

THEORY EXAMINATIONS

Register Number	20500106		
Name of the Student	Siddharth.s		
Degree and Branch	B.E CSE	Semester	✓
Subject code and Name	UCS1524 Logic programming.		
Assessment Test No.	1.	Date	22/9/22

Details of Marks Obtained

Part A		Part B				Part C			
Question No.	Marks	Question No.	(a)	(b)	Total Marks	Question No.	(a)	(b)	Total Marks
			Marks	Marks			Marks	Marks	
1	1	7			b	10			
2	1				b	11			
3	1	8			b	12			
4	2				b	13			
5	1	9			b				
6	2				b				
Total (A)	9	Total (B)			18	Total (C)			20
Grand Total (A+B+C)					Marks (in words)				
Signature of Faculty					✓	46/50			

Part - A

1. Propositional logic forms have objects, predicate, quantifiers and functions. Predicate logic has objects, relations, functions and predicates. Each propositional logic points to 1 context/variable. In predicate logic, functions are used to depict the logic.

$P \rightarrow Q$

$P(x,y) \rightarrow Q(x,y)$

$$2. \neg P \wedge (P \rightarrow Q)$$

$$= \neg P \wedge (\neg P \vee Q)$$

$$= (\neg P \wedge \neg P) \vee (\neg P \wedge Q)$$

$$= \neg P$$

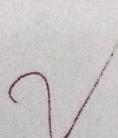
P. 0	10	1100	111
0. 0	1	1	1
0. 1	1	1	1
1. 0	0	0	0
1. 1	0	1	0

3. (i) closed as all the variables are bounded due to quantifiers
 (ii) open as u is not bounded by any quantifier.

4. $A \rightarrow \text{there is rain} ; B \rightarrow \text{climate is cool}$

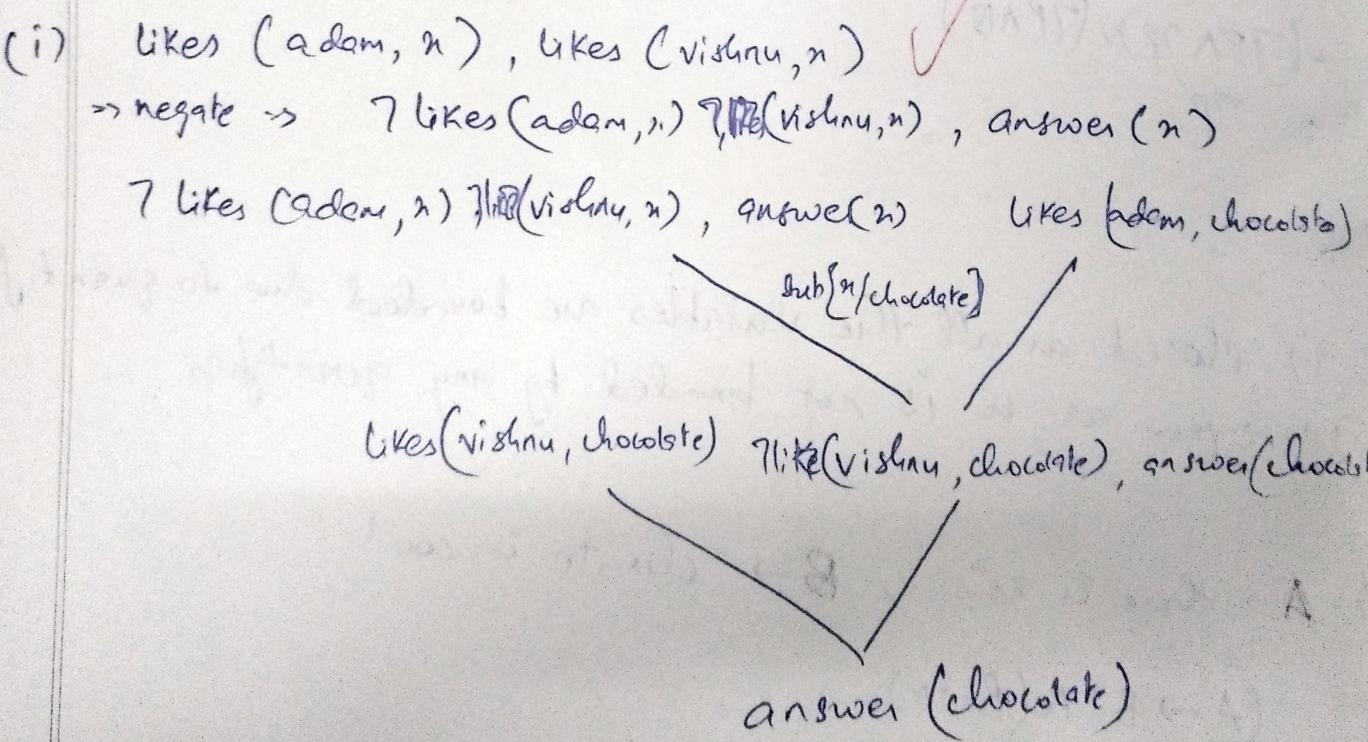
$$(A \rightarrow B) \wedge (B \rightarrow A)$$

$$= (\neg A \vee B) \wedge (\neg B \vee A)$$



~~not~~ restricted to Horn clauses (programming). The Horn clause states that there should be ~~at least~~ ^{almost} 1 ~~positive~~ ^{positive} literal. This is need to break the big clauses by resolution using positive clauses. For resolution to occur, it needs main clauses program to perform efficiently.

- b.
- likes (adam, chocolates)
 - likes (adam, cake)
 - likes (vishnu, chocolates)
 - likes (vishnu, cake)



? likes (adam, n), ?(vishnu, ?), answer(n)

sub {n/cake}

likes (adam, cake)

likes (vishnu, cake) ? like(vishnu, cake), answer (like)

answer (cake)

∴ answer: { chocolate, cake }

(ii) likes (n, chocolate)

→ negative → ? likes (n, chocolate), answer(n)

? likes (n, chocolate), likes (adam, chocolate)

answer n

Sub {n/adam}

✓ answer (adam)

likes (vishnu, chocolate)

Sub {n/vishnu}

answer (vishnu)

∴ answer: { adam, vishnu }

Part-B

7. (i) $(A \vee (B \vee C)) \wedge (C \vee \neg A)$
(ii) $((B \wedge \neg A) \vee C)$

L.H.S. $\stackrel{?}{=}$ (i) $\stackrel{?}{=}$ (ii)

R.H.S.:

$$(A \vee (B \vee C)) \wedge (C \vee \neg A)$$

$$= (A \wedge C) \vee (B \wedge C) \vee (C \wedge C) \vee (A \wedge \neg A) \vee (B \wedge \neg A) \vee (C \wedge \neg A) \quad (\text{distribution})$$

$$= (A \wedge C) \vee (B \wedge C) \vee C \vee F \vee (B \wedge \neg A) \vee (C \wedge \neg A) \quad (\text{inverse})$$

$$= (B \wedge C) \vee C \vee (B \wedge \neg A) \vee (C \wedge (A \vee \neg A)) \quad (\text{associative})$$

$$= (B \wedge C) \vee (B \wedge \neg A) \vee C \vee (C \wedge T) \quad (\text{idempotent})$$

$$= (B \wedge C) \vee (B \wedge \neg A) \vee C \vee C \quad (\text{identity})$$

$$= (B \wedge C) \vee C \vee (B \wedge \neg A)$$

$$= ((C \wedge (B \vee T)) \vee (B \wedge \neg A)) \quad (\text{associative})$$

$$= (C \wedge T) \vee (B \wedge \neg A) \quad (\text{true law})$$

$$= C \vee (B \wedge \neg A) \quad (\text{idempotent})$$

$$= (\text{ii}) = \text{R.H.S}$$

✓

✓

∴ Hence proved //

$$8 \text{ (i)} (P \rightarrow Q) \rightarrow R$$

$$= (\neg P \vee Q) \rightarrow R$$

$$= \neg(\neg P \vee Q) \vee R$$

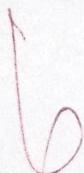
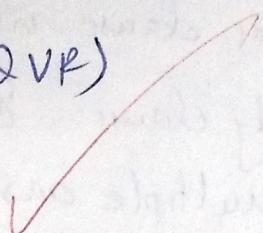
$$= (P \wedge \neg Q) \vee R$$

$$= (P \vee R) \wedge (\neg Q \vee R)$$

Removing \rightarrow (implication law)

~~double negation, distributed~~
(de Morgan's law)

(distribution)



$$\text{(ii)} (R \rightarrow S) \rightarrow \neg(S \rightarrow Q)$$

$$= (\neg R \vee S) \rightarrow \neg(S \rightarrow Q)$$

(implication law)

$$= (\neg R \vee S) \rightarrow (S \wedge \neg Q)$$

(implication)

$$= \neg(\neg R \vee S) \vee (S \wedge \neg Q)$$

(de Morgan)

$$= (R \wedge \neg S) \vee (S \wedge \neg Q)$$

$$= (R \vee S) \wedge (\neg S \vee \neg Q) \wedge (\neg Q \vee S) \wedge (\neg S \vee \neg Q) \quad (\text{distribution})$$

$$= (R \vee S) \wedge T \wedge (\neg Q \vee S) \wedge (\neg Q \vee \neg Q)$$

$$= (R \vee S) \wedge (\neg Q \vee S) \wedge (\neg Q \vee \neg Q)$$

9 Answer generation technique is a technique where an answer clause is assumed and on resolving the clauses, the answer to the question is brought in the answer clause instead of arriving at a contradiction (empty clause). It can find both single as well as multiple answers.

e.g. likes (Adam, apple)
 likes (Eve, apple)
 · likes (Eve, coffee)

Let question be :

- (i) Who likes coffee
- (ii) Who likes apples.

(i) Inference :- likes (\exists , coffee) \rightarrow The answer clause.
Clause : \exists likes (\exists , coffee), answer (\exists)

Resolving takes place,

\exists likes (\exists , coffee), answer (\exists)

likes (Eve, coffee)

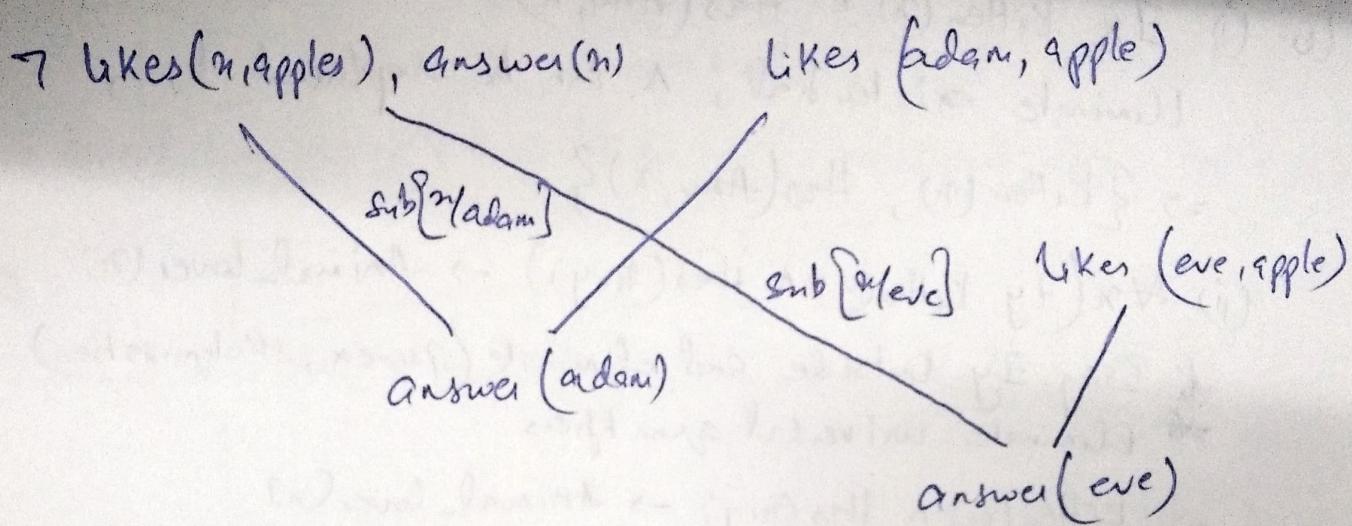
↓
[Subj/Eve]

answer (Eve)

\Rightarrow It can be inferred that Eve likes coffee

(iii) Inference : Likes (n , apple)
 Name : $\neg \text{Likes}(n, \text{apple})$, answer (n)

Resolving,



\Rightarrow It can be inferred that adam and eve likes apples.

✓ X

Part-C

(b) (i) $\exists x \text{ Kitten}(x) \wedge \text{Has}(\text{Any}, x)$

Eliminate existential, \wedge can be replaced by ,

$\Rightarrow \{\text{Kitten}(x), \text{Has}(\text{Any}, x)\}$

(ii) $\forall n (\exists y \text{ Kitten}(y) \wedge \text{Has}(n, y)) \rightarrow \text{Animal_lover}(n)$

* Bring $\exists y$ outside and eliminate (prenex, & Kolmogorov)

* Eliminate universal quantifiers

$\Rightarrow \text{Kitten}(y) \wedge \text{Has}(n, y) \rightarrow \text{Animal_lover}(n)$

* lover to CNF

$\Rightarrow ? \text{ Kitten}(y) \vee ? \text{ Has}(n, y) \vee \text{Animal_lover}(n)$

(iii) $\forall x \text{ Animal_lover}(n) \rightarrow \forall y \text{ Animal}(y) \rightarrow ? \text{ Hunt}(n, y)$

* Eliminate universal quantifiers * convert to CNF

$\Rightarrow ? \text{ Animal_lover}(n) \vee ? \text{ Animal}(y) \quad ? \text{ Hunt}(n, y)$

(iv) $\text{Hunt}(\text{Any}, \text{Ram}) \vee \text{Hunt}(\text{Sanjay}, \text{Ram})$

(v) $\text{Puppy}(\text{Ram})$

(vi) $\forall n \text{ Puppy}(n) \rightarrow \text{Animal}(n)$

* Eliminate universal quantifiers * convert to CNF

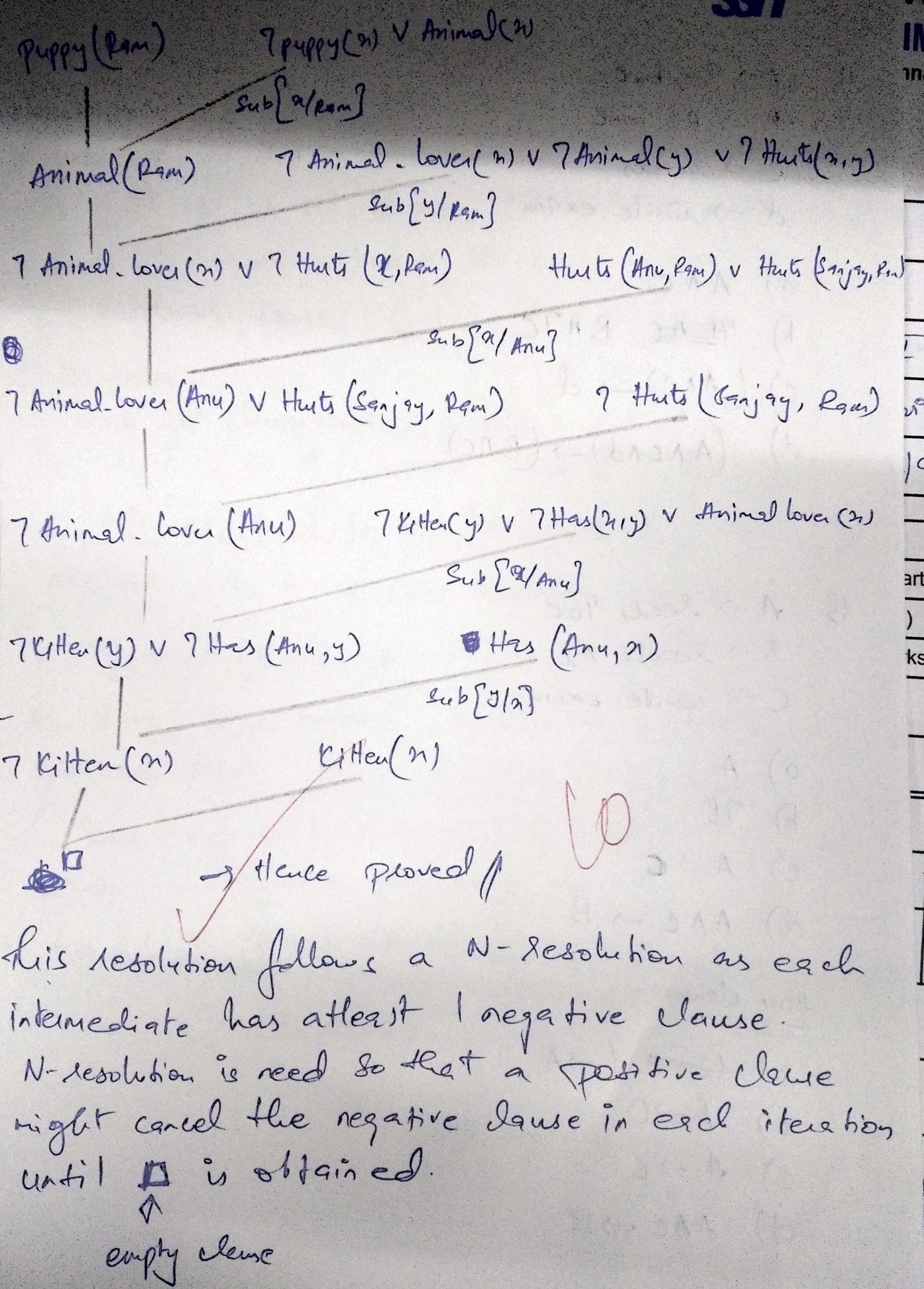
$\Rightarrow ? \text{ Puppy}(n) \vee \text{Animal}(n)$

(vii) ~~Inference~~ $\Rightarrow \text{Hunt}(\text{Sanjay}, \text{Ram})$

\Rightarrow clause = $? \text{ Hunt}(\text{Sanjay}, \text{Ram})$

$F = \{ \text{Kitten}(x), \text{Has}(\text{Any}, x), [? \text{ Kitten}(y) \vee ? \text{ Has}(n, y) \rightarrow \text{Animal_lover}(n)],$

$[? \text{ Animal_lover}(n) \vee ? \text{ Animal}(y) \vee ? \text{ Hunt}(n, y)], [\text{Hunt}(\text{Any}, \text{Ram}) \vee \text{Hunt}(\text{Sanjay}, \text{Ram})], \text{Puppy}(\text{Ram}), [? \text{ Puppy}(n) \vee \text{Animal}(n)], [? \text{ Hunt}(\text{Sanjay}, \text{Ram})]$



- 12 $A \rightarrow \text{ToC book}$
 $B \rightarrow \text{AI book}$
 $C \rightarrow \text{leads}$
 $d \rightarrow \text{write exam}$

- a) $A \wedge C$
b) ~~$\neg A$~~ $B \wedge C$
c) $(A \wedge C) \rightarrow d$
d) $(A \wedge C \wedge d) \rightarrow (B \wedge C)$

- 13 $A \rightarrow \text{leads ToC}$
 $B \rightarrow \text{leads AI}$
 $C \rightarrow \text{write exam}$

- a) A
b) $\neg B$
c) $A \rightarrow \text{C}$
d) $A \wedge C \rightarrow B$

Horn clauses:

- a) ~~$\neg A$~~ $\neg A \rightarrow A$
b) $B \rightarrow O$
c) $A \rightarrow C$
d) $A \wedge C \rightarrow B$

$$F = \{(\underline{l} \rightarrow A), (B \rightarrow 0), (A \rightarrow c), (A \wedge c) \rightarrow B\}$$

Checking satisfiability,

→ mark all one's

$$F = \{(\underline{l} \rightarrow A), (B \rightarrow 0), (A \rightarrow c), (A \wedge c) \rightarrow B\}$$

→ mark all clauses implied by the ones (mark A)

$$F = \{(\underline{l} \rightarrow \underline{A}), (\underline{B} \rightarrow 0), (\underline{A} \rightarrow c), (\underline{A} \wedge c \rightarrow B)\}$$

While loop,

mark all clauses implied by the marked clauses,
i.e. $A \rightarrow c$, as A is marked, mark C

$$F = \{(\underline{l} \rightarrow \underline{A}), (\underline{B} \rightarrow 0), (\underline{A} \rightarrow \underline{c}), (\underline{A} \wedge \underline{c} \rightarrow B)\}$$

$\underline{A} \wedge \underline{c} \rightarrow B$, as A and C are marked, mark B

$$F = \{(\underline{l} \rightarrow \underline{A}), (\underline{B} \rightarrow \underline{0}), (\underline{A} \rightarrow \underline{c}), (\underline{A} \wedge \underline{c} \rightarrow \underline{B})\}$$

As $B \rightarrow 0$, B is marked, we have to mark the 0 (as contradiction).

The Horn Satisfiability states that if $\perp(0)$ 0 is marked, then unsatisfiable, else satisfiable.

$$\Rightarrow F = \{(\underline{l}, \underline{A}), (\underline{B}, \underline{0}), (\underline{A} \rightarrow \underline{c}), (\underline{A} \wedge \underline{c} \rightarrow \underline{0})\}$$

⇒ Unsatisfiable.

P	Q	R	S	T	$A \rightarrow C$	$A \wedge C$	$A \wedge C \rightarrow B$	Satisfiability check
0	0	0	1	1	0	0	0	0
0	0	1	1	1	0	0	1	0
0	1	0	0	1	0	0	1	0
0	1	1	0	1	0	0	1	0
1	0	0	1	0	0	0	1	0
1	0	1	1	1	1	1	0	0
1	1	0	0	0	0	0	1	0
1	1	1	0	1	1	1	1	0

As there are no 1's in $P \wedge Q \wedge R \wedge S$,

\Rightarrow Unsatisfiable.

