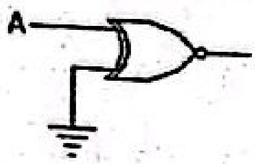
Question 1: (60 points, 3 points each). Select the correct answer

1	2	3	4	5	6	7	8	9	10
B	D	A	D	A	C	B	D	B	C

11	12	13	14	15	16	17	18	19	20
B	C	D	B	C	D	D	A	C	A

1. Simplify the following expression $\overline{AB\overline{CD}}$
   A. A'B'CD
   B. A' + B' + CD
   C. AB +C'D'
   D. A' +B' + C + D
   E. None
2. The code where all successive numbers differ from their preceding number by a single bit is
   A. Binary code
   B. BCD
   C. Excess – 3
   D. Gray
   E. None
3. (-8) is equal to a signed binary number
   A. 10001000
   B. 00001000
   C. 10000000
   D. 11000000
   E. None
4. How many AND gates are required to realize Y = CD+EF+G
   A. 4
   B. 5
   C. 3
   D. 2
   E. None
5. Which of following are known as universal gates
   A. NAND & NOR
   B. AND & OR
   C. XOR & OR
   D. NAND & AND
   E. None
6. For the gate in the given figure, the output will be
   A. 0
   B. 1
   C. A
   D. A'
   E. None



7. A full adder can be made out of
   A. two half adders
   B. two half adders and an OR gate
   C. two half adders and a NOT gate
   D. three half adders
   E. None
8. An OR gate with schematic "bubbles" on its inputs perfoms the same functions as a_____ gate.
   A. NOR
   B. OR
   C. NOT
   D. NAND
   E. None
9. An adder-subtractor single unit can be designed using full adder and
   A. OR gates
   B. XOR gates
   C. NOR gates
   D. NAND gates
   E. None
10. The Boolean function $F = A \oplus B \oplus C \oplus D = 1$ means:
   A. one or two or three of the inputs are ones
   B. all inputs are zeros ($A = 0, B = 0, C = 0, D = 0$)
   C. one or three of the inputs are ones.
   D. all inputs are ones ($A = 1, B = 1, C = 1, D = 1$)
   E. half of the inputs are zeros (for example: $A = 0, B = 0, C = 1, D = 1$)
11. The decimal number (64) in BCD requires ___ bits, and to represent the same decimal number in binary requires ___ bits.
   A. 3,2
   B. 8,7
   C. 7,7
   D. 6,5
   E. None
12. The largest hexadecimal number which has 2 integer digits and 1 fraction digit is in hexadecimal ____________, and it equals ____________ in decimal.
   A. $(FF.F)_{16},(999.9)_{10}$
   B. $(FF.0)_{16},(999.9)_{10}$
   C. $(FF.F)_{16},(255.9375)_{10}$
   D. $(FF.F)_{16},(255.9753)_{10}$
   E. None
13. The number $(B2.D)_{16}$ is equivalent to ____.
   A. $(177.7125)_8$
   B. $(262.64)_{10}$
   C. $(262.64)_{12}$
   D. $(178.8125)_{10}$
   E. None
14. Let $A=(69CE)_{16}$ and $B=(6AFF)_{16}$ be hexadecimal numbers. The addition operation of A+B is ____________ and the final carry bit (0 or 1) is ________.
   A. D4CD,1
   B. D4CD,0
   C. D5CD,1
   D. D5CD,0
   E. None

15. The 7-bit binary code for character "e" is 1100101. Using even parity, the sender inserts an extra parity bit equal to ____. The receiver receives an 8-bit binary code equal to 11100100, would the receiver detect an error (Yes/No)? _____.

A. 0, Yes
B. 1, Yes
C. 0, No
D. 1, No
E. None

16. The 10's complement of $(935)_{11}$ is _______.

A. 286
B. 074
C. 174
D. 175
E. None

17. What is the maximum number that we can count up to using 10 bits?

A. 1024
B. 9999
C. 1000
D. 1023
E. None

18. Convert (0055) hex value to decimal

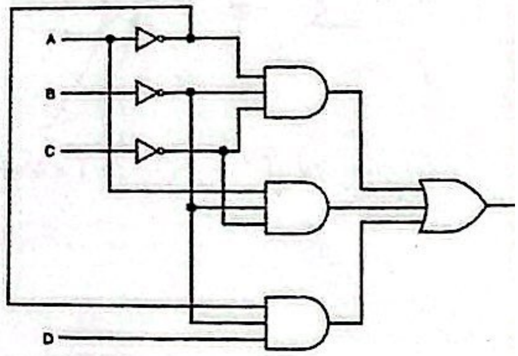
A. 85
B. 15
C. 146
D. 2047
E. None

19. Simplify the following Boolean expression $x = ACD + A'BCD$

A. CD
B. CDB
C. ACD + BCD
D. CDA'
E. None

20. Write the Boolean expression for output x in the following figure

A. x =A'B'C' + AB'C' + A'B'D
B. x= A'B'C' + A'B'C' + A'B'D
C. x= A'B'C' + AB'C' + A'B'D'
D. x= A'B'C' + A'B'C' + A'B'D'
E. None



Question#3: (14 points)

Design a logic circuit that has three inputs, *A*, *B*, and *C*, and whose output *F* will be HIGH only when a majority (two or more) of the inputs are HIGH.

1) **(4 points)** Find the truth table for the function *F*.

A	B	C	F	
0	0	0	0	0
0	0	1	0	1
0	1	0	0	2
0	1	1	1	3
1	0	0	0	4
1	0	1	1	5
1	1	0	1	6
1	1	1	1	7

$F = \Sigma(3, 5, 6, 7)$

2) **(2 points)** What is the canonical form for the function *F* given as SOM

$m_3 + m_5 + m_6 + m_7$

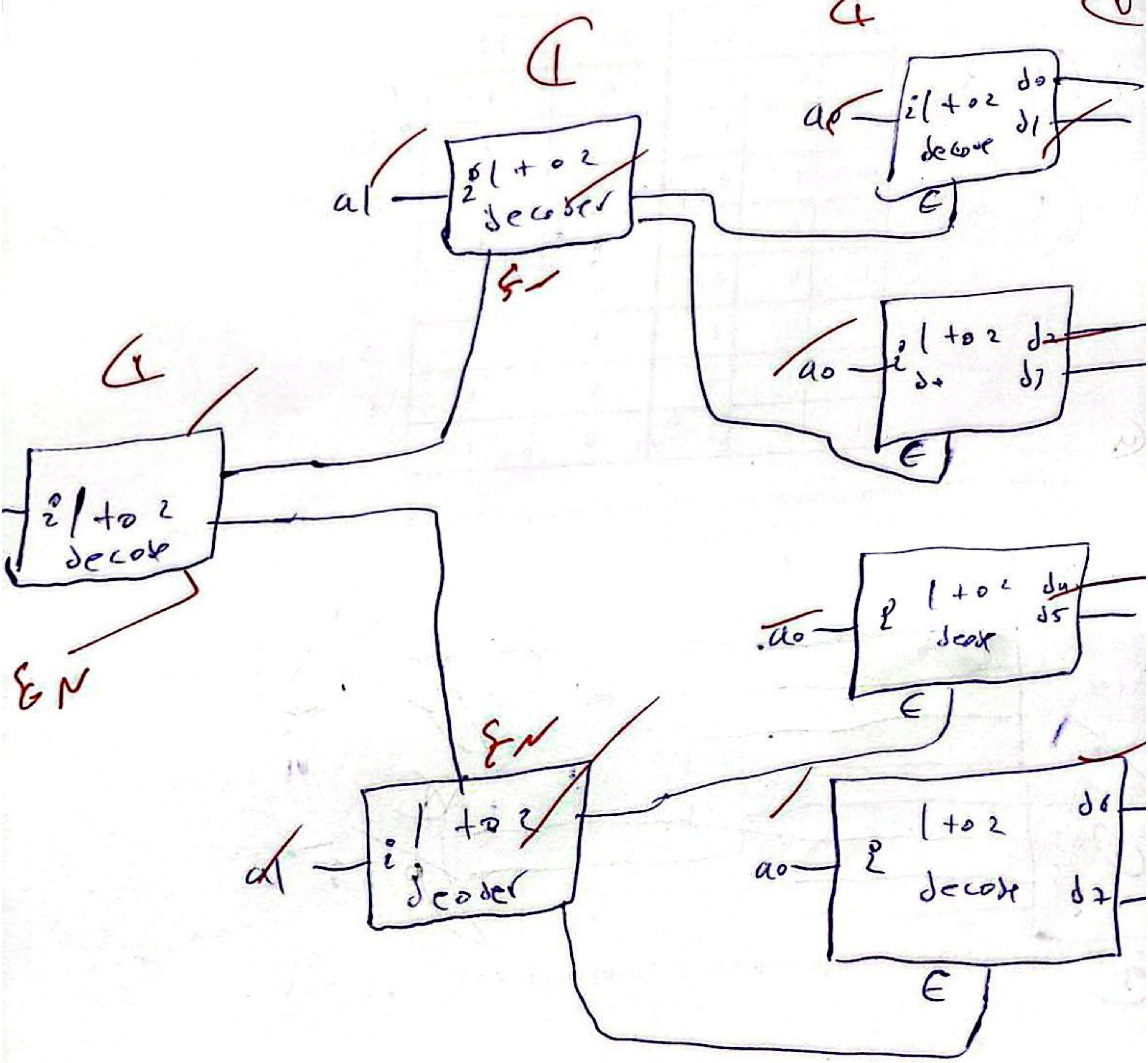
$A'BC + AB'C + ABC' + ABC$

3) **(4 points)** What is the minimized form for the function *F* given as SOP

A \ BC	00	01	11	10
0	0	0	1	0
1	0	1	1	1

$F = BC + AB + AC$

Q2 4)



Question#2: (16 points)

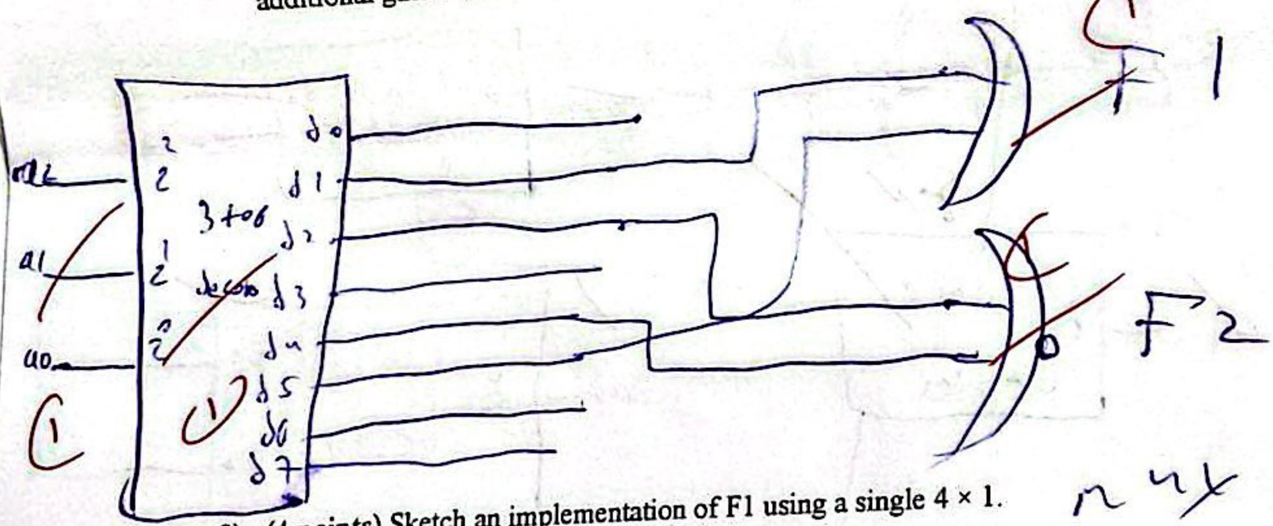
Consider the functions $F1(a_2,a_1,a_0)$ and $F2(a_2,a_1,a_0)$, whose truth table is shown below:

$F1 = \Sigma(1, 5)$

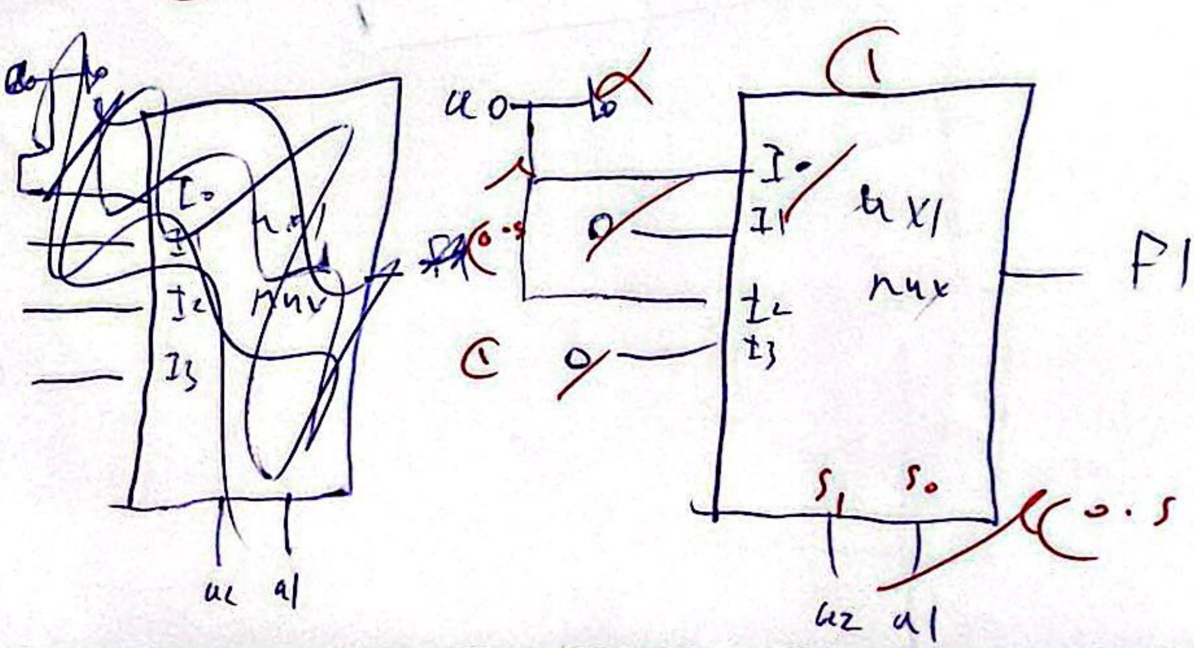
$F2 = \Pi(2, 4)$

a_2	a_1	a_0	F1	F2
0	0	0	0	1
0	0	1	1	1
0	1	0	0	0
0	1	1	0	1
1	0	0	0	0
1	0	1	1	1
1	1	0	0	1
1	1	1	0	1

1) **(4 points)** Sketch an implementation of F1 and F2 using a single 3-8 decoder and minimum additional gates with minimum number of inputs.



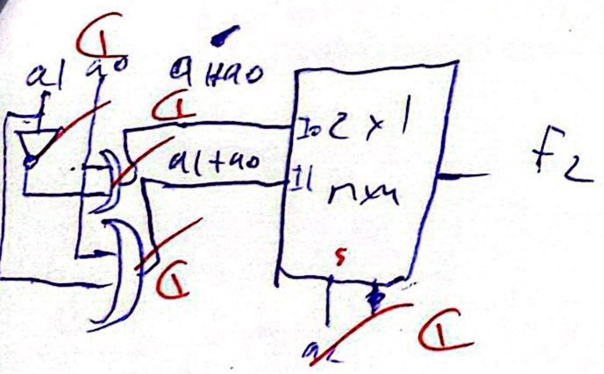
2) **(4 points)** Sketch an implementation of F1 using a single 4 × 1 mux

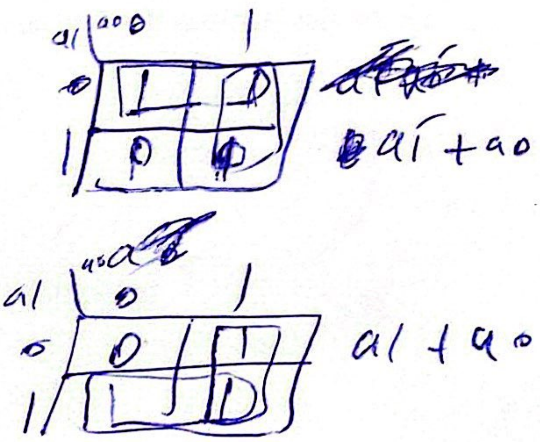


0 0 1

(4

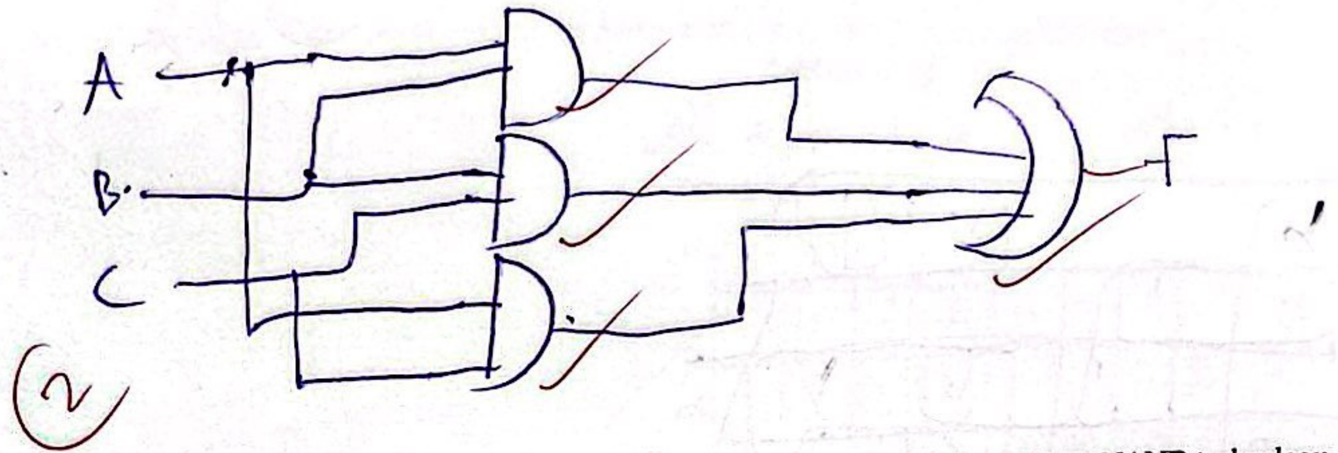
3) **(4 points)** *Sketch an implementation of F2 using a single 2 × 1 and minimum additional gates with minimum number of inputs.*



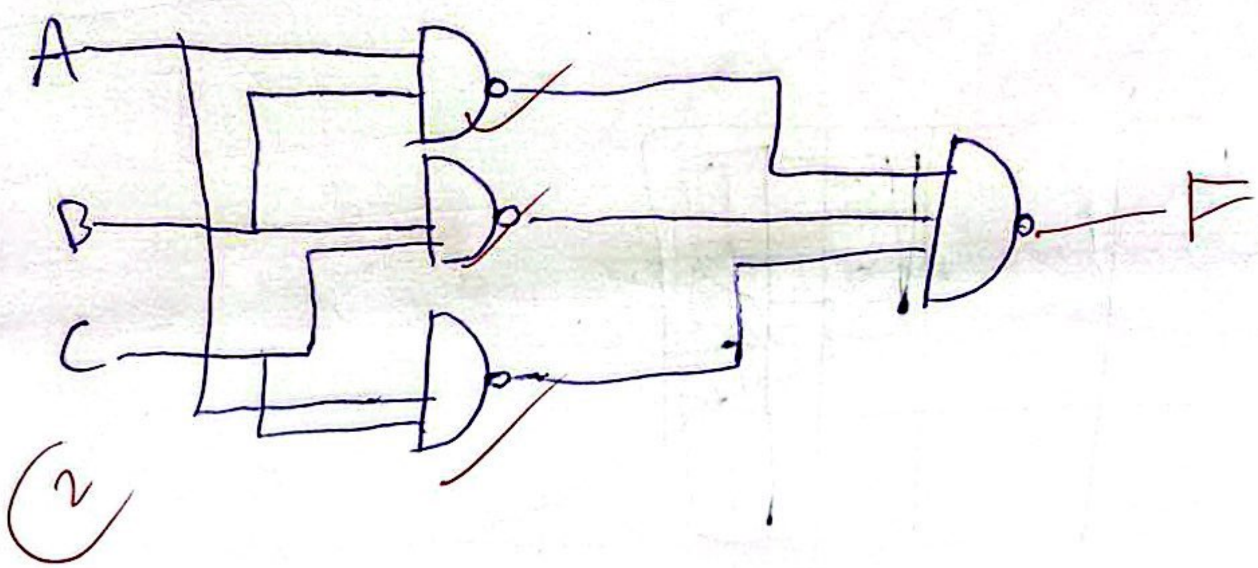


(4 4) **(4 points)** Show how you can construct a 3-8 decoder using minimum number of 1-2 decoders with enable inputs. In your implementation, mark which input corresponds to a_0, a_1, and a_2. Also, mark which output corresponds to $d_0 \ldots d_7$

4) (2 **points**) Implement the SOP form of the function *F* using AND-OR technology



5) (2 **points**) Implement the SOP form of the function *F* using NAND-NAND technology



Question#4: (10 points)

Given the following K-map of the function $g(a,b,c,d)$, where X is a don't-care:

K-Map of g

$ab \backslash cd$	00	01	11	10
00	X		X	1
01	X	1		
11		1	X	X
10	1		1	X

1) (4 points) Write the terms of all Prime Implicants (PIs) and all Essential Prime Implicants (EPIs) of g.

PIs = $b'd'$, $bc'd$, ac, $b'c$

2.5

EPIs = $b'd'$, $bc'd$

2) (4 points) Find all minimum Sum-of-Products expressions of g.

$g = b'd' + ac + bc'd$

$g = b'd' + bc'd + b'c$

4

3) (2 points) Find all minimum Product-of-Sums expressions of g.

$g = (b' + d) \cdot (b + c + d') \cdot (b' + c)$

2