CS2100 Assignment #2
AY2024/25 Semester 1
Deadline: Monday, 14 October 2024, 1:00pm
TEMPLATE FOR SUBMISSION

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Q1. (Total: 15 marks)

Cycle time: 13 ps [4 marks]

Clock frequency: 76.923 GHz [3 marks]

Time taken for `beq` instruction: 6 ps [3 marks]

Optimization: new ALU [5 marks]

Explain your answers below.

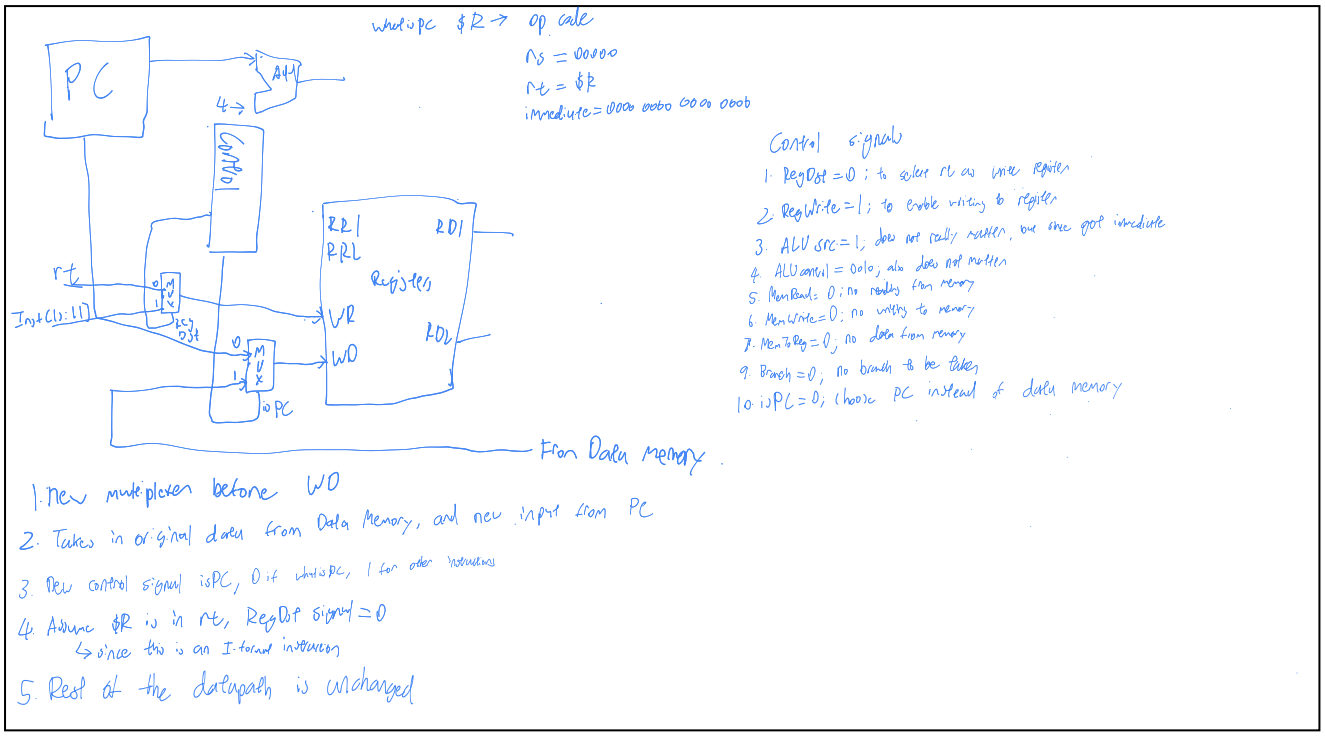
lw → Reg file + ALU + Mem read + reg file
sw → Reg file + ALU + Mem write
beq → Reg file + ALU
addi → Reg file + ALU + reg file

Optimise ALU
lw = 2+2+5+2
= 11ps
sw = 2+2+7
= 11ps
beq = 2+2
= 4ps
addi = 2+2+2
= 6ps

Optimise Reg file
lw = 1+4+5+1
= 11ps
sw = 1+4+7
= 12ps
beq = 1+4
= 5ps
addi = 1+4+1
= 6ps

∴ Optimising ALU will result in faster sw and beq instructions, and equal time for lw and addi

Q2. (Total: 5 marks)



Q3. (Total: 3 marks)

(a) $M31 =$ A+B'+C'+D'+E'+F' [1 mark]

(b) $m29 \cdot M31 =$ A'·B·C·D·E'·F [2 marks]

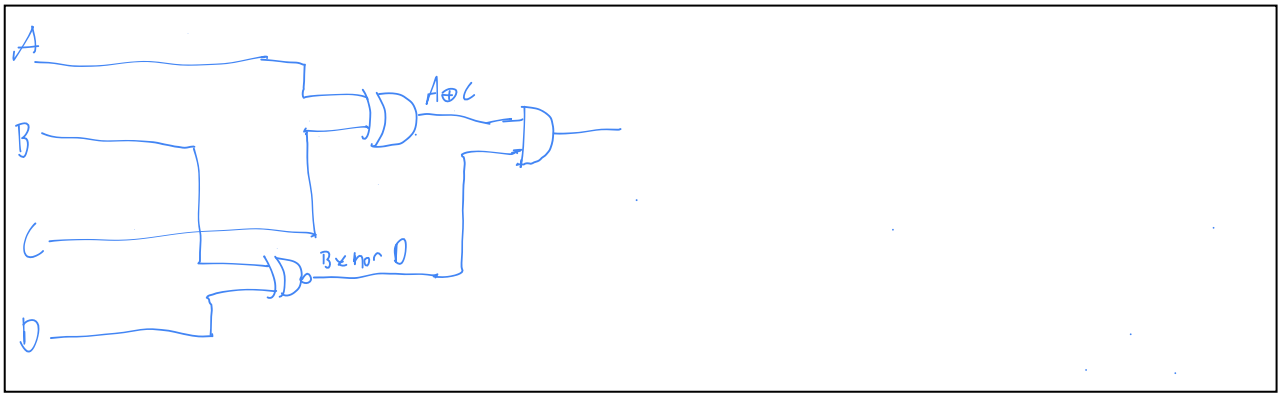
Q4. (Total: 4 marks)

(a) $F \cdot G' = \sum m($ 7, 13, 15 $)$ [2 marks]

(b) $G' \oplus H = \sum m($ 1, 5, 8, 12 $)$ [2 marks]

Q5. (Total: 3 marks)

Draw your circuit below.



Q6. (Total: 7 marks)

(a) Number of PIs in the K-map of Z: 6 [1 mark]

(b) Number of EPIs in the K-map of Z: 1 [1 mark]

(c) Number of distinct simplified SOP expressions for Z: 3 [1 mark]

(d) One simplified SOP expression for Z: [2 marks]

$B.C + B'.D + A'.B'$

(e) One simplified POS expression for Z: [2 marks]

$(B'+C).(A'+B+D)$

Q7. (Total:3 marks)

(a) [1 mark]

A	B	C	D	$IsZero$
0	0	0	0	1
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1

(b) Simplified SOP expression [2 marks]

$IsZero =$ $A'.B'.C'.D' + A'.B.C'.D + A.B'.C.D' + A.B.C.D$

Workings

Write your workings here. They will not be graded, but the grader might look at it to figure out where you went wrong.

Workings for Q3

M31 = 011 111

$M31 = A + B' + C' + D' + E' + F'$

m29 = 011 101

$= A' \cdot B \cdot C \cdot D \cdot E' \cdot F$

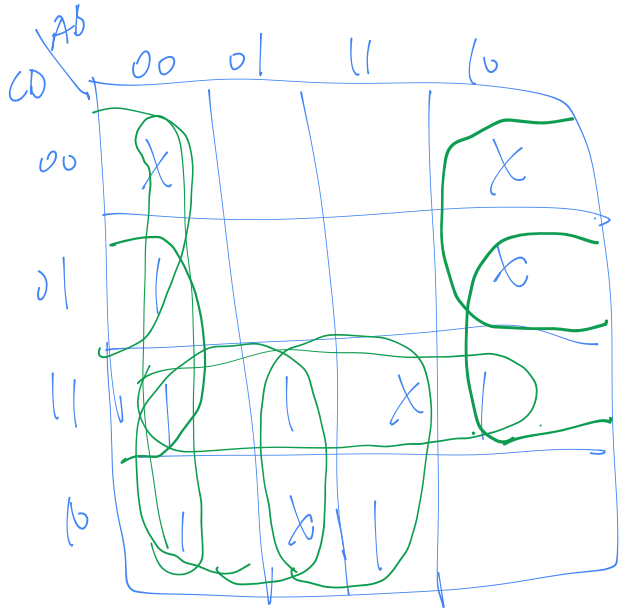
$M24 \cdot M31 = (A + B' + C' + D' + E' + F') \cdot (A' \cdot B \cdot C \cdot D \cdot E' \cdot F)$

$= ((A + B' + C' + D + E' + F') \cdot A') \cdot (B \cdot C \cdot D \cdot E' \cdot F)$, by commutative law

$= (A' \cdot B' + A' \cdot C' + A' \cdot D' + A' \cdot E' + A' \cdot F') \cdot (B \cdot C \cdot D \cdot E' \cdot F)$, by inverse and identity law

$= A' \cdot B \cdot C \cdot E' \cdot F$

K-map for Q6



PI = 6

EPI = 1