Fall 2019

CSE-5321-002 - Software Testing

Homework Assignment 2

Name	UTA ID
Goutami Padmanabhan	1001669338

Please find the worksheet I used for calculations (HW_2_answers.xlsx), attached to the zip file I submitted.

Problem 1

1. Test case Table

Test Case Number	Current State	Inputs						Internal					Expected Outputs					Next State
		N	V	E	C	U	L	D1	D2	D3	D4	D1D2D3D4==code	B	R	Y	G	X	
1	Start	-	-	-	-	-	-	null	null	null	null	-	F	F	F	F	T	S0
2	S0	F	-	T	F	F	F	null	null	null	null	-	F	F	F	F	T	S0
3	S0	F	-	F	T	F	F	null	null	null	null	-	F	F	F	F	T	S0
4	S0	F	-	F	F	T	F	null	null	null	null	-	F	F	F	F	T	S0
5	S0	F	-	F	F	F	T	null	null	null	null	-	F	F	F	F	T	S0
6	S0	T	V	F	F	F	F	V	null	null	null	-	T	F	F	F	T	S1
7	S1	F	-	T	F	F	F	V	null	null	null	-	T	F	F	F	T	S1
8	S1	F	-	F	F	T	F	V	null	null	null	-	T	F	F	F	T	S1
9	S1	F	-	F	F	F	T	V	null	null	null	-	T	F	F	F	T	S1
10	S1		-		T			null	null	null	null	-					T	S0
11	S1	T	V	F	F	F	F	V	V	null	null	-	F	T	F	F	T	S2
12	S2	F	-	T	F	F	F	V	V	null	null	-	F	T	F	F	T	S2

13	S2	F	-	F	F	T	F	V	V	null	null	-	F	T	F	F	T	S2
14	S2	F	-	F	F	F	T	V	V	null	null	-	F	T	F	F	T	S2
15	S2		-		T			V	null	null	null	-	T				T	S1
16	S2	T	V	F	F	F	F	V	V	V	null	-	F	F	T	F	T	S3
17	S3	F	-	T	F	F	F	V	V	V	null	-	F	F	T	F	T	S3
18	S3	F	-	F	F	T	F	V	V	V	null	-	F	F	T	F	T	S3
19	S3	F	-	F	F	F	T	V	V	V	null	-	F	F	T	F	T	S3
20	S3		-		T			V	V	null	null	-		T			T	S2
21	S3	T	V	F	F	F	F	V	V	V	V	-	F	F	F	T	T	S4
22	S4	T	V	F	F			V	V	V	V	-	F	F	F	T	T	S4
23	S4	F	F	F	F	T		V	V	V	V	-	F	F	F	T	T	S4
24	S4	F	F	F	F		T	V	V	V	V	-	F	F	F	T	T	S4
25	S4		-		T			V	V	V	null	-			T		T	S3
26	S4	F	-	T	F	F	F	V	V	V	V	-	F	F	F	F	T	S5
27	S5	T	V	F	F	F	F	V	V	V	V	-	F	F	F	F	T	S5
28	S5	F	F	T	F	F	F	V	V	V	V	-	F	F	F	F	T	S5
29	S5	F	F	F	T	F	F	V	V	V	V	-	F	F	F	F	T	S5
30	S5	F	F	F	F	F	T	V	V	V	V	-	F	F	F	F	T	S5
31	S5	F	-	F	F	T	F	null	null	null	null	-	F	F	F	F	T	S6
32	S6		-					null	null	null	null	F					T	S0
33	S6	F	-	F	F	F	F	null	null	null	null	T	T	T	T	T	F	S7
34	S7	T	V	F	F	F	F	null	null	null	null	-	T	T	T	T	F	S7
35	S7	F	F	T	F	F	F	null	null	null	null	-	T	T	T	T	F	S7
36	S7	F	F	F	T	F	F	null	null	null	null	-	T	T	T	T	F	S7
37	S7	F	F	F	F	T	F	null	null	null	null	-	T	T	T	T	F	S7
38	S7	F	-	F	F	F	T	null	null	null	null	-	F	F	F	F	T	S0

2. Sequence enumeration

Length	Sequence	Response	Equivalence	Carry to next level
0	Idle	B=R=Y=G=F,D1=D2=D3=D4=null,X=T	-	
1	N	B=T,R=Y=G=F,D1=V,D2=D3=D4=null,X=T	-	Yes
1	E	B=R=Y=G=F,D1=D2=D3=D4=null,X=T	Idle	
1	C	B=R=Y=G=F,D1=D2=D3=D4=null,X=T	Idle	
1	U	B=R=Y=G=F,D1=D2=D3=D4=null,X=T	Idle	
1	L	B=R=Y=G=F,D1=D2=D3=D4=null,X=T	Idle	
2	NN	R=T,B=Y=G=F,D1=V,D2=V,D3=D4=null,X=T	-	Yes
2	NE	B=T,R=Y=G=F,D1=V,D2=D3=D4=null,X=T	N	
2	NC	B=R=Y=G=F,D1=D2=D3=D4=null,X=T	Idle	
2	NU	B=T,R=Y=G=F,D1=V,D2=D3=D4=null,X=T	N	
2	NL	B=T,R=Y=G=F,D1=V,D2=D3=D4=null,X=T	N	
3	NNN	Y=T,B=R=G=F,D1=V,D2=V,D3=V,D4=null,X=T	-	Yes
3	NNE	R=T,B=Y=G=F,D1=V,D2=V,D3=D4=null,X=T	NN	
3	NNC	B=T,R=Y=G=F,D1=V,D2=D3=D4=null,X=T	N	
3	NNU	R=T,B=Y=G=F,D1=V,D2=V,D3=D4=null,X=T	NN	
3	NNL	R=T,B=Y=G=F,D1=V,D2=V,D3=D4=null,X=T	NN	
4	NNNN	G=T,B=R=Y=F,D1=V,D2=V,D3=V,D4=V,X=T	-	Yes
4	NNNE	Y=T,B=R=G=F,D1=V,D2=V,D3=V,D4=null,X=T	NNN	
4	NNNC	R=T,B=Y=G=F,D1=V,D2=V,D3=D4=null,X=T	NN	
4	NNNU	Y=T,B=R=G=F,D1=V,D2=V,D3=V,D4=null,X=T	NNN	
4	NNNL	Y=T,B=R=G=F,D1=V,D2=V,D3=V,D4=null,X=T	NNN	
5	NNNNN	G=T,B=R=Y=F,D1=V,D2=V,D3=V,D4=V,X=T	NNNN	
5	NNNNE	B=R=Y=G=F,D1=V,D2=V,D3=V,D4=V,X=T	-	Yes
5	NNNNC	Y=T,B=R=G=F,D1=V,D2=V,D3=V,D4=null,X=T	NNN	
5	NNNNU	G=T,B=R=Y=F,D1=V,D2=V,D3=V,D4=V,X=T	NNNN	
5	NNNNL	G=T,B=R=Y=F,D1=V,D2=V,D3=V,D4=V,X=T	NNNN	
6	NNNNEN	B=R=Y=G=F,D1=V,D2=V,D3=V,D4=V,X=T	NNNNE	
6	NNNNEE	B=R=Y=G=F,D1=V,D2=V,D3=V,D4=V,X=T	NNNNE	
6	NNNNEC	B=R=Y=G=F,D1=V,D2=V,D3=V,D4=V,X=T	NNNNE	
6	NNNNEU	B=R=Y=G=F,D1=D2=D3=D4=null,X=T	-	Yes
6	NNNNEL	B=R=Y=G=F,D1=V,D2=V,D3=V,D4=V,X=T	NNNNE	
6a	NNNNEU and D1D2D3D4!=code	B=R=Y=G=F,D1=D2=D3=D4=null,X=T	-	

6a	NNNNEU and D1D2D3D4==code	B=R=Y=G=T,D1=D2=D3=D4=null,X=F	-	Yes
7	NNNNEUN	B=R=Y=G=T,D1=D2=D3=D4=null,X=F	NNNNEU	
7	NNNNEUE	B=R=Y=G=T,D1=D2=D3=D4=null,X=F	NNNNEU	
7	NNNNEUC	B=R=Y=G=T,D1=D2=D3=D4=null,X=F	NNNNEU	
7	NNNNEUU	B=R=Y=G=T,D1=D2=D3=D4=null,X=F	NNNNEU	
7	NNNNEUL	B=R=Y=G=F,D1=D2=D3=D4=null,X=T	Idle	

Cannonical states
Jumps to previous state

3. Canonical states

Canonical states are N,NN,NNN,NNNN,NNNNE,NNNNEU

Problem 2

Test Case Number	Input					Expected output
	Number of Drinks	Discount Type	Drink Type	Size	Payment Type	Return
1	1	None	Coffee	Small	Cash	1.66954
2	1	Student	Tea	Regular	CreditCard	1.142459
3	1	Teacher	Soda	Large	DebitCard	1.790915
4	4	None	Tea	Large	Cash	5.613434
5	4	Student	Coffee	Grande	DebitCard	11.46303
6	4	Teacher	Slushy	Small	CreditCard	5.041917
7	7	None	Soda	Regular	CreditCard	11.57846
8	7	Student	Slushy	Large	Cash	10.62725
9	7	Teacher	Coffee	Regular	Cash	12.76781
10	7	Military	Tea	Small	DebitCard	6.376466
11	12	None	Slushy	Grande	DebitCard	28.59749
12	12	Military	Coffee	Large	CreditCard	24.4116
13	12	Frequent	Soda	Small	Cash	13.00351
14	17	Military	Cappuccino	Regular	Cash	45.19237
15	17	Frequent	Tea	Grande	CreditCard	27.77224
16	17	Coupon	Soda	Grande	Cash	38.34004
17	17	Employee	Slushy	Regular	DebitCard	18.88787

18	20	Frequent	Cappuccino	Large	DebitCard	60.55938
19	20	Coupon	Cappuccino	Small	CreditCard	51.98013
20	20	Employee	Coffee	Grande	Cash	46.32973
21	31	Coupon	Coffee	Regular	DebitCard	55.2239
22	31	Employee	Cappuccino	Small	CreditCard	67.14101
23	31	Student	Soda	Small	Cash	37.79145
24	50	Teacher	Cappuccino	Grande	Cash	238.9818
25	50	Military	Soda	Large	CreditCard	82.52348
26	50	Frequent	Coffee	Regular	DebitCard	79.17405
27	1	Military	Slushy	Grande	CreditCard	2.086425
28	4	Coupon	Tea	Regular	Cash	4.303632
29	7	Coupon	Slushy	Large	CreditCard	11.28461
30	7	Employee	Tea	Grande	DebitCard	10.40864
31	12	Employee	Soda	Regular	CreditCard	14.88659
32	17	None	Coffee	Small	CreditCard	30.13777
33	20	None	Soda	Regular	DebitCard	32.11778
34	31	Teacher	Tea	Large	DebitCard	42.60712
35	31	Frequent	Slushy	Grande	Cash	57.32842
36	50	Student	Cappuccino	Small	DebitCard	126.1654
37	1	Employee	Cappuccino	Large	Cash	2.753559
38	4	Military	Soda	Grande	DebitCard	8.783513
39	4	Frequent	Cappuccino	Regular	CreditCard	10.62705
40	12	Student	Tea	Small	Cash	11.22687
41	12	Teacher	Cappuccino	Grande	CreditCard	60.90339
42	17	Student	Coffee	Large	CreditCard	36.6174
43	20	Military	Slushy	Small	Cash	21.24201
44	20	None	Tea	Large	CreditCard	29.80328
45	50	None	Slushy	Regular	Cash	71.84796
46	50	Coupon	Tea	Small	DebitCard	48.22538
47	7	None	Cappuccino	Grande	DebitCard	36.30759
48	1	Frequent	Slushy	Small	DebitCard	1.03054
49	12	Coupon	Coffee	Large	DebitCard	25.09473
50	17	Teacher	Tea	Small	DebitCard	17.30755
51	31	Military	Coffee	Regular	CreditCard	53.72058
52	50	Employee	Coffee	Large	CreditCard	89.74852
53	1	Coupon	Soda	Grande	CreditCard	2.394799
54	4	Employee	Soda	Small	Cash	4.063597
55	7	Frequent	Coffee	Small	Cash	9.349423
56	20	Student	Soda	Regular	DebitCard	28.906
57	20	Teacher	Slushy	Regular	CreditCard	28.99102
58	31	None	Cappuccino	Large	Cash	113.8138

Problem 3

3 a) $a'b'c + bc + bd + ac'$

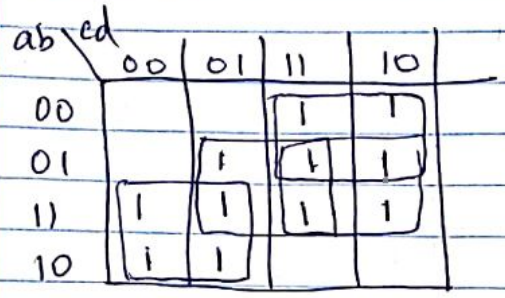
Listing the missing combinations

$a'b'c \Rightarrow a'b'cd, a'b'cd'$

$bc \Rightarrow abcd, a'bcd, abcd', a'bcd'$

$bd \Rightarrow abcd, a'bcd, abc'd, a'bc'd$

$ac' \Rightarrow abc'd, ab'c'd, abc'd', ab'c'd'$



Ans: $ac' + bd + bc + a'c$

3 b) $a'b'c'd' + a'b'cd + a'b + ac'd' + acd$

Listing the missing combinations

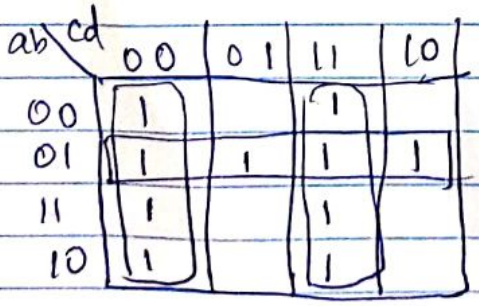
$a'b'c'd' \Rightarrow a'b'c'd'$

$a'b'cd \Rightarrow a'b'cd$

$a'b \Rightarrow a'bcd, a'bc'd, a'bc'd', a'bcd'$

$ac'd' \Rightarrow abc'd', ab'c'd'$

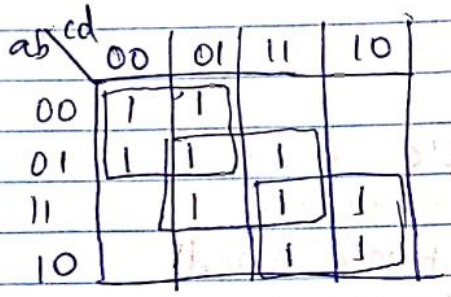
$acd \Rightarrow abcd, ab'cd$



Ans: $c'd' + cd + a'b$

3c) $a'b'c' + a'bd + a'bc' + abd + acd' + acd' + ab'cd$

$a'b'c' \Rightarrow a'b'c'd$, $a'b'c'd'$
$a'bd \Rightarrow a'bcd$, $a'bc'd$
$a'bc' \Rightarrow a'bc'd$, $a'bc'd'$
$abd \Rightarrow abcd$, $abc'd$
$acd' \Rightarrow abcd'$, $ab'cd'$
$acd' \Rightarrow abcd'$, $ab'cd'$
$ab'cd \Rightarrow ab'cd$



ANS: $a'c' + bd + ac$

3 d) $a'b'c' + a'b'd + c'd' + ac' + c'd + ab'cd$

Listing the missing combinations

$a'b'c' \Rightarrow a'b'c'd,\ a'b'c'd'$

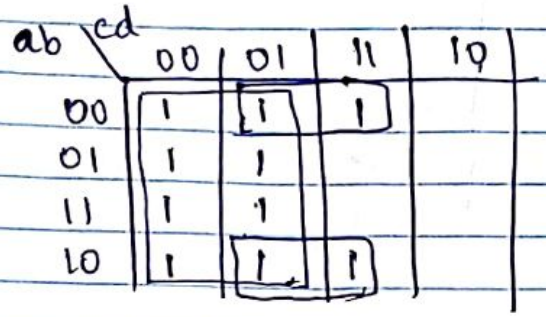
$a'b'd \Rightarrow a'b'cd,\ a'b'c'd$

$c'd' \Rightarrow ab\,c'd',\ ab'c'd',\ a'b'c'd',\ abc'd'$

$ac' \Rightarrow abc'd,\ ab'c'd,\ abc'd',\ ab'c'd'$

$c'd \Rightarrow ab\,c'd,\ a'bc'd,\ ab'c'd,\ a'b'c'd$

$ab'cd \Rightarrow ab'cd$



Ans: $c' + d\,a'b' + ab'd$

$c' + a'b'd + ab'd$

$c' + b'd(a' + a)$

$c' + b'd$

3 e) $a'c' + abd + a'c + ac$

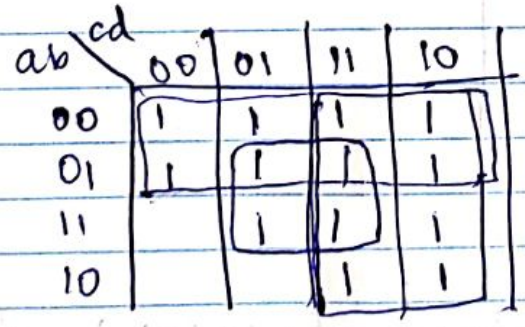
Listing the missing combinations

$a'c' \Rightarrow a'bc'd,\ a'b'c'd,\ a'b'c'd',\ a'bc'd'$

$abd \Rightarrow abcd,\ abc'd$

$a'c \Rightarrow a'bcd,\ a'b'cd,\ a'bcd',\ a'b'cd'$

$ac \Rightarrow abcd,\ ab'cd,\ abcd',\ ab'cd'$



Ans: $a' + c + bd$

Problem 4

4
a) $a'b'+c'$

Condition			Decision
a	b	c	$a'b'+c'$
F	F	F	T
F	F	T	T
F	T	F	T
F	T	T	F
T	F	F	T
T	F	T	F
T	T	F	T
T	T	T	F

c/d - condition decision coverage
c - condition coverage
d - decision coverage

c/d = FFF, TTT
c = FFT, TTF
d = (FFF, FTT)

Term Omission fault (TOFs) = $a'b'$, c'
Term Negation fault (TNFs) = $a+b+c'$, $a'b'+c$

4b) $a'(b'+c) = a'b'+a'c$

Condition			Decision
a	b	c	$a'b'+a'c$
F	F	F	T
F	F	T	T
F	T	F	F
F	T	T	T
T	F	F	F
T	F	T	F
T	T	F	F
T	T	T	F

c/d = (FFF, TTT)
c = (FTF, TFT)
d = (FFF, FTF)

Term Omission fault (TOFs) = $a'b'$, $a'c$
Term Negation faults (TNFs) = $a+b+a'c$, $a'b'+a+c'$

4c) $abc + c'd' + a'b'$

Condition				Decision
a	b	c	d	abc + c'd' + a'b'
F	F	F	F	T
F	F	F	T	T
F	F	T	F	T
F	F	T	T	T
F	T	F	F	T
F	T	F	T	F
F	T	T	F	F
F	T	T	T	F
T	F	F	F	T
T	F	F	T	F
T	F	T	F	F
T	F	T	T	F
T	T	F	F	T
T	T	F	T	F
T	T	T	F	T
T	T	T	T	T

c/d = (FFTF, TTFT)
e = (FFFF, TTTT)
d = (FFFF, FTFT)

Term Omission faults (TOFs) = abc, c'd', a'b'

Term Negation faults (TNFs) = a'+b'+c', c'd'+a'b',
abc + c + d + a'b',
abc + c'd' + a + b

4d) $(a'b'c' \text{ XOR } (a'b)')' + abcd$

$a \text{ XOR } b = ab' + a'b \longrightarrow (1)$

Using this(1) in the above problem

$(a'b'c' \text{ XOR } (a'b)')' + abcd$

$= (a'b'c' \text{ XOR } (a+b'))' + abcd$

$= (a'b'c')(a+b')' + (a'b'c')'(a+b') + abcd$

$= (a'b'c')(a'b) + (a+b+c)(a+b') + abcd$

$= a'a'(bb')c' + aa + ab + ac + ab' + bb' + b'c + abcd$

$= 0 + aa + ac + a(b+b') + bb' + b'c + abcd$

$= 0 + aa + ac + a \cdot 1 + bb' + b'c + abcd$

$= 0 + a(1+a) + ac + bb' + b'c + abcd$

$= a \cdot 1 + ac + bb' + b'c + abcd$

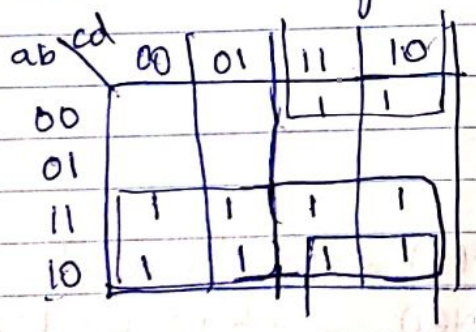
$= a(1+c) + bb' + b'c + abcd$

$= a \cdot 1 + bb' + b'c + abcd$

$= a + 0 + b'c + abcd$

$= a + b'c + abcd$

Minimizing this expression using K-map



$a \Rightarrow abcd, ab'cd, abc'd, abcd', ab'c'd, abc'd', ab'cd', ab'c'd'$,

$b'c \Rightarrow ab'cd', ab'cd, a'b'cd, a'b'cd, ab'cd', a'b'cd'$

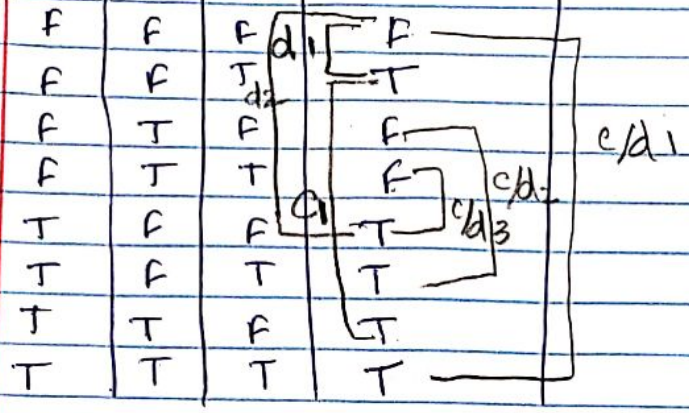
$abcd \Rightarrow abcd$

ANS: $a + b'c$

a + b'c

Condition | Decision

a	b	c	a + b'c
F	F	F	F
F	F	T	T
F	T	F	F
F	T	T	F
T	F	F	T
T	F	T	T
T	T	F	T
T	T	T	T



c/d = (FFF, TTT)

c = (FFT, TTF)

d = (FFF, FFT)

Term Omission Faults (TOFs) = a, b'c

Term Negation faults (TNFs) = ~~a+b+c'~~ a + b + c', a' + b'c

Problem 5-1-a.

a = (b < 10) || c

Test Case	Inputs		Expected Outputs
	b	**c**	**a**
1	9	F	T
2	10	F	F
3	10	T	T

Problem 5-1-b.

a = b || (c>=5)

Test Case	Inputs		Expected Outputs
	b	**c**	**a**
1	T	4	T
2	F	4	F
3	F	5	T

Problem 5-1-c.

a = (b <=5) & (c>=8)

Test Case	Inputs		Expected Outputs
	b	**c**	**a**
1	5	7	F
2	5	8	T
3	6	8	F

Problem 5-1-d.

a = (b>5) & (b<=15)

Test Case	Inputs	Expected Outputs
	b	**a**
1	5	F
2	6 or 15	T
3	16	F
4	15 or 6	T

Problem 5-2)

a) $a'b'+c'$ $\Rightarrow$ $n+1 = 3+1 = 4$ tests

COI a XFF
b FXT > FFT, TFT, FTT is the base set
c TFX, FTX, TTX

UC1 = FFT, TFT, FTT, TFF
UC2 = FFT, TFT, FTT, FTF

b) $a'(b'+c) = a'b'+a'c$ $\Rightarrow$ $n+1 = 3+1 = 4$ tests

COI a XFF, XTT
b FXF > FFF, FTF, FTT is the base set
c FTX

UC1 = FFF, FTF, FTT, TFF
UC2 = FFF, FTF, FTT, TTT

c) $a + c'd' + a'b'$

COI a XTTT, XTTF, XTFT
b FXTT, FXTF, FXFT
c FTXF > FTFF, FTTF, FTFT is the base set
d FTFX

UC1 = FTFF, FTTF, FTFT, FFTF, TTTF
UC2 = FTFF, FTTF, FTFT, FFFT, TTTF
UC3 = FTFF, FTTF, FTFT, TTFT, FFTF
UC4 = FTFF, FTTF, FTFT, TTFT, FFFT

5-2d) $(a'b'c' \text{ XOR } (a'b)') + abcd$

$a \text{ XOR } b = ab' + a'b \longrightarrow (1)$

Using (1) in the above question

$(a'b'c' \text{ XOR } (a'b)') + abcd$

$= (a'b'c' \text{ XOR } (a+b')) + abcd$

$= (a'b'c') \cdot (a+b')' + (a'b'c')' (a+b') + abcd$

$= (a'b'c')(a'b) + (a+b+c)(a+b') + abcd$

$= a'a'(bb')c' + aa + ab + ac + ab' + bb' + b'c + abcd$

$= 0 + aa + ab + a(b+b') + bb' + b'c + abcd$

$= aa + ac + a \cdot 1 + bb' + b'c + abcd$

$= a(1+a) + ac + bb' + b'c + abcd$

$= a \cdot 1 + ac + bb' + b'c + abcd$

$= a(1+c) + bb' + b'c + abcd$

$= a \cdot 1 + bb' + b'c + abcd$

$= a + 0 + b'c + abcd$

$= a + b'c + abcd \Rightarrow$ Reducing through k map from 4d

$\boxed{a + b'c}$

COI a XTF, XFF, XTT

b FXT > FFT, FTT, FFF is the base set

c FFX

UC1 = FFT, FTT, FFF, TTT

UC2 = FFT, FTT, FFF, TFF

Problem 5

3) 2 UC solution 1 masking solution

$a' + b'c + d$

COI a XTFF, XFFF, XTTF
b TXTF
c TFXF
> TFTF, TTTF, TFFF
d TTFX, TFFX, TTTX

UC1 = TFTF, TTTF, TFFF, FFFF, TTTT
UC2 = TFTF, TTTF, TFFF, FFFF, TFFT
UC3 = TFTF, TTTF, TFFF, FTTF, TTTT
UC4 = TFTF, TTTF, TFFF, FTTF, TFFT

m1 = TFTF, TTTF, TFFF, FTFF, TTTT
m2 = TFTF, TTTF, TFFF, FTFF, TFFT
m3 = TFTF, TTTF, TFFF, FTFF, TTFT
m4 = TFTF, TTTF, TFFF, TTFT, FFFF
m5 = TFTF, TTTF, TFFF, TTFT, FTTF