CS 2614
Fall 2024

Name _____

CS 2614
Second Midterm Exam
Fall 2024

Name: Solutions

Student Number: _____

1. Place all bookbags and other materials in the back of classroom.
2. You may NOT use a calculator/phone/laptop in any way or have it at your desk.
3. No references are allowed.
4. State all assumptions and show your work.
5. Place your answer in the spaces provided.
6. Answer all questions

Problem	% credit
1 (10%)	
2 (10%)	
3 (20%)	
4 (15%)	
5 (15%)	
6 (10%)	
7 (20%)	
Total	

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Question 1 [10 marks]

What is wrong with the following register transfer statements?

a) zT: PC ← AR, PC ← PC+1

PC cannot be simultaneously changed.

b) xT: R1← R1', R1← R2

R1 cannot be concurrently changed.

Question 2 [10 marks]

Design a combinational circuit using a Read-Only Memory (ROM) that converts a 3-bit binary input representing a decimal number (0 to 7) into its corresponding Gray code output. Gray code is a binary numeral system where two successive values differ in only one bit.

(a) Draw the truth table showing the 3-bit binary input values (000 to 111) and their respective Gray code outputs. [5 marks]

INPUT			OUTPUT		
x_2	x_1	x_0	y_2	y_1	y_0
0	0	0	0	0	0
0	0	1	0	0	1
0	1	0	0	1	1
0	1	1	0	1	0
1	0	0	1	1	0
1	0	1	1	1	1
1	1	0	1	0	1
1	1	1	1	0	0

(b) Determine the required size of the ROM (in terms of addressable memory locations and bits per location). [5 marks]

8 x 3 = 24 bits

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Question 3 [20 marks]

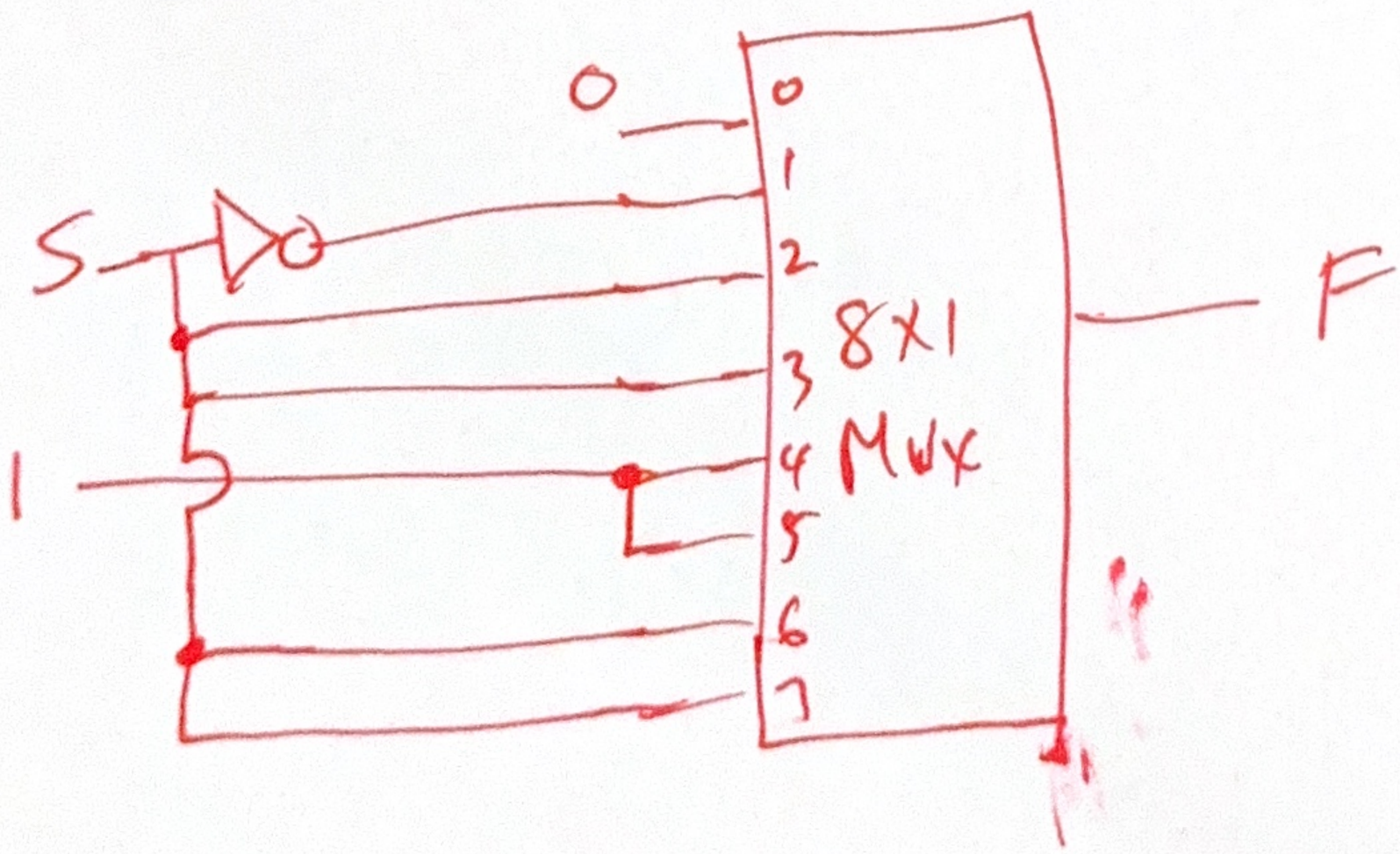
We want to implement the following Boolean function with an 8x1 multiplexer.
F(P,Q,R,S) = ∑(2,5,7,8,9,10,11,13,15)

(a) Complete the truth table for the function F

P	Q	R	S	F
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

F = 0 when S = 0; F = S' when S = 1

(b) Implement the function in part (a) using an **8 x 1** multiplexer.



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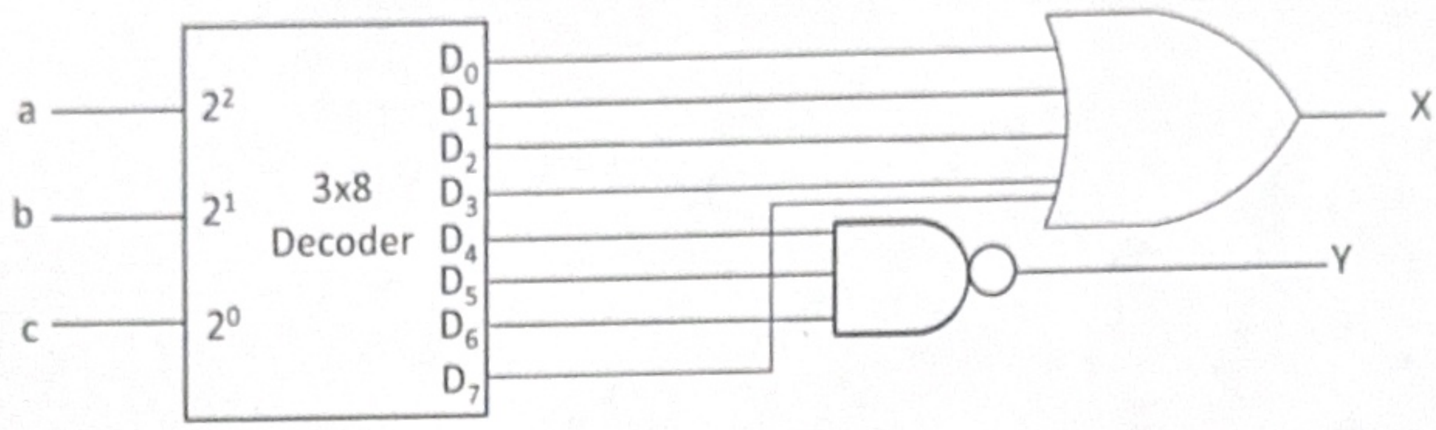
Question 4 [15 marks]

Fill in the truth table for the output functions X, Y of the circuit shown below.



A	B	C	X	Y
0	0	0	1	1
0	0	1	1	1
0	1	0	1	1
0	1	1	1	1
1	0	0	0	1
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

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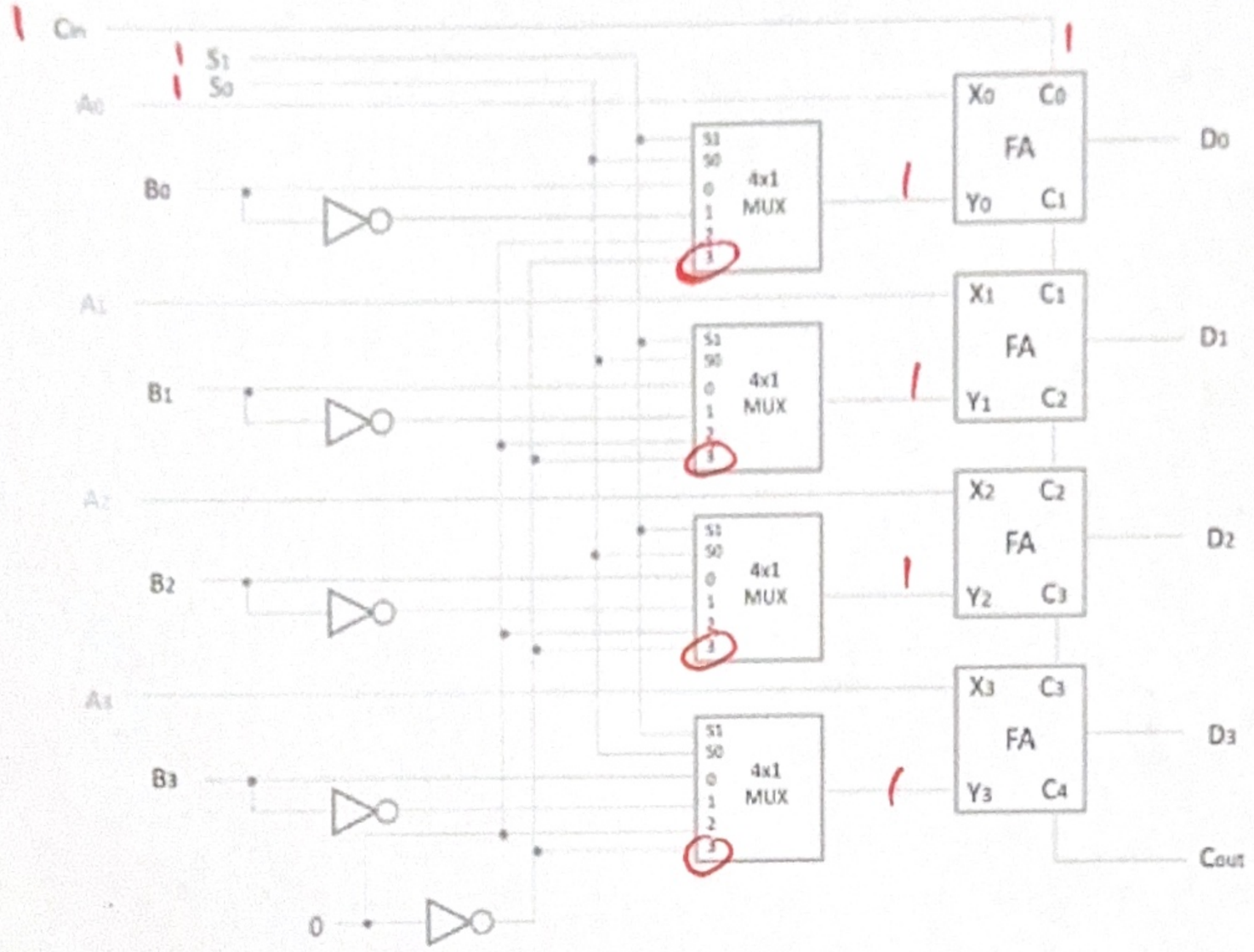
Question 5 [15 marks]

Consider the following 4-bit arithmetic circuit where A_0 to A_3, and B_0 to B_3 are the bits of two registers A and B. S_1, S_0 and C_{in} are the select inputs.



A-1+1
=A

If the select inputs $S_1 = 1$, $S_0 = 1$, $C_{in} = 1$, what arithmetic operation is performed by the circuit?

Ans: Transfer.

Question 6 [10 marks]

We want to complement the four least significant bits of Register A by Exclusive Or (XOR) operation of Register A with another Register B. Specify the contents of Register B. All registers are 8 bits wide.

A = x x x x x x x x
⊕ B = 0 0 0 0 1 1 1 1
---
x x x x x' x' x' x'

Ans: B= 0000 1111

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Question 7 [20 marks]

The 8-bit registers AR, BR, CR and DR initially have the following values:

AR = 11110010 = F2
BR = 11111111 = FF
CR = 10111001 = B9
DR = 11101010 = EA

Determine the 8-bit values in each register after the execution of the following INDEPENDENT microoperations. **Specify the values in hexadecimal numbers.**

	AR	BR	CR	DR
AR ← AR + BR	F1	FF	B9	EA
CR ← CR /\ DR, BR ← BR + 1	F2	00	A8	EA
AR ← AR - CR	39	FF	B9	~~39~~ EA

a)
```
  1 1 1 1  1 1
  1 1 1 1  0 0 1 0
+ 1 1 1 1  1 1 1 1
-------------------
[1] 1 1 1 0 0 0 1  = F1H
```

b)
```
  1 0 1 1  1 0 0 1
^ 1 1 1 0  1 0 1 0
-------------------
  1 0 1 0  1 0 0 0  = A8H
```
CR =

```
  1 1 1 1  1 1 1 1
  1 1 1 1  1 1 1 1
+               1
-------------------
[1] 0 0 0 0 0 0 0 0  = 00
```
BR =

c)
```
    1        1 1
  1 1 1 1  0 0 1 0
  0 1 0 0  0 1 1 1
+ (CR)'
-------------------
[1] 0 0 1 1  1 0 0 1  = 39H
```
DR =

CR = 1011 1001
(CR)' = 0100 0111