SYSC 4101

Laboratory 8—answer

Exercise 1

Consider the following predicate: P = A or (B and not(C))

Question 1:

	A	B	C	P	
1	0	0	0	0	A(5) B(3)
2	0	0	1	0	A(6)
3	0	1	0	1	C(4)
4	0	1	1	0	A(8)
5	1	0	0	1	--
6	1	0	1	1	--
7	1	1	0	1	--
8	1	1	1	1	--

For A we need either (1, 5) or (2, 6) or (4, 8)
For B we need (1, 3)
For C we need (3, 4)
An adequate test suite is (1, 3, 4, 5)
Another possibility is (1, 3, 4, 8)
Yet another one is (1, 2, 3, 4, 6)

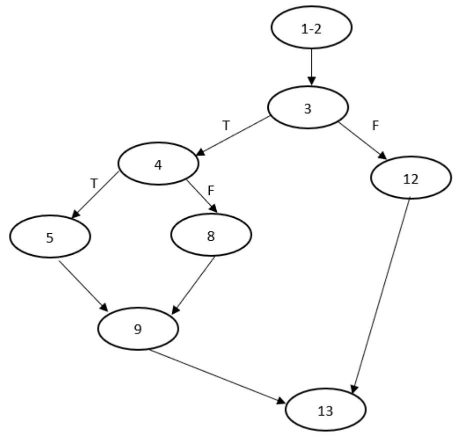
Question 2:

UTP for A: 100, 101, 111
UTP for $B.\bar{C}$: 010

NFP for A in A: 000, 001, 011
NFP for B in $B.\bar{C}$: 000
NFP for C in $B.\bar{C}$: 011

Exercise 2

Question 1:



Question 2:

Test Case 1 exercises path 1-3-4-5-9-13
Test Case 2 exercises path 1-3-4-8-9-13
Test Case 3 exercises path 1-3-12-13
All the edges are exercised: the test suite is all edges adequate

Question 3:

First Predicate: `(a > 12 && b < 45)`

	A `a > 12`	B `b < 45`	P1 = A && B	
1	0	0	0	--
2	0	1	0	A(4)
3	1	0	0	B(4)
4	1	1	1	--

For A(a>12) we need (2,4)
For B(b<45) we need (3,4)
We need (2,3,4) that is three tests:
Row 2: a test with a>12=F and b<45=T,
Row 3: a test with a>12=T and b<45=F,
Row 4: a test with a>12=T and b<45=T.

Second Predicate: `(c > 4 || b > 0)`

	C `c > 4`	D `b > 0`	P2 = C || D	
1	0	0	0	C(3) D(2)
2	0	1	1	--
3	1	0	1	--
4	1	1	1	--

For C(c>4) we need (1,3)
For D(b>0) we need (1,2)
We need (1,2,3) that is three tests:
Row 1: a test with c>4=F and b>0=F,
Row 2: a test with c>4=F and b>0=T,
Row 3: a test with c>4=T and b>0=F.

Question 4:

For the first predicate, we need inputs that satisfy

a<=12 && b<45	not satisfied by {TC1, TC2, TC3}	missed test requirement (i)
a>12 && b>=45	not satisfied by {TC1, TC2, TC3}	missed test requirement (ii)
a>12 && b<45	satisfied by {TC1, TC2}	

For the second predicate, we need inputs that satisfy

c<=4 && b<=0 — satisfied by TC2

c<=4 && b>0 — not satisfied by {TC1, TC2, TC3} — missed test requirement (iii)

we also need a>12 && b<45 (this second predicate is only reached if the first predicate is true)

c>4 && b<=0 — not satisfied by {TC1, TC2, TC3} — missed test requirement (iv)

we also need a>12 && b<45 (this second predicate is only reached if the first predicate is true)

We need other (new) test cases

a<=12 && b<45 — (a=0, b=0, c=0) — satisfies (i)

a>12 && b>=45 — (a=20, b=50, c=0) — satisfies (ii)

c<=4 && b>0 — (a=20, b=20, c=0) — satisfies (iii)

with a>12 && b<45

c>4 && b<=0 — (a=20, b=-20, c=20) — satisfies (iv)

with a>12 && b<45

Question 5:

UTP (a>12 and b<45) = (a>12 = T, b <45=T) (Note there is only one product in the Disjunctive Normal Form.)

NFP (a>12 and b<45, a>12) = (a>12=F, b<45=T)

Cube 11 -> 01

NFP (a>12 and b<45, b<45) = (a>12=T, b<45=F)

Cube 11 -> 10

UTP (c>4) = (c>4=T, b>0=F) (Note there is only one clause in each product.)

NFP (c>4, c>4) = (c>4=F, b>0=F)

Cube 1x -> 0x

UTP (b>0) = (c>4=F, b>0=T)

NFP (b>0, b>0) = (c>4=F, b>0=F)

Cube x1 -> x0

Exercise 3

Question A:

P = (a && b) || (b && !c) || (!c)

	a	b	c	P	
1	0	0	0	1	c(2)
2	0	0	1	0	--
3	0	1	0	1	c(4)
4	0	1	1	0	a(8)
5	1	0	0	1	c(6)
6	1	0	1	0	b(8)
7	1	1	0	1	--
8	1	1	1	1	--

For a we need (4, 8)
For b we need (6, 8)
For c we need either (1, 2) or (3, 4) or (5, 6)
One possible test suite: {4, 5, 6, 8}

Question B:

UTP(ab) = {111}
UTP(b!c) = Impossible, since c needs to be 0 to make b!c=1 (second product in the disjunctive normal form) and we need c to be 1 to make !c=0 (third product in the disjunctive normal form)
UTP(!c) = {000, 100}

NFP(ab, a) = {011}	cube 11- becomes 01-, we need c=1
NFP(ab, b) = {101}	cube 11- becomes 10x, we need c=1
NFP(b!c, b) = impossible	cube -10 becomes -00, impossible to make !c=0 with c=0
NFP(b!c, c) = {011}	cube -10 becomes -11, we need a=0
NFP(!c, c) = {001, 101, 011}	cube --0 becomes --1, any combination that makes a.b=0 works

As can be observed, we cannot find clause values for a UTP and for a NFP. This is simply due to the fact that the predicate, although in a Disjunctive Normal Form (DNF), is not a minimal DNF. In fact the second term, b && !c, is not necessary (or is redundant with the other terms), and can be removed. The predicate can in fact be written as P = (a && b) || (!c).
This exercise shows that even if the predicate is not written as a minimal DNF, you can still find UTPs and NFPs and, in the event you encounter difficulties (impossibility) when finding UTPs or NFPs, then this is because the DNF is not minimal.

Exercise 4

Consider the predicate `P = (A && !B) || !C`.

Question A:

	A	B	C	P	
1	0	0	0	1	C(2)
2	0	0	1	0	A(6)
3	0	1	0	1	C(4)
4	0	1	1	0	--
5	1	0	0	1	--
6	1	0	1	1	B(8)
7	1	1	0	1	C(8)
8	1	1	1	0	--

For A we need: (2,6)
For B we need: (6,8)
For C we need: (1,2) or (3,4) or (7,8)
Three possible adequate test suites (only one is required for the exercise)
{1,2,6,8} or {2,3,4,6,8} or {2,6,7,8}

Question B:

UTP (A and not(B)) = {101}
NFP (A and not(B), A) = {001}   cube 10- becomes 00-, we need !c=0
NFP (A and not(B), B) = {111}   cube 10- becomes 11-, we need !c=0
UTP (not(C)) = {000, 010, 110}
NFP (not(C), C) = {001, 011, 111}   cube --0 becomes --1, any combination that makes a.!b=0 works

Question C:

We can start with repeating the truth table and identifying combinations of truth values that are feasible.

	a>b	b<=c	c<=a	Feasible?
1	0	0	0	yes, with a<c<b for instance
2	0	0	1	yes, with c<=a<b for instance
3	0	1	0	yes, with a<=b<c for instance
4	0	1	1	yes, with a=b=c
5	1	0	0	no
6	1	0	1	yes, with a>b>c for instance
7	1	1	0	yes, with b<a<c for instance
8	1	1	1	yes, with b<c<=a for instance

The only unfeasible combination of truth values is 1,0,0. None of the test requirements in questions A and B use this test input. All the inputs considered in questions A and B are feasible.

Exercise 5

Consider the predicate `P = (A && !B) || (!A && D) || (!C && !D).`

UTP (a and not(b)) = {1001, 1011, 1010}
Cube:10xx Given A=1 and B=0 we must find values for the other two clauses so that the other two terms evaluate to false. Since A=1, any value for D will make "A and D" false.
Let set D to 1, now "not(C) and not(D)" must be false: any value of D works.
Let set D to 0, now "not(C) and not(D)" must be false: C=1

UTP(not(A) and D) = {0001, 0011, 0101, 0111}
Cube: 0xx1

UTP (not(C) and not(D)) = {0000, 0100, 1100}
Cube: xx00

NFP(A and not(B),A) = {0010}
Cube: 10xx -> 00xx
With A=0, B=0, the other two terms must be 0. Since A=0, D must be 0. Since D=0, C must be 1

NFP (A and not(B), B) = {1110, 1101, 1111}
Cube: 10xx -> 11xx
With A=1, B=1, the other two terms must be 0. Since A=1, any value for D works for the second term. In the third term, if D=0, C must be 1, if D=1, C can be 0 or 1

NFP (not (A) and D, A) = {1101, 1111}
0xx1 -> 1xx1

NFP (not(A) and D, D) = {0010, 0110}
0xx1 -> 0xx0

NFP (not(C) and not(D), C) = {0010, 0110, 1110}
xx00 -> xx10

NFP (not(C) and not(D), D) = {1101}
xx00 -> xx01