



TECHNICAL UNIVERSITY OF MOMBASA

School of Engineering and Technology

Department of Electrical and Electronic Engineering

UNIVERSITY EXAMINATION FOR:

Bachelor of Science in Electrical and Electronic Engineering

EEE 4509: Digital Systems Design II

END OF SEMESTER EXAMINATION

SERIES: APRIL 2025

TIME: 2 HOURS

DATE: April 2025

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **five** Questions; Question ONE is compulsory. In addition, attempt any Other TWO Questions.

Do not write on the question paper.

Question ONE (Compulsory 30 marks)

- a) (i) Explain micro operation as used with digital systems
- (ii) Explain the **FOUR** categories of micro operations encountered in a digital system
- (iii) Describe the following micro operations
 - I $R_0 \leftarrow R_1 + R_2$
 - II $R_0 \leftarrow R_1 + R_2 + 1$ [7 marks]
- b) Using full adder and associated combinational logic circuits of FIG Q1(b), design a 4 – bit arithmetic circuit to perform the following:

When $S = 0$ the circuit performs $F_i = A_i + B_i$

When $S = 1$ the circuit performs $F_i = A_i - B_i$ [13 marks]

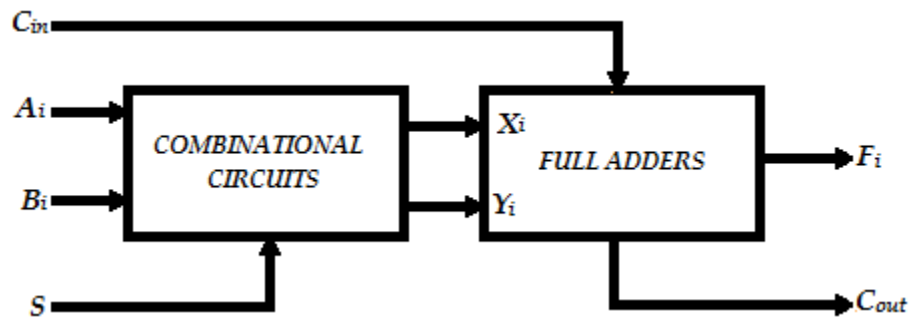


FIG. Q1(b)

c) Explain the following THREE hardware design phases of a digital system

(i) Circuit design.

(ii) System design

(iii) Logic design

[6 marks]

d) Describe the event that takes place as symbolised by the following micro operation statements:

i) W: $M[A1] \leftarrow B2$

ii) R: $MBR \leftarrow M$

[4 marks]

Question TWO

a) Show the block diagram of the hardware that implements the following register transfer statement:

$yT_2 = R2 \leftarrow R1, R1 \leftarrow R2$

[4 marks]

b) With the aid of a diagram, explain the various parts of a digital computer system.

[6 marks]

c) Differentiate between immediate addressing and direct addressing as used in a digital computer system

[2

marks]

d) i) An 8-bit single computer requires 3 kilobytes of RAM and 2 kilobytes of ROM to operate. Assuming that ROM starts at memory location 0000H followed immediately by RAM, draw the memory map for the system

ii) Implement the memory in (i) using ROM chips of 512 X 4 and 512 X 8

[12 marks]

Question THREE

a) Design an arithmetic circuit with two selection variables S_1 and S_0 that generates the following arithmetic operations. Draw the logic diagram of two typical stages

S_1	S_0	Operation	Function
0	0	$F = A + B$	$F = A + B + 1$
0	1	$F = B - A - 1$	$F = B - A$
1	0	$F = A - 1$	$F = A$
1	1	$F = \overline{A}$	$F = \overline{A} + 1$

[14 Marks]

- b) With the aid of a diagram, explain the operation of a scratchpad memory used by a processor unit

[6

marks]

Question FOUR

- a) Assuming that the program counter contains the appropriate, opcode and using Instruction Register and Temporary Register, write the symbolic sequence of operation required to execute the following instruction:

(i) Add **B** to **A**

(ii) Add immediate operand to **A**

[6 marks]

- b) A processor unit employs a scratchpad memory. The processor consists of 32 registers of eight bits each. Determine

(i) The size of the scratchpad memory

(ii) The number of lines needed for the address

(iii) The number of lines for input data.

[5 marks]

- c) (i) Prove the validity of the following relationships for a digital logic system:

I $x \oplus 0 = x$

II $x \oplus 1 = \bar{x}$

III $x \oplus \bar{y} = x y$

- (ii) Explain in words the operations specified by the following register transfer operations:

I $R3 \leftarrow R3 - 1$

II If ($S_1 = 1$) then $R0 \leftarrow R1$ else if ($S_2 = 1$) then $R0 \leftarrow R2$

III $R2 \leftarrow R2 + 1, R1 \leftarrow R$

[9 marks]

Question FIVE

- a) Explain the components and concepts of register-transfer logic in digital circuit design

[8 marks]

- b) A typical processor unit is designed to consist of a register file with seven registers R1 through R7, two multiplexers to select bus **A** input and **B** input, a destination select decoder, an **ALU** and a shifter register and a status register.

(i) Draw a block diagram of processor unit with appropriate interconnection and describe its operation.

(ii) Draw the corresponding control word diagram and describe the function of each field

(iii) Give the bit values in the control word for the following micro-operation

I ($R1 \leftarrow R1 - R2$)

II ($R2 \leftarrow R4$)

[12 Marks]