

**CS 150, Spring 1992
Midterm #1 Solutions
Professor A. R. Newton**

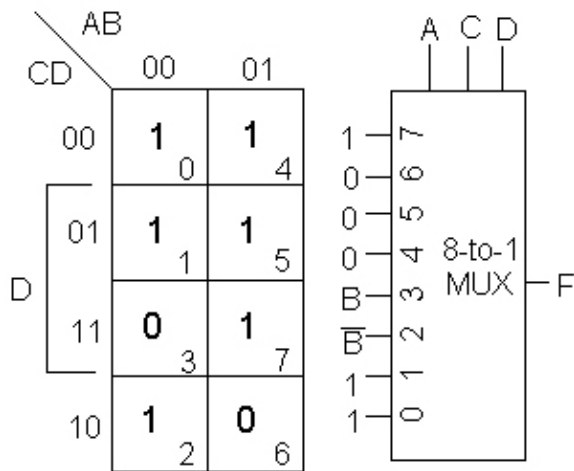
Problem #1a

T = tape properly threaded, M = manual mode (automatic = $\sim M$), E = end-of-tape present, S = start pressed,
 C = 'tape on' from computer, R = run tape drive.
 $R = T \sim E(MS + \sim MC)$

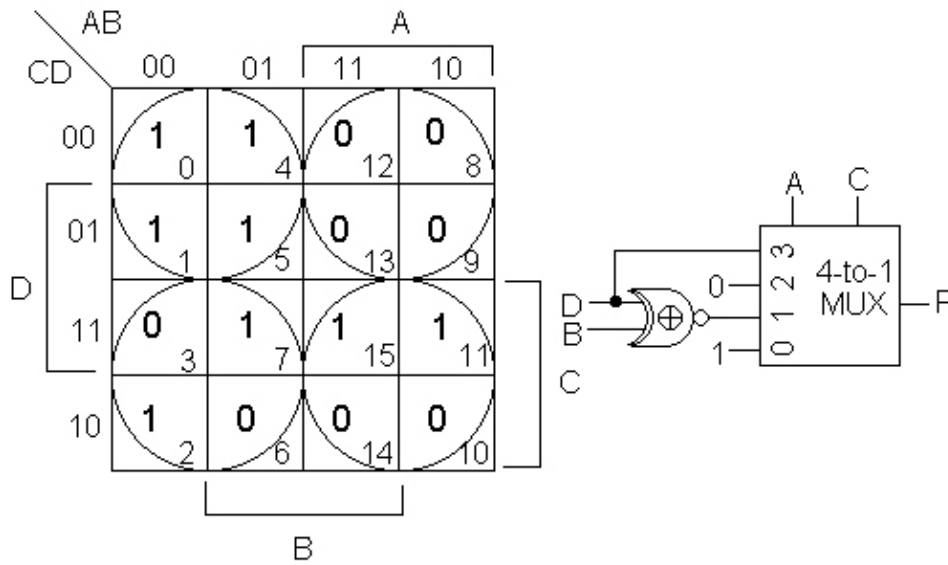
Problem #1b

- (i) Maxterm representation: $F = [\text{Product/PI}] M(6,7,9,10,13,14,15)$
- (ii) Minimum S-of-P form: $\sim F = BC + A\sim CD + AC\sim D$
- (iii) Minimum P-of-S form: $F = (\sim B + \sim C)(\sim A + C + \sim D)(\sim A + \sim C + D)$

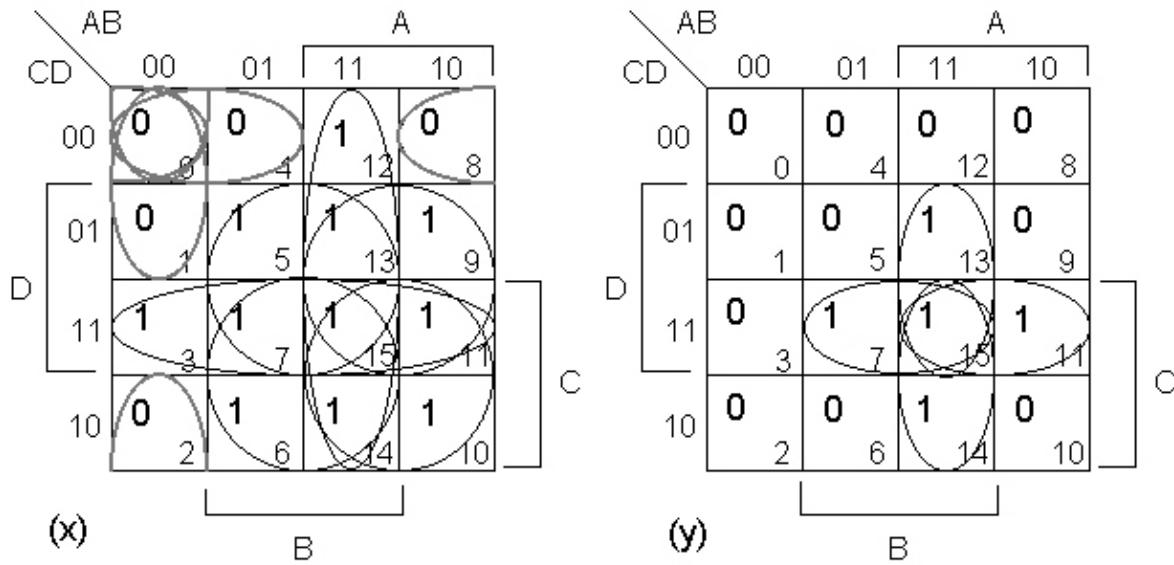
Problem #2a



Problem #2b



Problem #3a



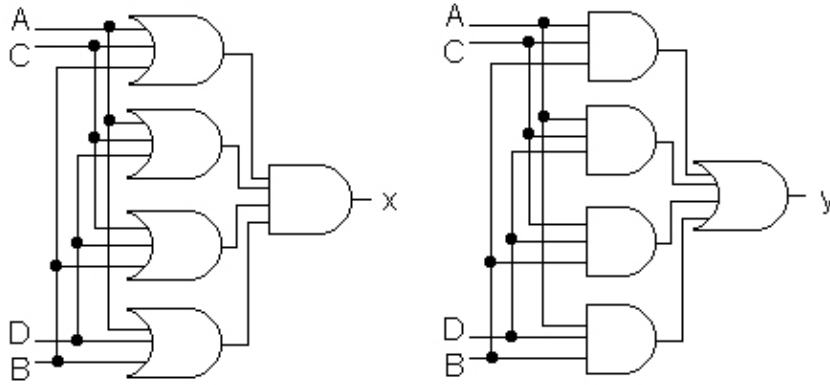
Problem #3b

Better to realize $\sim x$ and then De Morgan (fewer gates):

$$\sim x = \sim A \sim B \sim C + \sim A \sim C \sim D + \sim B \sim C \sim D + \sim A \sim B \sim D$$

$$x = (A + B + C)(A + C + D)(B + C + D)(A + B + D)$$

$$y = ABC + ACD + BCD + ABD$$



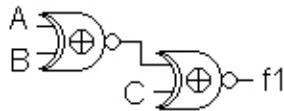
Problem #4a

$$f1 = (A\sim B + \sim AB) = A (+) B$$

$$f2 = AB + f1C = AB + C(A\sim B + \sim AB) = AB + C(A (+) B)$$

$$f3 = f1\sim C + \sim f1C = f1 (+) C = A (+) B (+) C$$

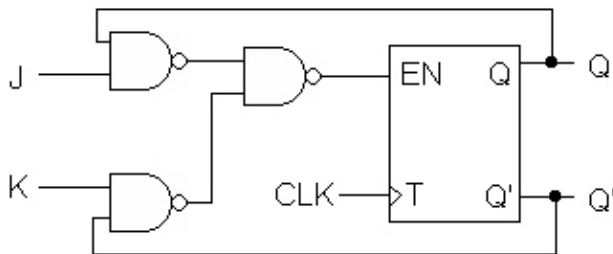
Problem #4b



Problem #5a

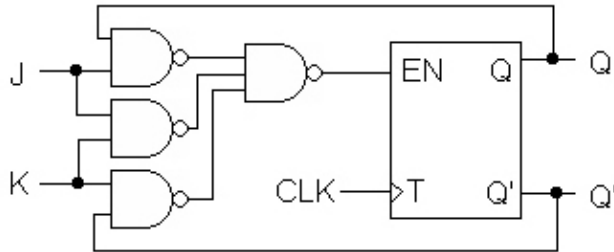
Qn	J	K	Qn+1	En
0	0	0	0	0
0	0	1	0	0
0	1	0	1	1
0	1	1	1	1
1	0	0	1	0
1	0	1	0	1
1	1	0	1	0
1	1	1	0	1

		JK			
		00	01	11	10
Qn	00	0 0	0 2	1 6	1 4
	01	0 1	1 3	1 7	0 5



Problem #5b

Yes, a hazard does exist in the $Q \rightarrow \sim Q$ transition, as shown in the K-map above. It will not cause a problem if the clock pulse is wider than two gate delays. It can be removed by adding the implicant shown in grey above, corresponding to the logic gate below.



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