# EENG 5560 HW 2 Report

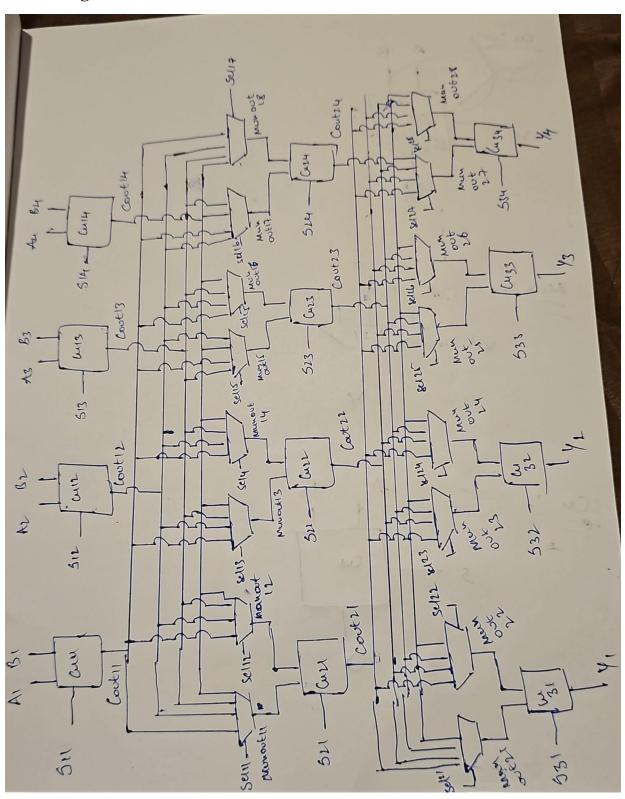
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# **Design**

## Block diagram



Overall component: top box

Input ports:

Port name	Bit width	Purpose
A1 B1 ,A2	6	Operand 1-operand 8
<b>B2</b>		
,A3 B3,A4		
<b>B4</b>		
S11-S14,	5	Cu selection lines
S21- S24,		
S31-s34		
Sel11- Sel18	2	Mux selection lines
Sel21- Sel28		

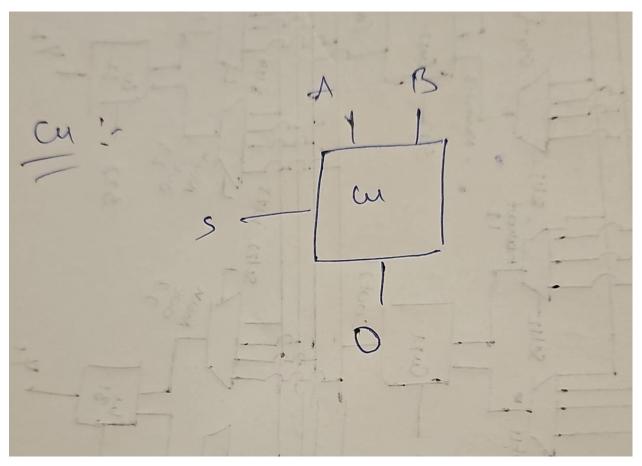
### Output ports:

Port name	Bit width	Purpose
Y1,	6	Out put
Y2,Y3,Y4		

Necessary intermediate signals:

Port name	Bit width	Purpose
Cuout11- Cuout14, Cuout21- cuout24, Cuout31- cuout34	6	Connection between CUs output and Mux input
Muxout 11- muxout18, Muxout21- muxout28	6	Connection between mux out put and cu's input

Subcomponent: Computational Unit (CU)



#### Input ports:

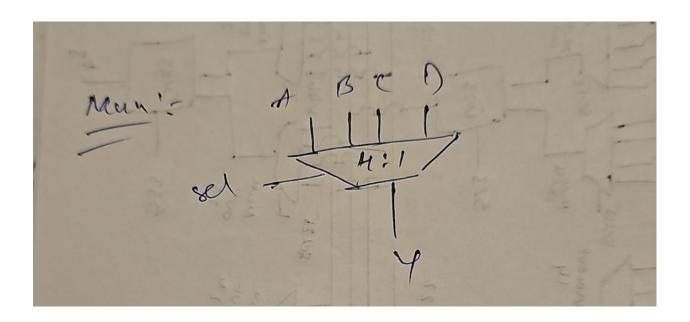
Port name	Bit width	Purpose
A	6	Operand 1
В	6	Operand 2
S	5	Selection line

### Output ports:

Necessary intermediate signals:

No intermediate signals used.

Subcomponent: mux:



### Input ports:

Port name	Bit width	Purpose
A	6	Operand 1
В	6	Operand 2
C	6	Operand 3
D	6	Operand 4
S	2	Selection line

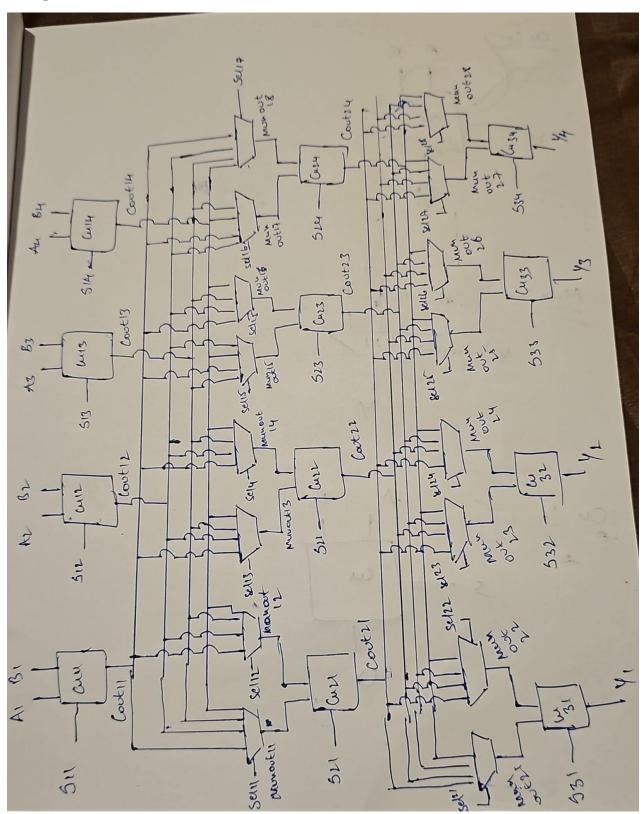
#### Output ports:

Port name	Bit width	Purpose
0	6	Out put

Necessary intermediate signals:

No intermediate signals used.

## Design



Overall component: top box

#### Input ports:

Port name	Bit width	Purpose
A1 B1 ,A2	6	Operand 1-operand 8
<b>B2</b>		
,A3 B3,A4		
B4		
S11-S14, S21- S24,	5	Cu selection lines
S31-s34		
Sel11- Sel18 Sel21- Sel28	2	Mux selection lines

#### Output ports:

Port name	Bit width	Purpose
Y1,	6	Out put
Y2,Y3,Y4		

#### Necessary intermediate signals:

Port name	Bit width	Purpose
Cuout11- Cuout14, Cuout21- cuout24, Cuout31- cuout34	6	Connection between CUs output and Mux input
Muxout 11- muxout18, Muxout21- muxout28	6	Connection between mux out put and cu's input

A1,B1 are inputs for CU11

A2,B2 are inputs for CU12

A3,B3 are inputs for CU13

A4,B4 are inputs for CU14

Operations in the cu:

00000 = AND

00001 = OR

00010 = NAND

00011 = N0R

00100 = XOR

00101 = XNOR

00110 = ADD

00111 = SUB

01000 = MUL

01001 = GREATER THAN

01010 =LESS THAN

01011 = EQUAL TOO

01100 = GREATHER THAN OR EQUALTOO

01101 = LESS THAN OR EQUAL TOO

01110 = NOT EQUAL TOO

01111 = GRND

10000 = arithmetic shift left

10001 = arithmetic shift right

10010 = logical shift right

10011 =logical shift left

10100 =rotation shift right

10101 =rotation shift left

#### **Design explanation:**

a1,a2,a3,a4,b1,b2,b3,b4 are the inputs to the cu's of the 1st row.

The 4 outputs of the 1st row CU's are connected to the inputs of the muxes.

Output of the muxes are connected as the inputs of the cu's in  $2^{nd}$  row.

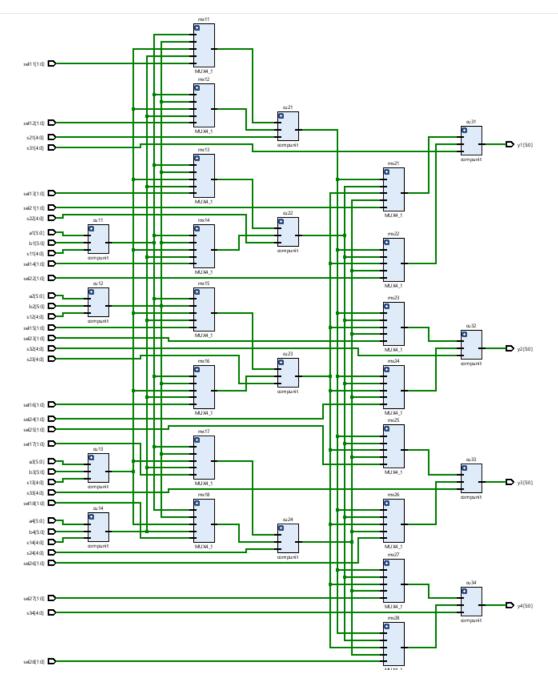
The 4 outputs of the 2st row CU's are connected to the inputs of the muxes.

Output of the muxes are connected as the inputs of the cu's in 3<sup>nd</sup> row.

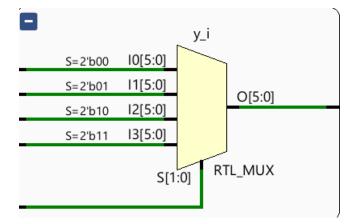
Output of the cu's as main output.

### **Results**

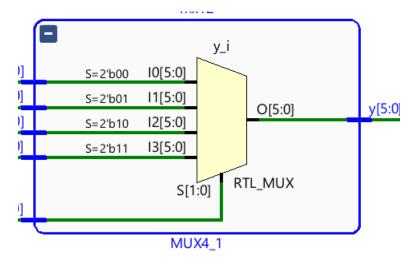
#### **Generated Schematic**



Sub component: mux



CU

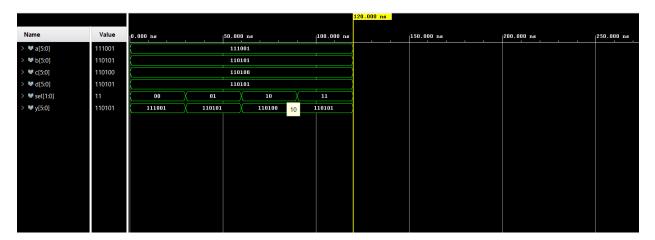


### Waveforms

CU waveform



#### Mux waveform



#### Topbox waveform:

											200.000
Name	Value	0.000 ns	20.000 ns	40.000 ns	60.000 ns	80.000 ns	100.000 ns	120.000 ns	140.000 ns	160.000 ns	180.000 ns
> <b>₩</b> a1[5:0]	101000						101000				
▶ <b>⊌</b> a2[5:0]	110100						110100				
▶ <b>₩</b> a3[5:0]	010110						010110				
₩ a4[5:0]	000110			010110					000110		
₩ b1[5:0]	011100						011100				
▶ <b>⊌</b> b2[5:0]	000100			101001					000100		
▶ <b>⊌</b> b3[5:0]	000010			011010					000010		
▶ <b>₩</b> b4[5:0]	001010			011010					001010		
> <b>♥</b> s11[4:0]	00000			10100	01	11010			00000		
▼ s12[4:0]	10011			00111					10011		
₩ s13[4:0]	10010			00010					10010		
> <b>♥</b> s14[4:0]	01000			00100					01000		
▼ s21[4:0]	01111			00001					01111		
> <b>♥</b> s22[4:0]	10101			01111					10101		
> <b>♥</b> s23[4:0]	01111			00000					01111		
▼ s24[4:0]	01110			01111					01110		
▼ s31[4:0]	01111						01111				
▶ <b>⊌</b> s32[4:0]	01111			01001					01111		
♥ s33[4:0]	00001			01111					00001		
₩ s34[4:0]	01111						01111				
♥ sel11[1:0]	00						00				
♥ sel12[1:0]	01						01				
₩ sel13[1:0]	00						00				
₩ sel14[1:0]	01						01				

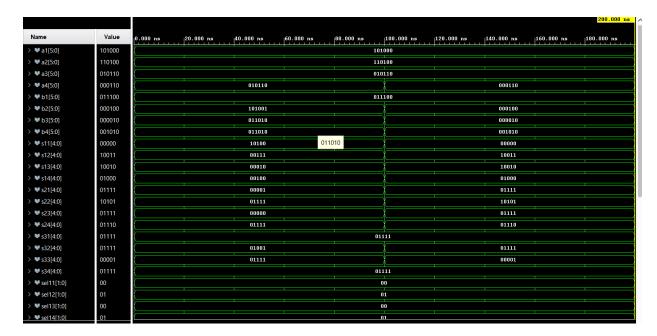


Figure 1 - Waveforms

#### **Table/Calculations:**

## Case 1:

CU#	SourceA	SourceB	Oper	Calculated Op	Simulated Op	Match	
CU11	101000	11100	ror	10	10	Yes	Ş
CU12	110100	101001	sub	10000	10000	Yes	Ş
CU13	10110	11010	nand	101101	101101	Yes	S S
Cu14	10110	11010	xor	001100	1100	yes	Ş
Cu21	(Cu11)	(cu12)	or	10010	10010	yes	
Cu22	(Cu11)	(cu12)	gnd	SHUTDOWN	SHUTDOWN	yes	i s
Cu23	(Cu13)	(cu14)	add	111001	111001	yes	
Cu24	(Cu13)	(cu14)	gnd	0	0	yes	
Cu31	Cu21	cu22	gnd	0	0	yes	\$ S
Cu32	Cu21	Cu23	gt	0	0	yes	OUT PUT
Cu33	Cu21	cu22	gnd	0	0	yes	
Cu34	Cu21	cu22	gnd	0	0	yes	8

Case 2:

CU#	SourceA	SourceB	Oper	Calculated Op	Simulated Op	Match	
CU11	101000	011100	AND	001000	001000	Yes	
CU12	110100	000100	LSL	0	0	Yes	
CU13	010110	000010	LSR	101	101	Yes	
Cu14	000110	001010	MULT	111100	111100	yes	
Cu21	CU14	CU12	GRND	0	0	yes	
Cu22	Cu11	Cu12	ROL	1000	1000	yes	
Cu23	CU11	CU12	GRND	0	0	yes	
Cu24	Cu13	Cu14	- NE	111111	111111	yes	
	=						
Cu31	CU21	CU22	GRND	0	0	yes	
Cu32	CU21	CU21	GRND	0	0	yes	
Cu33 -	Cu21	Cu23	OR OR	111111	111111	yes	
				111111			output
Cu34	CU21	CU22	GRND	0	0	yes	