CSE:- 5360-001
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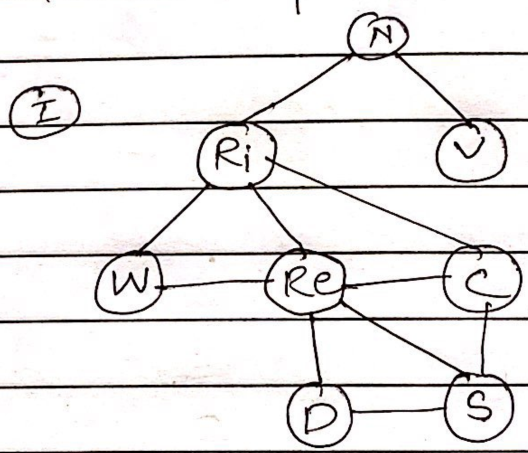
ASSIGNMENT-5.

Q.1.] No two colors should be given to two sections who share a border.
- colors:- (Red, green, blue)
- section:- (N, I, Ri, V, Re, W, C, S, D)

a] Variables:- N, I, Ri, V, Re, W, C, S, D.
Domains:- {Red, Green, Blue}
Constraint:- No two section sharing border must have same color.

- Constraint Graph:-



Also, It denotes 'I' as a clearly seperate entity, which will simplify the problem & constraint satisfaction

b) Unassigned Variables
→ N, Ri, V, W, Re, C, D, S, I

i]

Variables	Degree	Rem. values
N	2	3
$\boxed{Ri}$	5	3
V	2	3
Re	5	3
W	2	3
C	3	3
D	2	3
S	3	3
I	0	3

Chosen :- Ri

ii]

Variables	Degree	Remaining values
N	2	2
V	2	2
$\boxed{Re}$	5	2
W	2	2
C	3	2
D	2	3
S	3	3
I	0	3

Chosen :- Re

iii]

Variables	Degree	Remaining values
N	2	2
V	2	2
W	2	1
$\boxed{C}$	3	1

Variable	Degree	Rem. values
D	2	2
S	3	2
I	0	3

<u>Chosen</u> :- C

iv]

Variable	Degree	Rem. values
N	2	2
V	2	2
W	2	1
D	2	2
$\boxed{S}$	3	1
I	0	3

<u>Chosen</u> :- S

v]

Variable	Degree	Rem. values
N	2	2
V	2	2
W	2	1
$\boxed{D}$	2	1
I	0	3

<u>Chosen</u> :- D

vi)

Variable	Degree	Rem. values
N	2	2
V	2	2
$\boxed{W}$	2	1
I	0	3

<u>Chosen</u> :- W

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vii]

Variable	Degree	Rem. values
N	2	2
$\boxed{V}$	2	2
I	0	3

Chosen :- V

viii]

Variable	Degree	Rem. values
$\boxed{N}$	2	1
I	0	3.

Chosen :- N.

ix]

Variable	Degree	Rem. values
$\boxed{I}$	0	3

Chosen :- I.

c] Valid Solution

→ Using MRV & degree values retrieved from above solution, a valid solution can be designed as follows :-

i] N : RGB, Ri : RGB, V : RGB, Re : RGB, W : RGB, C : RGB, D : RGB, S : RGB, I : RGB

ii] N : RGB, Ri : R, V : GB, Re : GB, W : RGB, S : RGB, C : RGB, D : RGB, I : RGB

iii] N : GB, Ri : R, V : GB, Re : G, W : B, C : B, D : RB, S : RB, I : RGB

iv] N : GB, Ri : R, V : GB, Re : G, W : B, C : B, D : RB, S : R, I : RGB

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v] N: GB, Ri: R, V: GB, Re: G, W: B, C: B, D: B, S: R, T: RGB.

vi] N: G, Ri: R, V: B, Re: G, W: B, C: B, D: B, S: R, T: RGB

Hence, all variable have been assigned colors & no two section showing borders have similar colors.

Q.2.] CHECK EQUIVALENCE (KB1, KB2) {
return CHECK4_IMPLIES (KB1, KB2) &&
CHECK4_IMPLIES (KB2, KB1)
}

CHECK4_IMPLIES (KB1, KB2)
{
RETURN OR (NOT (KB1), KB2)
}

NOT (KB1)
{
RETURN (!KB1)
}

OR (KB1, KB2)
{
RETURN KB1 || KB2
}

Algorithm
→ 1. Check for logical equivalence between KB1, KB2
2. Expand & Simplify equivalence cond. check implication b/w KB1 & KB2 & KB2 & KB1
3. Define function to check every truth value & return output.

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Q.3.] a) KB does entail S1, because as per the entailment rule, if KB is true for any State, S1 is true too & if KB is false at any state, S1 is either true or false.

∴ KB |= S1.

b) NOT(KB) does not entail NOT(S1), because as per entailment conditions & also the given truth table. It can be concluded that if the truth values are negated, there are some state where truth value of KB is true, S_1 is false. which doesn't satisfy entailment

∴ KB |≠ S1.

	NOT(KB)	NOT(S1)	
	False	False	
*	True	false	*
	False	false	
*	True	false	*
	True	True	
	True	True	
	True	True	
	True	True	

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Q.4] Cases where Knowledge base is false
1:- A is true, B is true, C is true, D is true
2:- A is true, B is false, C is true, D is false.
∴ CNF Form
$(\neg A \vee \neg B \vee \neg C \vee \neg D) \wedge (\neg A \vee B \vee \neg C \vee D)$

A	B	C	D	KB
T	T	T	T	F
T	T	T	F	T
T	T	F	T	T
T	T	F	F	T
T	F	T	T	T
T	F	T	F	F
T	F	F	T	T
T	F	F	F	T
F	T	T	T	T
F	T	T	F	T
F	T	F	T	T
F *	T	F	F	T *
F	F	T	T	T
F *	F	T	F	T *
F	F	F	T	T
F	F	F	F	T

CNF (KB) = Γ(ROW1) $\wedge$ Γ(ROW6).

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Q.5] i) Forward Chaining

$A \leftrightarrow B$: $A \rightarrow B \wedge B \rightarrow A$

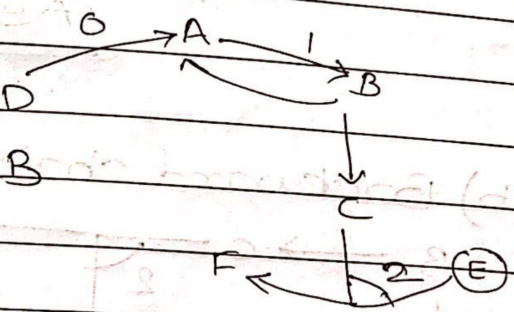
$B \rightarrow C$

$D \rightarrow A$

$C \wedge E \rightarrow F$

E

D.



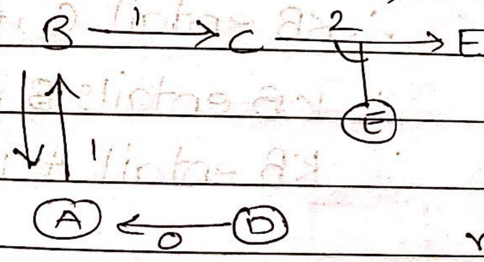
Now, D & E are in KB

consider D.

$D \rightarrow A$

reducing 1 from every implication where 1 element is D.

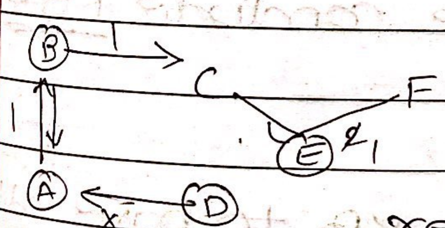
Now, $D \rightarrow A$ is 0, A will be added to KB.



E is also in KB

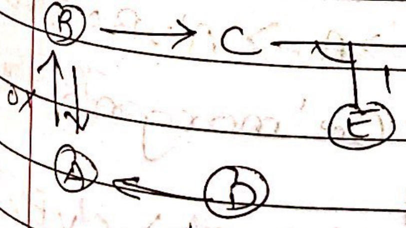
$C \wedge E \rightarrow F$

reducing 1 from every implication where 1 element is E



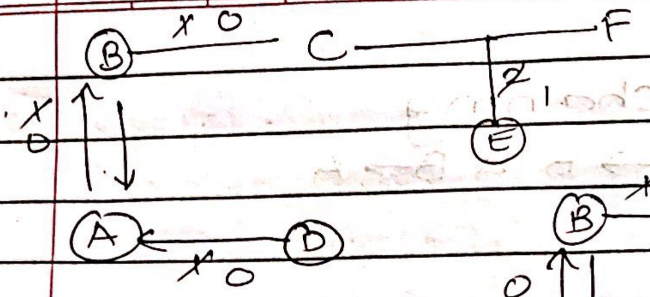
Now, A is in KB

reduce 1 from every imp. where A is first element

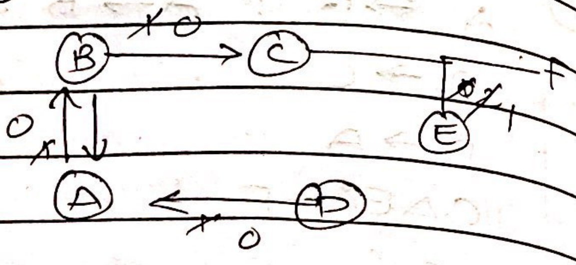


Now, $A \rightarrow B$ is 0, B is in KB.

reduce 1 from every imp. where B is first element

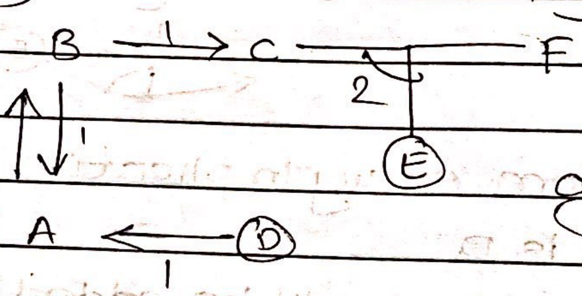


Now as $B \rightarrow C$ is 0
C is in KB.



As, KB entails C.

b) Backword chaining.



To prove, KB entail C
we start from C &
go back to initial
nodes

$\therefore$ KB entail C, if B is true
$\therefore$ KB entails B, if A is true
$\therefore$ KB entail A if D is true

As, D is true, we conclude KB entails C

c) Resolution.

$\rightarrow$ Converting KB to have all 'V' relations

$A \leftrightarrow B \Rightarrow A \rightarrow B \land B \rightarrow A \Rightarrow A' \lor B \land B' \lor A$

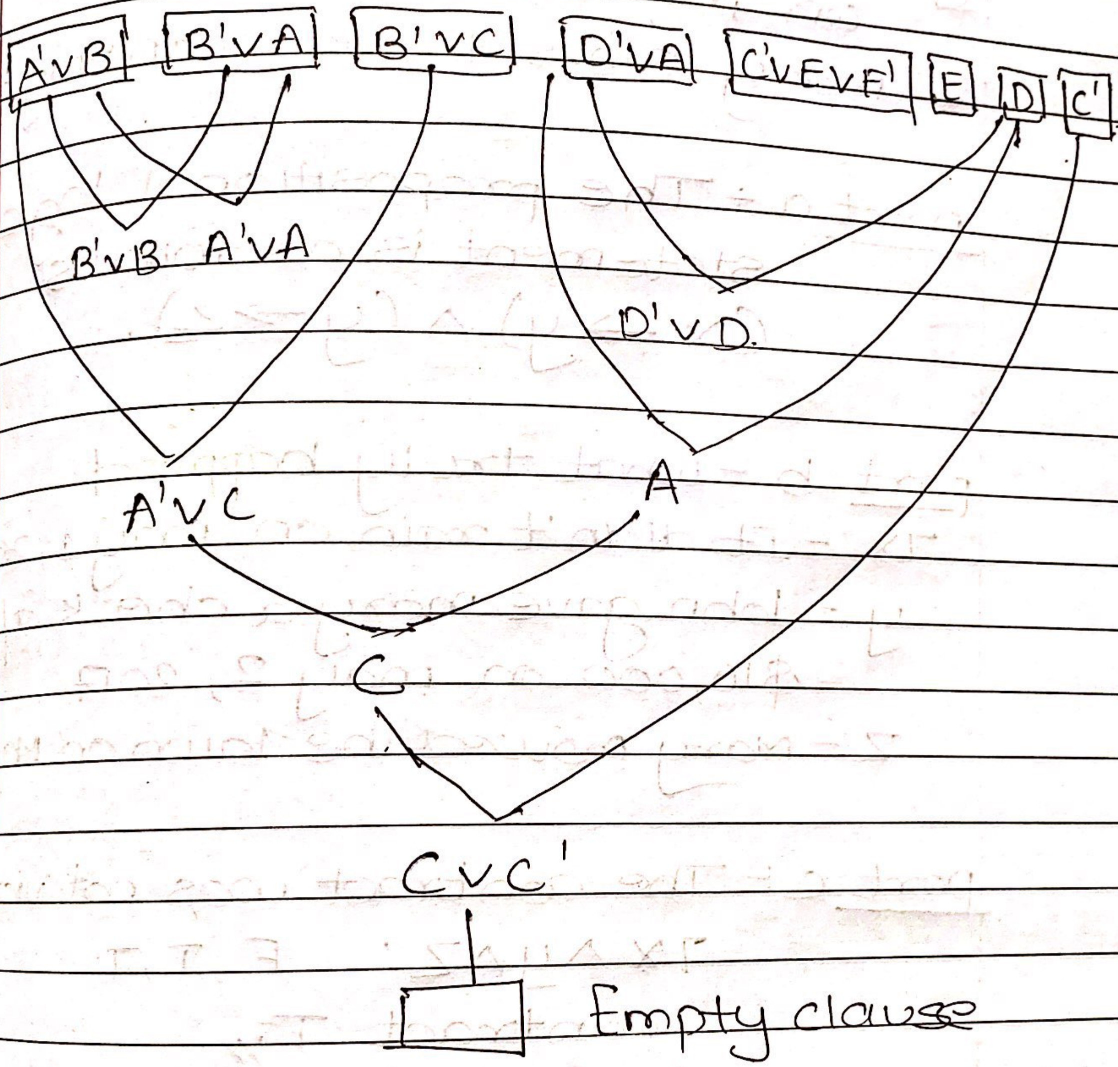
$B \rightarrow C \Rightarrow B' \lor C$ } De'morgan's law

$D \rightarrow A \Rightarrow D' \lor A$

$C \land E \rightarrow F \Rightarrow C' \lor E' \rightarrow F' \Rightarrow C' \lor E \lor F'$

E & D.

Solving via contradiction,
we prove to entail C'



Hence, we can conclude that our assumption was false as it results in empty clause.

∴ KB ⊨ C. This is true

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Q.6.] x : It rains on may 1, 2017
y : John gives mary a check of $10,000 on may 2, 2017.
z : Mary mows the lawn on May 3, 2017

part a : The propositional logic statement is as follows.
$(x \rightarrow y) \wedge (y \rightarrow z)$.

part b :- what truly happend
$\neg x$:- It didn't rain on may 1, 2017
y :- John gave mary a check of $10,000 on may 2, 2017
z :- Mary mowed the lawn on May 3, 2017

part c :- The contract was not violated
$\neg x \wedge y \wedge z$: F, T, T.
contract T

x	y	z	$(x \rightarrow y)$	$(y \rightarrow z)$	contract $(x \rightarrow y) \wedge (y \rightarrow z)$
T	T	T	T	T	T
T	T	F	T	F	F
T	F	T	F	T	F
T	F	F	F	T	F
* F	T	T	T	T	T
F	T	F	T	F	F
F	F	T	T	T	T
F	F	F	T	T	T

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Q.7] Knowledge base to first-order logic
constraint :- John, mary, shadow,
smartphone, laptop.
Boolean :- Male, female, dog, people,
predicates name.

Function (a, b, c) mean a gives b to c.
Gives (x, y, z).
male (x), female ($\frac{x}{y}$) means x is
male / female. x, y are variables.

Conversion

$\exists x$ Dog (x) → Name (shadow).
Gives (John, shadow, Mary)
Male (Shadow) → Gives (mary,
smartphone, John)
Female (shadow) → Gives (Mary,
laptop, John).
$\forall x \forall y$ gives (John, x, y) → people (y)
$\land$ Dog (x) $\land$ male (x)

gives (mary, laptop, John).

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Q.8.] Predicates

i] taller (John, y), taller (x, son(x))

soln:- unify [taller (John, y), taller (x, son(x))]

= { x/John, y/son(John) }.

ii] taller (y, Barry), taller (Barry, x)

→ Unify [taller (y, Barry), taller (Barry, x)]

= { y/Barry, x/Barry }.

iii) taller (x, Jane), taller (Bob, Jane)

→ Unify [taller (x, Jane), taller (Bob, Jane)]

= { x/Bob }.

iv) taller (Son(x), Jane), taller (Bob, Jane)

→ Unify [taller (Son(x), Jane), taller (Bob, Jane)]

= { Son(x)/Bob }

v) taller (Barry, John), taller (x, y)

→ Unify [taller (Barry, John), taller (x, y)]

= { x/Barry, y/John }.