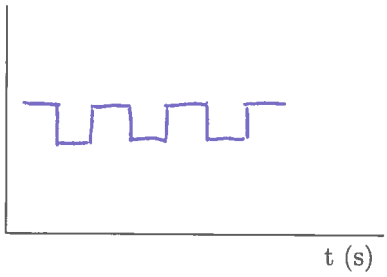
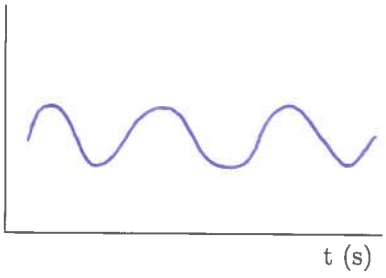
Name: SOLUTIONS

Read each question carefully before answering. Answer all parts. Show all work, calculations, and/or reasoning, otherwise no points will be awarded. K-maps may be used to double check your work, but may NOT be used as your actual work. Point values are as indicated.

1. (5 points) Draw an example of an analog and a digital signal on the axes below. Clearly indicate which is which.

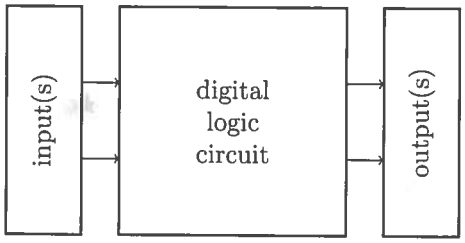


label: digital

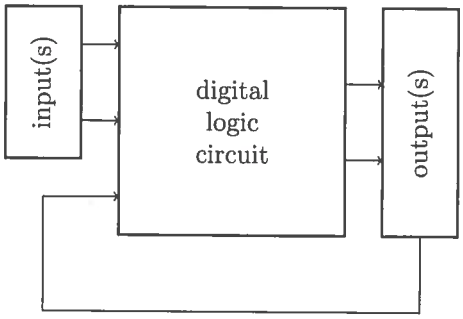


label: analog

2. (5 points) Label which of the circuits is sequential, and which is combinational.



label: combinational



label: sequential

3. Express the following decimal numbers as 8-bit signed binary numbers. Use **2's complement** for all negative numbers.

(a) (5 points) 56_{10}

2|56
2|28 r0
2|14 r0
2|7 r0
2|3 r1
2|1 r1
0 r1

0 0 1 1 1 0 0 0

(b) (5 points) -166_7

$166_7 = 49 + 7(6) + 6$

97

$97 = 01100001$

10011110

10011111

2|97
2|48 r1
2|24 r0
2|12 r0
2|6 r0
2|3 r0
2|1 r1
0 r1
0

1 0 0 1 1 1 1 1

4. Express the following decimal numbers as **unsigned** binary numbers, rounding the non-integer component to fit into the spaces below.

(a) (5 points) 25.76_{10}

2|25
2|12 r1
2|6 r0
2|3 r0
2|1 r1
0 r1

0.76 × 2 = 1.52

0.52 × 2 = 1.04

0.04 × 2 = 0.08

0.08 × 2 = 0.16

1 1 0 0 1 . 1 1 0 0

(b) (5 points) 18.83_{10}

2|18
2|9 r0
2|4 r1
2|2 r0
2|1 r0
0 r1

0.83 × 2 = 1.66

0.66 × 2 = 1.32

0.32 × 2 = 0.64

0.64 × 2 = 1.28

1 0 0 1 0 . 1 1 0 1

5. Express the following as 5-bit signed binary numbers and then add them, using **2's complement** for negative numbers. Indicate if there is an overflow in any of the answers.

(a) (5 points) $(-11)_{10} + (-14)_{10}$

11 = 01011
10100
-11 = 10101
14 = 01110
10001
-14 = 10010

1 0
10101
10010
00111

overflow

(b) (5 points) $12_{10} + 3_{10}$

12 = 01100
3 = 00011
01111

01111

6. Express the following as 5-bit signed binary numbers and then multiply them, using **2's complement** for negative numbers. Indicate if there is an overflow in any of the answers.

(a) (5 points) $13_{10} \times 11_{10}$

13 = 01101
11 = 01011

00000 01101
× 00000 01011
00000 01101
00000 01101 x
00000 11010 xx
00010 11011

00010 11011

overflow

(b) (5 points) $5_{10} \times (-2)_{10}$

5 = 00101
2 = 00010
11101
-2 = 11110

11111 11110
× 00000 00101
11111 11110
11111 11110 x
11111 01010 xx

11111 01010

10110
- 1
10101

$01010_2 = 10_{10}$

7. Use the truth table to answer the following questions.

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

(a) (5 points) Find the reduced **sum of products** equation.

$A'B'C' + A'BC' + A'BC + AB'C$ } uniting

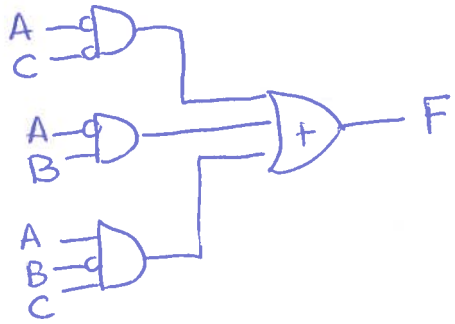
$A'C' + A'BC + AB'C$

$A'(C' + BC) + AB'C$ } elimination

$A'(C' + B) + AB'C$

$\boxed{A'C' + A'B + AB'C}$

(b) (5 points) Draw the simplified circuit diagram.



8. Use the truth table to answer the following questions.

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

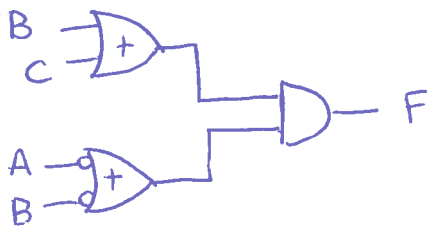
(a) (5 points) Find the reduced **product of sums** equation.

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

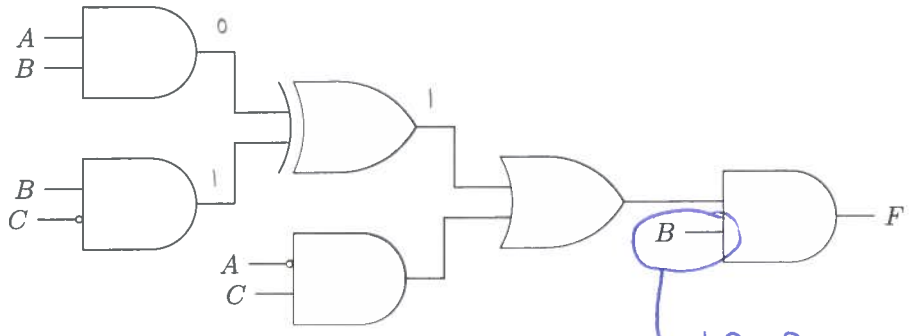
$(B+C)(A'+B')$

2 uniting steps!

(b) (5 points) Draw the simplified circuit diagram.



9. Use the circuit diagram to answer the following questions.



(a) (5 points) Fill out the truth table.

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

(b) (5 points) Find the reduced **sum of products** equation.

$A'BC' + A'BC + ABC$ } uniting

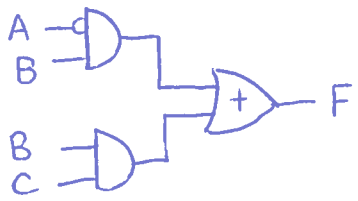
$A'B + ABC$

$B(A' + AC)$ } elimination

(c) (5 points) Draw the simplified circuit diagram.

$B(A' + C)$

$A'B + BC$



10. Use the maxterm expression $F(A,B,C) = \Pi M(2,3,5) + \Pi D(0,7)$ to answer the following questions.

(a) (5 points) Fill out the truth table.

A	B	C	F
0	0	0	X
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	X

(b) (5 points) Find the reduced **product of sums** equation.

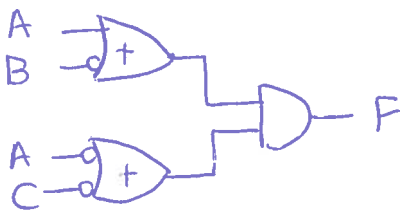
$(A+B'+C)(A+B'+C')(A'+B+C')$ } uniting

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

$(A'+B'+C')$ will help us reduce w/ uniting

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

(c) (5 points) Draw the simplified circuit diagram.



11. (5 points) Convert the equation $F_{SOP} = BC' + A'B' + CD' + AD$ to a reduced **product of sums** equation.

1st DeMorgan $(B'+C)(A+B)(C'+D)(A'+D')$

$(AB'+AC+BC)(A'C'+C'D'+A'D)$

$AB'C'D' + A'BCD$

2nd DeMorgan $(A'+B+C+D)(A+B'+C'+D')$

12. (5 points) Convert the equation $F_{POS} = (C+D)(C'+D')(A'+B+D')$ to a reduced **sum of products** equation.

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

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

$A'CD' + BCD' + CD' + A'C'D + BC'D$

absorption

$CD' + A'C'D + BC'D$