CENG 424 - Assignment 1

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1) Answer for Q1 (Splitting)

KB is:

1) $D_{SA} \Leftrightarrow (\neg F_{SB} \wedge \neg F_{SC})$
2) $F_{SA} \Leftrightarrow (\neg D_{SB} \wedge \neg D_{SC})$
3) $B_{SLA} \Leftrightarrow (\neg B_{RSB} \wedge \neg B_{RSC})$
4) $B_{RSA} \Leftrightarrow (\neg B_{SLB} \wedge \neg B_{SLC})$
5) $\neg D_{SC}$ 6) $\neg D_{SD}$
7) $\neg F_{SA}$ 8) $\neg F_{SD}$
9) $(F_{SB} \wedge \neg F_{SC}) \vee (F_{SC} \wedge \neg F_{SB})$
10) $(D_{SA} \wedge \neg D_{SB}) \vee (D_{SB} \wedge \neg D_{SA})$

11) $(D_{SA} \wedge F_{SB} \wedge B_{SLC} \wedge B_{RSD}) \vee (D_{SA} \wedge F_{SB} \wedge B_{SLD} \wedge B_{RSC}) \vee$
$(D_{SA} \wedge F_{SC} \wedge B_{SLB} \wedge B_{RSD}) \vee (D_{SA} \wedge F_{SC} \wedge B_{SLD} \wedge B_{RSB}) \vee$
$(D_{SA} \wedge F_{SD} \wedge B_{SLB} \wedge B_{RSC}) \vee (D_{SA} \wedge F_{SD} \wedge B_{SLC} \wedge B_{RSB}) \vee$
$(D_{SB} \wedge F_{SA} \wedge B_{SLC} \wedge B_{SLD}) \vee (D_{SB} \wedge F_{SA} \wedge B_{SLD} \wedge B_{RSC}) \vee$
$(D_{SB} \wedge F_{SC} \wedge B_{SLA} \wedge B_{RSD}) \vee (D_{SB} \wedge F_{SC} \wedge B_{SLD} \wedge B_{RSA}) \vee$
$(D_{SB} \wedge F_{SD} \wedge B_{SLA} \wedge B_{RSC}) \vee (D_{SB} \wedge F_{SD} \wedge B_{SLC} \wedge B_{RSA}) \vee$
$(D_{SC} \wedge F_{SA} \wedge B_{SLB} \wedge B_{RSD}) \vee (D_{SC} \wedge F_{SA} \wedge B_{SLD} \wedge B_{RSB}) \vee$
$(D_{SC} \wedge F_{SB} \wedge B_{SLA} \wedge B_{RSD}) \vee (D_{SC} \wedge F_{SB} \wedge B_{SLD} \wedge B_{RSA}) \vee$
$(D_{SC} \wedge F_{SD} \wedge B_{SLA} \wedge B_{RSB}) \vee (D_{SC} \wedge F_{SD} \wedge B_{SLB} \wedge B_{RSA}) \vee$
$(D_{SD} \wedge F_{SA} \wedge B_{SLB} \wedge B_{RSC}) \vee (D_{SD} \wedge F_{SA} \wedge B_{SLC} \wedge B_{RSB}) \vee$
$(D_{SD} \wedge F_{SB} \wedge B_{SLC} \wedge B_{RSA}) \vee (D_{SD} \wedge F_{SB} \wedge B_{SLA} \wedge B_{RSC}) \vee$
$(D_{SD} \wedge F_{SC} \wedge B_{SLA} \wedge B_{RSB}) \vee (D_{SD} \wedge F_{SC} \wedge B_{SLB} \wedge B_{RSA})$

12) $(D_{SA} \wedge \neg D_{SB} \wedge \neg D_{SC} \wedge \neg D_{SD}) \vee (D_{SB} \wedge \neg D_{SA} \wedge \neg D_{SC} \wedge \neg D_{SD}) \vee$
$(D_{SC} \wedge \neg D_{SA} \wedge \neg D_{SB} \wedge \neg D_{SD}) \vee (D_{SD} \wedge \neg D_{SA} \wedge \neg D_{SB} \wedge \neg D_{SC}) \vee$
$(F_{SA} \wedge \neg F_{SB} \wedge \neg F_{SC} \wedge \neg F_{SD}) \vee (F_{SB} \wedge \neg F_{SA} \wedge \neg F_{SC} \wedge \neg F_{SD}) \vee$
$(F_{SC} \wedge \neg F_{SA} \wedge \neg F_{SB} \wedge \neg F_{SD}) \vee (F_{SD} \wedge \neg F_{SA} \wedge \neg F_{SB} \wedge \neg F_{SC}) \vee$
$(B_{SLA} \wedge \neg B_{SLB} \wedge \neg B_{SLC} \wedge \neg B_{SLD}) \vee (B_{SLB} \wedge \neg B_{SLA} \wedge \neg B_{SLC} \wedge \neg B_{SLD}) \vee$
$(B_{SLC} \wedge \neg B_{SLA} \wedge \neg B_{SLB} \wedge \neg B_{SLD}) \vee (B_{SLD} \wedge \neg B_{SLA} \wedge \neg B_{SLB} \wedge \neg B_{SLC}) \vee$
$(B_{RSA} \wedge \neg B_{RSB} \wedge \neg B_{RSC} \wedge \neg B_{RSD}) \vee (B_{RSB} \wedge \neg B_{RSA} \wedge \neg B_{RSC} \wedge \neg B_{RSD}) \vee$
$(B_{RSC} \wedge \neg B_{RSA} \wedge \neg B_{RSB} \wedge \neg B_{RSD}) \vee (B_{RSD} \wedge \neg B_{RSA} \wedge \neg B_{RSB} \wedge \neg B_{RSC})$

$D_{SC} \in 1$
$D_{SD} \in 1$
$F_{SA} \in 1$
$F_{SD} \in 1$
$\perp$

$D_{SC} \in 0$, $D_{SD} \in 0$
$F_{SA} \in 0$, $F_{SD} \in 0$

(on next page.)

1) $DSA \Leftrightarrow (\neg FSB \wedge \neg FSC)$

2) DSB

3) $BSLA \Leftrightarrow (\neg BRSB \wedge \neg BRSC)$

4) $BRSA \Leftrightarrow (\neg BSLB \wedge \neg BSLC)$

5) $(FSB \wedge \neg FSC) \vee (FSC \wedge \neg FSB)$

6) $(DSA \wedge \neg DSB) \vee (DSB \wedge \neg DSA)$

7) $(DSA \wedge FSB \wedge BSLC \wedge BRSD) \vee (DSA \wedge FSB \wedge BSLD \wedge BRSC) \vee$
$(DSA \wedge FSC \wedge BSLB \wedge BRSD) \vee (DSA \wedge FSC \wedge BSLD \wedge BRSB) \vee$
$(DSB \wedge FSC \wedge BSLA \wedge BRSD) \vee (DSB \wedge FSC \wedge BSLD \wedge BRSA)$

8) $(DSA \wedge \neg DSB) \vee (DSB \wedge \neg DSA) \vee (FSB \wedge \neg FSC) \vee (FSC \wedge \neg FSB) \vee$
$(BSLA \wedge \neg BSLB \wedge \neg BSLC \wedge \neg BSLD) \vee (BSLB \wedge \neg BSLA \wedge \neg BSLC \wedge \neg BSLD) \vee$
$(BSLC \wedge \neg BSLA \wedge \neg BSLD \wedge \neg BSLB) \vee (BSLD \wedge \neg BSLA \wedge \neg BSLB \wedge \neg BSLC) \vee$
$(BRSA \wedge \neg BRSB \wedge \neg BRSC \wedge \neg BRSD) \vee (BRSB \wedge \neg BRSA \wedge \neg BRSC \wedge \neg BRSD) \vee$
$(BRSC \wedge \neg BRSA \wedge \neg BRSB \wedge \neg BRSD) \vee (BRSD \wedge \neg BRSA \wedge \neg BRSB \wedge \neg BRSC)$

$DSB \in 0$

$DSB \in 1$

1) $DSA \Leftrightarrow (\neg FSB \wedge \neg FSC)$

2) $BSLA \Leftrightarrow (\neg BRSB \wedge \neg BRSC)$

3) $BRSA \Leftrightarrow (\neg BSLB \wedge \neg BSLC)$

4) $(FSB \wedge \neg FSC) \vee (FSC \wedge \neg FSB)$

5) $\neg DSA$

6) $(DSA \wedge FSB \wedge BSLC \wedge BRSD) \vee (DSA \wedge FSB \wedge BSLD \wedge BRSC) \vee$
$(DSA \wedge FSC \wedge BSLB \wedge BRSD) \vee (DSA \wedge FSC \wedge BSLD \wedge BRSB) \vee$
$(FSC \wedge BSLA \wedge BRSD) \vee (FSC \wedge BSLD \wedge BRSA)$

7) $\neg DSA \vee (FSB \wedge \neg FSC) \vee (FSC \wedge \neg FSB) \vee$ ---
(Rest is same with 8th sentence on the upper post, please give mercy.)

$DSA \in 1$

$\perp$

$DSA \in 0$

(on next page)

1) $FSB \vee FSC$

2) $BSLA \leftrightarrow (\neg BRSB \wedge \neg BRSC)$

3) $BRSA \leftrightarrow (\neg BSLB \wedge \neg BSLC)$

4) $(FSB \wedge \neg FSC) \vee (FSC \wedge \neg FSB)$

5) $(FSC \wedge BSLA \wedge BRSD) \vee$
$(FSC \wedge BSLD \wedge BRSA)$.

6) $(FSB \wedge \neg FSC) \vee (FSC \wedge \neg FSB) \vee$
$(BSLA \wedge \neg BSLB \wedge \neg BSLC \wedge \neg BSLD) \vee (BSLB \wedge \neg BSLA \wedge \neg BSLC \wedge \neg BSLD) \vee$
$(BSLC \wedge \neg BSLA \wedge \neg BSLB \wedge \neg BSLC) \vee (BSLD \wedge \neg BSLA \wedge \neg BSLB \wedge \neg BSLC) \vee$
$(BRSA \wedge \neg BRSB \wedge \neg BRSC \wedge \neg BRSD) \vee (BRSB \wedge \neg BRSA \wedge \neg BRSC \wedge \neg BRSD) \vee$
$(BRSC \wedge \neg BRSA \wedge \neg BRSB \wedge \neg BRSD) \vee (BRSD \wedge \neg BRSA \wedge \neg BRSB \wedge \neg BRSC)$

$FSC \leftarrow 0$ ↘

$\perp$

↘ $FSC \leftarrow 1$

1) $BSLA \leftrightarrow (\neg BRSB \wedge \neg BRSC)$

2) $BRSA \leftrightarrow (\neg BSLB \wedge \neg BSLC)$

3) $\neg FSB$

4) $(BSLA \wedge BRSD) \vee (BSLD \wedge BRSA)$

5) $\neg FSB \vee$ -- (Rest is same with 6th sentence on the upper part.)

↘ $FSB \leftarrow 0$

$FSB \leftarrow 1$ ↘

$\perp$

(On the next page.)

1) $BSLA \Leftrightarrow (\neg BRSB \wedge \neg BRSC)$

2) $BRSA \Leftrightarrow (\neg BSLB \wedge \neg BSLC)$

3) $(BSLA \wedge BRSD) \vee (BSLD \wedge BRSA)$

4) $(BSLA \wedge \neg BSLB \wedge \neg BSLC \wedge \neg BSLD) \vee (BSLB \wedge \neg BSLA \wedge \neg BSLC \wedge \neg BSLD) \vee$
$(BSLC \wedge \neg BSLA \wedge \neg BSLB \wedge \neg BSLD) \vee (BSLD \wedge \neg BSLA \wedge \neg BSLB \wedge \neg BSLC) \vee$
$(BRSA \wedge \neg BRSB \wedge \neg BRSC \wedge \neg BRSD) \vee (BRSB \wedge \neg BRSA \wedge \neg BRSC \wedge \neg BRSD) \vee$
$(BRSC \wedge \neg BRSA \wedge \neg BRSB \wedge \neg BRSD) \vee (BRSD \wedge \neg BRSA \wedge \neg BRSB \wedge \neg BRSC)$

$BSLA \leftarrow 1$

$BSLA \leftarrow 0$

1) $\neg BRSB \wedge \neg BRSC$

2) $BRSA \Leftrightarrow (\neg BSLB \wedge \neg BSLC)$

3) $BRSD \vee (BSLD \wedge BRSA)$

4) $(\neg BSLB \wedge \neg BSLC \wedge \neg BSLD) \vee (BRSA \wedge \neg BRSB \wedge \neg BRSC \wedge \neg BRSD) \vee$
— (rest is same with 4th sentence' rest part of upper part.)

$BRSB \leftarrow 1$
$BRSC \leftarrow 1$

$\bot$

$BRSB \leftarrow 0$
$BRSC \leftarrow 0$

1) $BRSA \Leftrightarrow (\neg BSLB \wedge \neg BSLC)$

2) $BRSD \vee (BSLD \wedge BRSA)$

3) $(\neg BSLB \wedge \neg BSLC \wedge \neg BSLD) \vee$
$(BRSA \wedge \neg BRSD) \vee (BRSD \wedge \neg BRSA)$

$BSLB \leftarrow 0$
$BSLC \leftarrow 0$
$BSLD \leftarrow 0$

1) $BRSA$
2) $BRSD \vee BRSA$
3) $\neg BRSD$

$BRSA \leftarrow 1$
$BRSD \leftarrow 0$

$\top$

(SATISFIABLE)

Any interpretation I s.t. $I(BSB) = 1$, $I(FSC) = 1$, $I(BSLA) = 1$, $I(BRSD) = 1$, $I(BSA) = 0$, $I(BSC) = 0$, $I(BSD) = 0$. $I(FSA) = 0$, $I(FSB) = 0$, $I(FSD) = 0$. $I(BRSB) = 0$, $I(BRSC) = 0$, $I(BSLB) = 0$ and $I(BSLC) = 0$ is a model of this formula.

2) Answer for Q2 (CNF)

$$(p \to r) \vee (q \leftrightarrow r) \vee \neg(w \to p)$$

$$\equiv (p \to r) \vee ((\neg q \vee r) \wedge (r \vee q)) \vee \neg(w \to p)$$

$$\equiv (p \to r) \vee ((\neg q \vee r) \wedge (r \vee q)) \vee \neg(\neg w \vee p)$$

$$\equiv (p \to r) \vee ((\neg q \vee r) \wedge (r \vee q)) \vee (w \wedge \neg p)$$

$$\equiv (\neg p \vee r) \vee ((\neg q \vee r) \wedge (r \vee q)) \vee (w \wedge \neg p)$$

$$\equiv (\neg p \vee r) \vee (w \wedge \neg p) \vee ((\neg q \vee r) \wedge (r \vee q))$$

$$\equiv ((\neg p \vee r \vee w) \wedge (\neg p \vee w \vee \neg p)) \vee ((\neg q \vee r) \wedge (r \vee q))$$

$$\equiv ((\neg p \vee r \vee w) \wedge (\neg p \vee w)) \vee ((\neg q \vee r) \wedge (r \vee q))$$

$$\equiv ((\neg p \vee r \vee w) \vee ((\neg q \vee r) \wedge (r \vee q))) \wedge ((\neg p \vee w) \vee ((\neg q \vee r) \wedge (r \vee q)))$$

$$\equiv ((\neg p \vee r \vee w \vee \neg q) \wedge (\neg p \vee r \vee w \vee q)) \wedge ((\neg p \vee w \vee \neg q) \wedge (\neg p \vee w \vee r \vee q))$$

$$\left\{ \begin{array}{l} \neg p \vee r \vee w \vee \neg q \\ \neg p \vee w \vee q \\ \neg p \vee w \vee \neg q \vee r \\ \\ \neg p \vee w \vee r \vee q \end{array} \right\}$$