

4 ✓

12 Pages

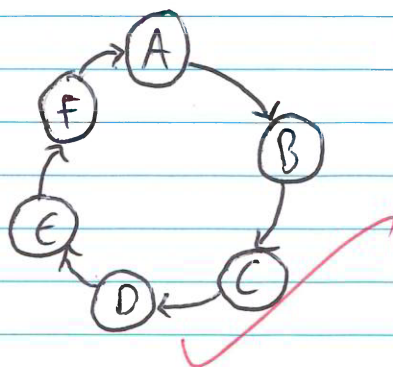
1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either read your cursive script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. **Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.**

List the numbers of the questions you have attempted	Office Use
1	12 ✓
2	14 ✓
3	16 ✓
4	22 ✓
Total	64/100

(Gweler yr ochr arall am y fersiwn Cymraeg)

PL 1

1. i) a)



b)

PS	NS
A	B
B	C
C	D
D	E
E	F
F	A

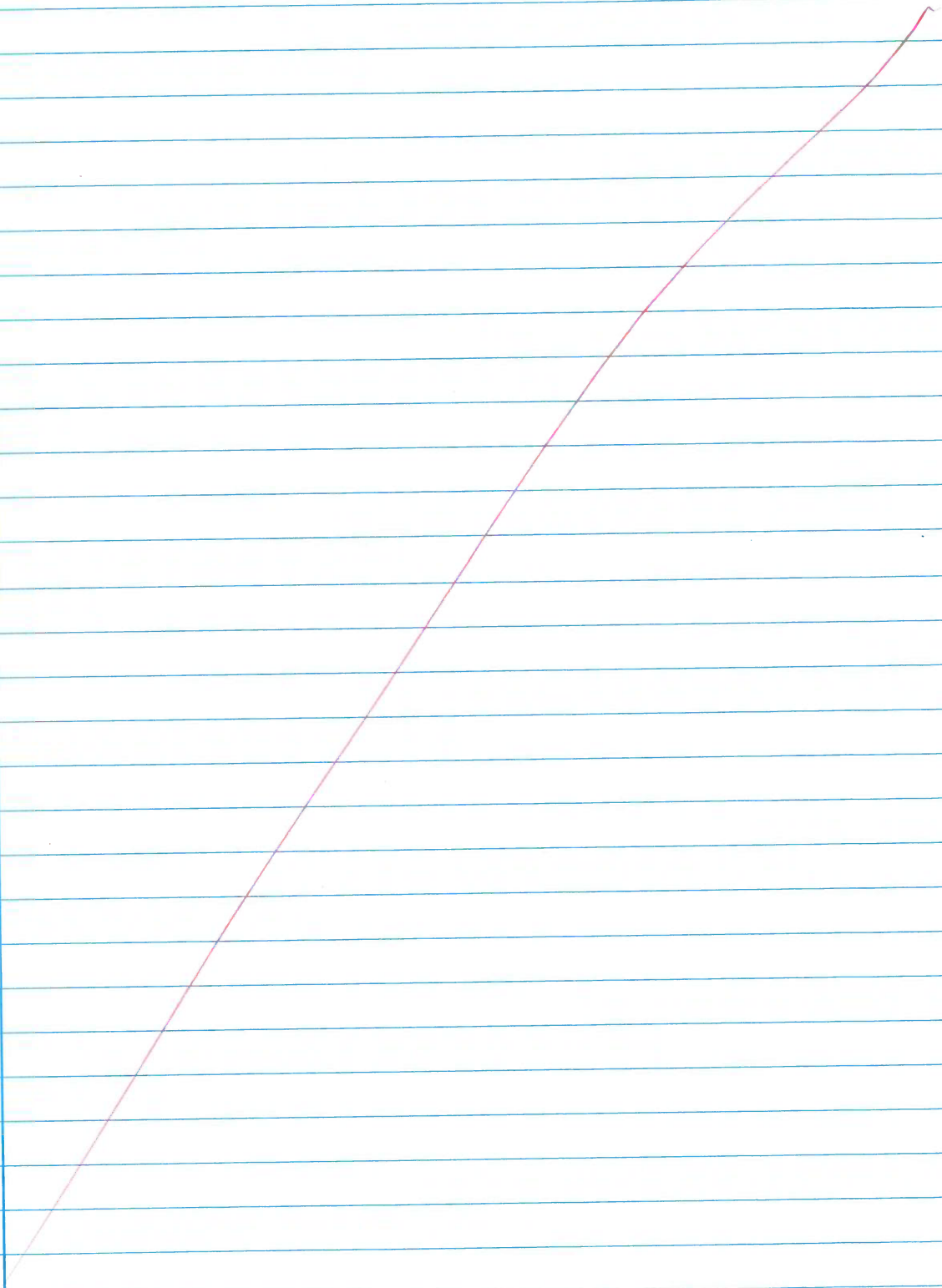
- c)
- A $\rightarrow$ 000
 - B $\rightarrow$ 001
 - C $\rightarrow$ 010
 - D $\rightarrow$ 011
 - E $\rightarrow$ 100
 - F $\rightarrow$ 101

d)

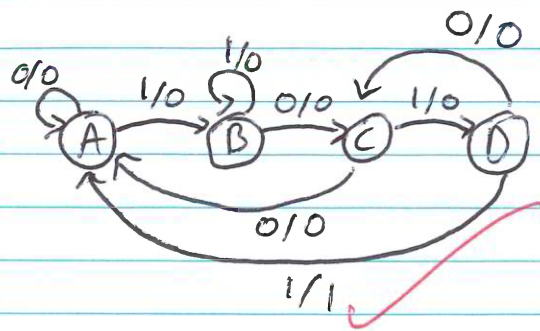
PS	NS	$J_2 K_2$	$J_1 K_1$	$J_0 K_0$
$q_2 q_1 q_0$	$Q_2 Q_1 Q_0$			
000	001			
001	010			
010	011			
011	100			
100	101			
101	000			

Question No.

Examiner Only



2. i) a) and b)



c) State Table:

~~P S~~	~~x~~	~~N S~~	~~z~~
A			
B			
C			
D			

P S	x	N S	z
A	0	A	0
A	1	B	0
B	0	C	0
B	1	B	0
C	0	A	0
C	1	D	0
D	0	C	0
D	1	A	1

State Assignments:

A → 00
 B → 01
 C → 10
 D → 11

d) Excitation table:

~~NS~~ ~~x~~ ~~PS~~ ~~D₁~~ ~~D₀~~

PS		x	NS		Q ₁ z	Q ₀ D ₁	D ₀
q ₁	q ₀		Q ₁	Q ₀			
0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	1
0	1	0	1	0	0	1	0
0	1	1	0	1	0	0	1
1	0	0	0	0	0	0	0
1	0	1	1	1	0	1	1
1	1	0	1	0	0	1	0
1	1	1	0	0	1	0	0

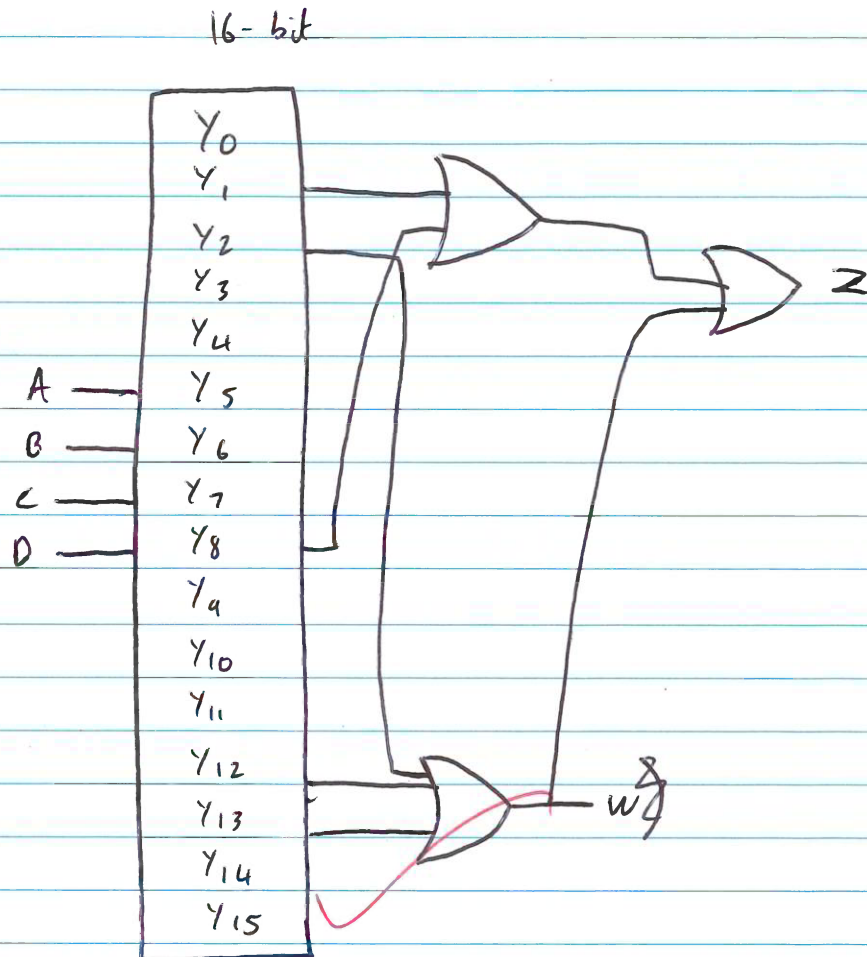
2 ✓

4 ✓

14
25

3. i) a) $w(A, B, C, D) = \sum_m(2, 12, 13)$

$z(A, B, C, D) = \sum_m(1, 2, 8, 12, 13)$



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b) A B C D w z c)

$$w = \overline{A}BC + A\overline{B}C + ABC$$

0 0 0 0 0 0

1 0 0 0 1 0 1

$$z = \overline{A}BC + A\overline{B}C + ABC + ABC + ABC$$

2 0 0 1 0 1 1

3 0 0 1 1 0 0

$$w = \overline{A}\overline{B}C\overline{D} + A\overline{B}C\overline{D} + ABC\overline{D}$$

4 0 1 0 0 0 0

5 0 1 0 1 0 0

6 0 1 1 0 0 0

$$z = \overline{A}\overline{B}C\overline{D} + \overline{A}B\overline{C}\overline{D} + A\overline{B}C\overline{D} + ABC\overline{D} + ABC\overline{D}$$

7 0 1 1 1 0 0

8 1 0 0 0 0 1

Simplified:

9 1 0 0 1 0 0

10 1 0 1 0 0 0

11 1 0 1 1 0 0

$$w = \overline{A}\overline{B}C\overline{D} + A\overline{B}C(\overline{D} + D)$$

where $(\overline{D} + D) = 1$ so

12 1 1 0 0 1 1

13 1 1 0 1 1 1

$$w = \overline{A}\overline{B}C\overline{D} + A\overline{B}C$$

14 1 1 1 0 0 0

15 1 1 1 1 0 0

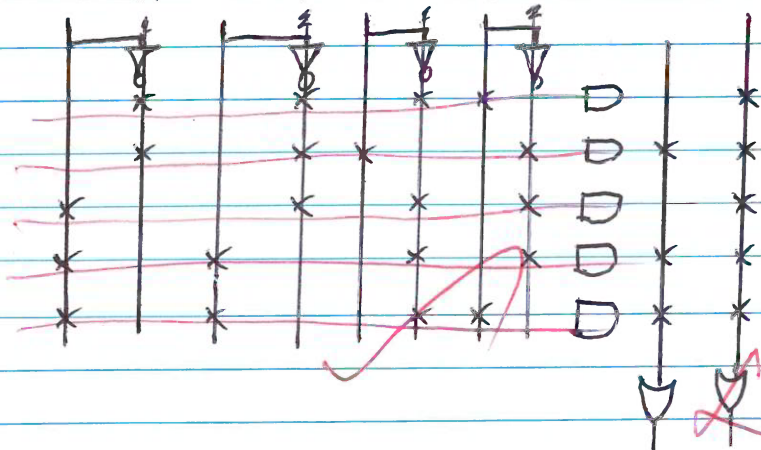
$$z = \overline{A}\overline{B}C\overline{D} + \overline{A}B\overline{C}\overline{D} + A\overline{C}\overline{D}(\overline{B} + B) + A\overline{B}C\overline{D} + ABC\overline{D}$$

where $(\overline{B} + B) = 1$

$$z = \overline{A}\overline{B}C\overline{D} + \overline{A}B\overline{C}\overline{D} + A\overline{C}\overline{D} + A\overline{C}\overline{D} + ABC\overline{D}$$

$$= \overline{A}\overline{B}C\overline{D} + \overline{A}B\overline{C}\overline{D} + A\overline{C}\overline{D} + A\overline{C}\overline{D} + ABC\overline{D}(\overline{D} + D)$$

$$z = \overline{A}\overline{B}C\overline{D} + \overline{A}B\overline{C}\overline{D} + A\overline{C} + A\overline{C}\overline{D} + ABC\overline{D}$$

d) A $\overline{A}$ B $\overline{B}$ C $\overline{C}$ D $\overline{D}$ w z

4. i) a) $y = \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}CD + A\bar{B}CD + ABCD$

Truth table:

A	B	C	D	F
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
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

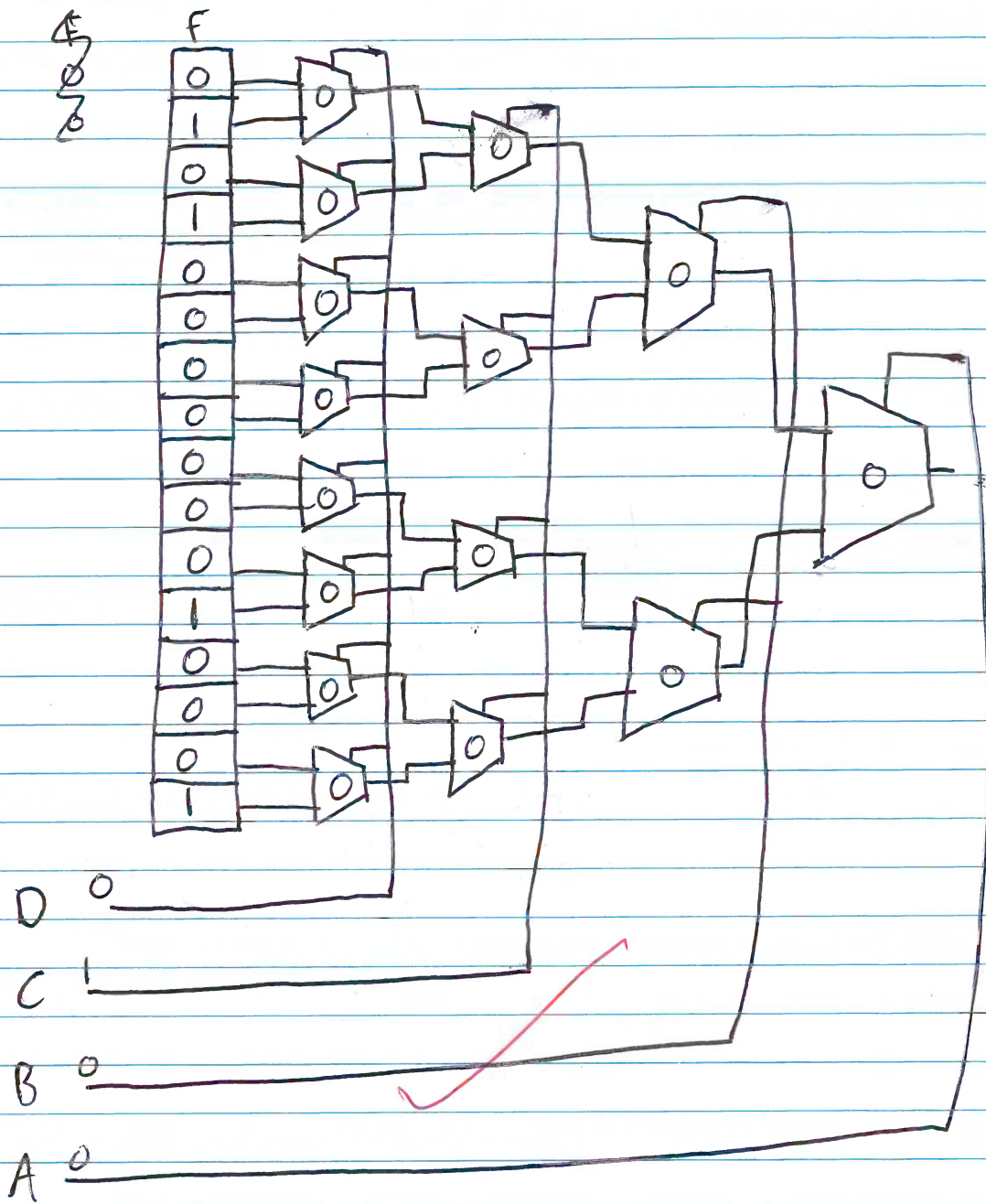
Truth table:

A	B	C	D	F
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
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

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b) Truth table output:



c) The 4-bit input value, in this instance 0010, is represented bitwise by the letters ABCD where A is 0, B is 0, C is 1 and D is 0. These values control the outputs of the multiplier blocks. When the bit has a value of 0, the top input of the multiplier is carried forward to the output. When the bit value is 1, the bottom input is carried forward. The D bit controls the first column of 8 multipliers, the C value the 2nd column of 4 and so on.

goth. The output of each multiplier has been written on the diagram. In this example, for the input 0010, none of the 1 values from the truth table are carried forward in the multiplication and the final output is 0.

4.ii) $f = f_1 + f_2$

$f_1 = x_1 x_2$

$f_2 = \bar{x}_2 x_3$

Truth table

