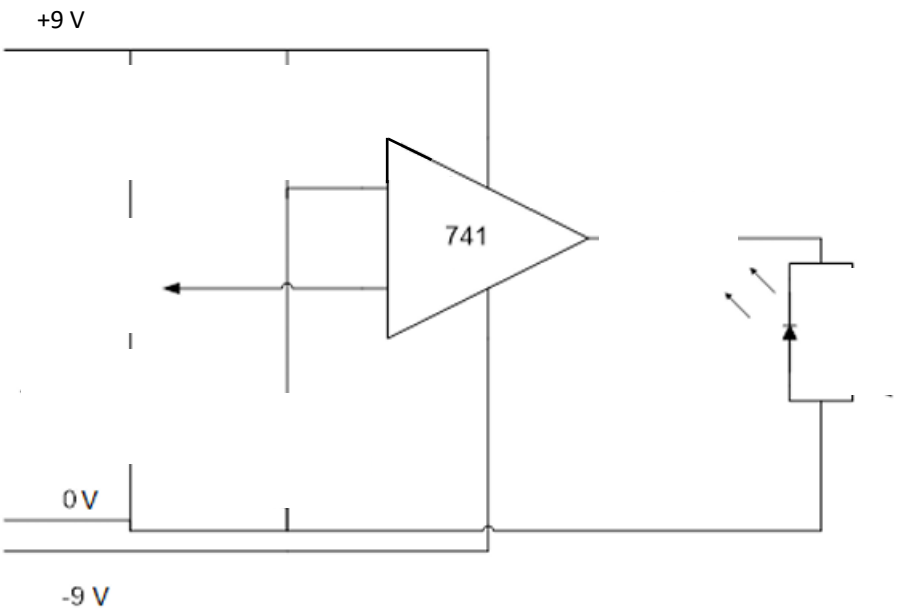
ANSWER SHEET

QUESTION 3: SWITCHING CIRCUITS

QUESTION 3.2



QUESTION 3.8



LEARNER'S NAME: _____

ANSWER SHEET

QUESTION 5: DIGITAL AND SEQUENTIAL DEVICES

QUESTION 5.3.1

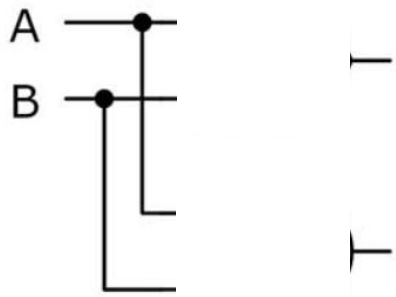


FIGURE 5.3.1

QUESTION 5.3.2

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

FIGURE 5.3.2

QUESTION 5.12.1

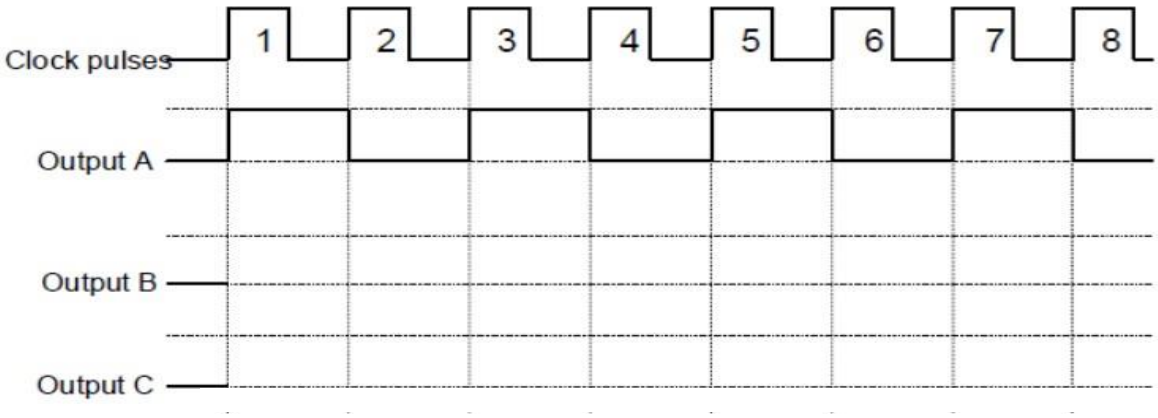


FIGURE 5.12.1