

PRACTICE PROBLEMS 8
Lecture 11 - 12

1. Fill in the following table

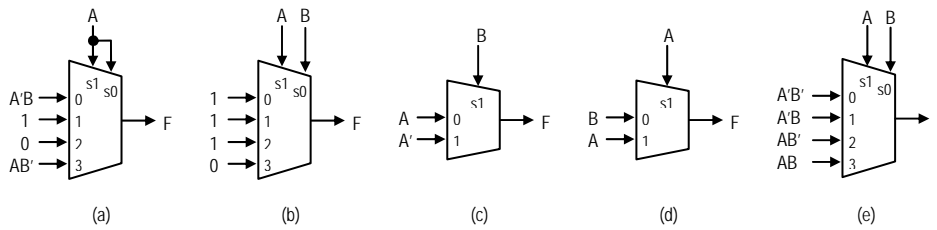
$X \cdot 1 =$	$X + 1 =$
$X \cdot 0 =$	$X + 0 =$

2. What does canonical mean? Provide two canonical representations of $F = a + b'c + bc'$.

3. Using only muxes, build a circuit to perform

- a. $F = A \text{ NAND } B$
- b. $F = A + B + C$

4. Which of the following circuits are functionally equivalent to $F = a \text{ xor } b$?



5. Using the Shannon Expansion Theorem, expand $F(a, b, c) = ac + ab'c + b$, with respect to

- a. Variable a
- b. Variable b
- c. Variable c

6. Convert $F = a \text{ xor } b \text{ xor } c$ into a BDD, using the variable ordering $a \leq b \leq c$.

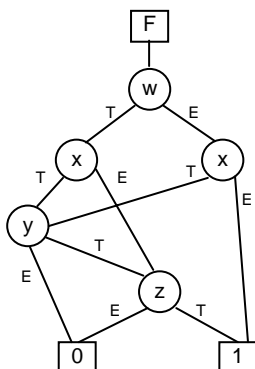
7. Convert $F(a, b, c, d) = a + bc'd + a'bcd + b'd$ to its corresponding BDD representation, using the variable ordering $a < b < c < d$. Be sure to reduce the BDD if possible.

8. Convert $F(a, b, c, d) = ab + a'bc' + a'b'c + d$ to its corresponding BDD representation. Use the variable ordering $a \leq b \leq c \leq d$.

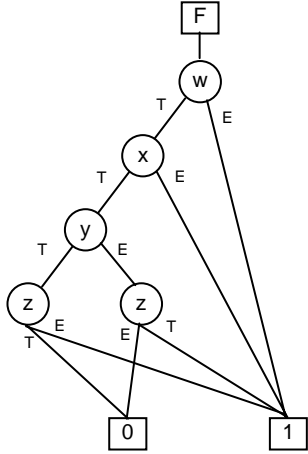
9. Given $F = abc + bc'd + b'd$, which of the following variable orderings is "best" to implement a ROBDD?

- a. Variable ordering $d < c < b < a$
- b. Variable ordering $b < c < a < d$

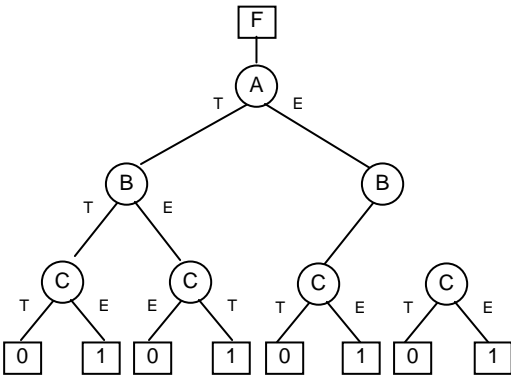
10. Determine the equation represented by the BDD below.



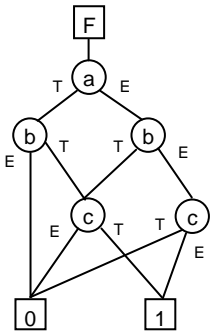
11. Determine the equation represented by the BDD below.



12. Convert the following BDD into an ROBDD, using the variable ordering $A < B < C$.



13. Convert the following BDD into an ROBDD, using the variable ordering $C < A < B$.

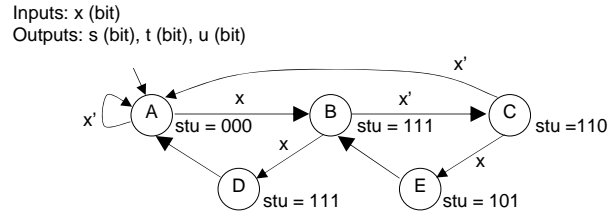


14. Let $F=ad$, $G=c+d$, $H=ab'$, and $I=FG+F'H$

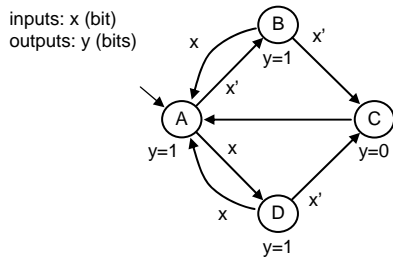
- Build a BDD for F , G , and H . Then composed the BDD for I by iteratively connecting the previously created BDDs.
- Using the ITE algorithm create a BDD for I .
- What are the benefits of using the ITE algorithm?

15. Let $F=ab+c$, $G=c'd$, $H=a'b'+ab$, and $I=FG+F'H$. Use the ITE algorithm to create a BDD for I. Be sure to show the corresponding steps of the ITE algorithm and the resulting BDD. Use the variable ordering $a < c < b < d$.
16. Let $F=abc + cd + a'b'c'$. Use the ITE algorithm to create the corresponding BDD for F. Be sure to show the corresponding steps of the ITE algorithm and the resulting BDD. Use the variable ordering $c < a < d < b$.

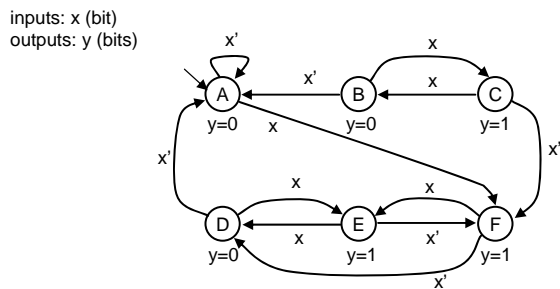
17. Encoding the FSM below using the encoding techniques specified below
- Minimum bit-width binary encoding
 - One-hot encoding
 - Output encoding.



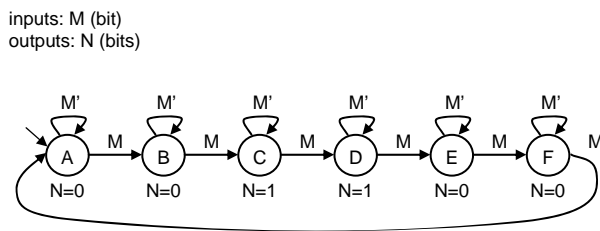
18. Reduce the number of states for the FSM below by eliminating redundant states by using an implication table. Draw the resulting FSM.



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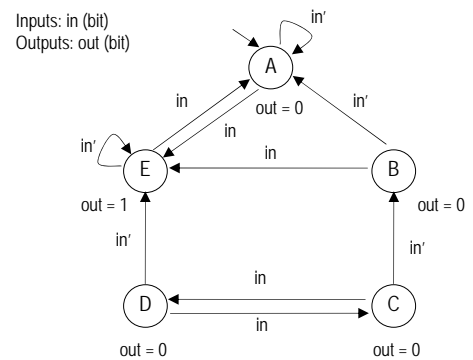


21. Minimize the following state table using the partitioning approach. Show the corresponding partitions, you do not need to show the minimized FSM.

Inputs		Outputs	
Current State	a	Next State	f
P	0	S	1
P	1	T	1
Q	0	R	1
Q	1	T	1
R	0	T	0
R	1	R	0
S	0	T	0
S	1	R	0
T	0	S	1
T	1	Q	1
U	0	R	0
U	1	T	0

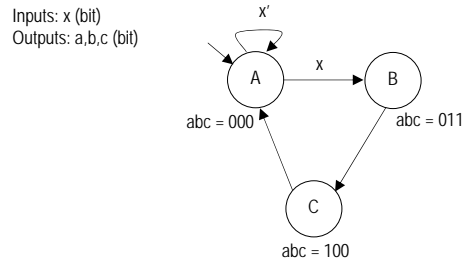
22. Using the FSM provided

- Derive the equivalent state table
- Utilizing the state table minimize the FSM (i.e. partitioning approach), be sure to show each step
- Draw the minimized FSM



23. Which of the following yields the optimal state encoding assignment

- Minimum bit width binary encoding (A=00, B=01, C=10)
- Modified minimum bit width binary encoding (A=00, B=01, C=11)
- One-hot
- Output encoding



ECE 574A Only

24. Given $F(a, b, c) = ab + a'bc' + b'c'$, determine the optimal variable ordering.

25. Describe how the optimal variable ordering can be found. What is the complexity of your method?