ASSIGNMENT 5
SOLN

PROB 1

We know that TT-ENTAILS(KB, α)

Checks for $KB \models \alpha$ by checkig if

$KB \Rightarrow \alpha$

Also $KB1 \Leftrightarrow KB2$ is the same as

$(KB1 \Rightarrow KB2) \wedge (KB2 \Rightarrow KB1)$

So

```
CHECK_EQUIVALENCE(KB1, KB2)
{
    return TT-ENTAILS(KB1, KB2) AND
                 TT_ENTAILS(KB2, KB1)
}
```

PROB 2

(a)

In all the cases when KB is true, S1 is true. So $KB \models S1$

(b)

In some cases where $\neg KB$ is true (KB is false), $\neg S1$ is not true (S1 is not false). So $\neg KB \not\models \neg S1$.

PROB 3

The sentence that satisfies the two cases is.

$$\text{NOT}(A \wedge B \wedge C \wedge D) \wedge \text{NOT}(A \wedge \text{NOT } B \wedge C \wedge \text{NOT } D)$$

Converting to CNF.

Applying De Morgans

$$(\text{NOT } A \vee \text{NOT } B \vee \text{NOT } C \vee \text{NOT } D) \wedge (\text{NOT } A \vee \text{NOT}(\text{NOT } B) \vee \text{NOT } C \vee \text{NOT}(\text{NOT } C))$$

Flattening.

$$(\text{NOT } A \vee \text{NOT } B \vee \text{NOT } C \vee \text{NOT } D) \wedge (\text{NOT } A \vee B \vee \text{NOT } C \vee D)$$

Which is in CNF

PROB 4

(i) Convert to Horn form

$A \Rightarrow B$

$B \Rightarrow A$

$B \Rightarrow C$

$D \Rightarrow A$

$C \wedge E \Rightarrow F$

E

D

FC:

Apply MP to $D \Rightarrow A$, D

gives A

Apply MP to $A \Rightarrow B$, A

gives B

Apply MP to $B \Rightarrow C$, B

gives $\underline{\underline{C}}$

So $KB \models C$

ii

GS: $\begin{array}{|c|} C \\ \hline \end{array}$ Can use $B \Rightarrow C$

GS: $\begin{array}{|c|} B \\ C \\ \hline \end{array}$ Can use. $A \Rightarrow B$

GS $\begin{array}{|c|} A \\ B \\ C \\ \hline \end{array}$ Can use $B \Rightarrow A$, B is already there.

GS $\begin{array}{|c|} A \\ B \\ C \\ \hline \end{array}$ Can use $D \Rightarrow A$

GS: $\begin{array}{|c|} D \\ A \\ B \\ C \\ \hline \end{array}$, D is already True

So using MP, $D \Rightarrow A$, D, so A is true.

MP $A \Rightarrow B$, A, So B is true.

MP $B \Rightarrow C$, B So C is true

So $KB \models C$

$KB \wedge \neg\alpha$:

(iii) $(A \Leftrightarrow B) \wedge (B \Rightarrow C) \wedge (D \Rightarrow A)$
$\wedge [(C \wedge E) \Rightarrow F] \wedge E \wedge D \wedge \neg C.$

Convert to CNF:

Remove $\Leftrightarrow$:

$[(A \Rightarrow B) \wedge (B \Rightarrow A)] \wedge (B \Rightarrow C) \wedge (D \Rightarrow A)$
$\wedge [(C \wedge E) \Rightarrow F] \wedge E \wedge D \wedge \neg C$

Remove $\Rightarrow$:

$(\neg A \vee B) \wedge (\neg B \vee A) \wedge (\neg B \vee C) \wedge (\neg D \vee A)$
$\wedge [\neg(C \wedge E) \vee F] \wedge E \wedge D \wedge \neg C$

Demorgan's Law:

$(\neg A \vee B) \wedge (\neg B \vee A) \wedge (\neg B \vee C) \wedge (\neg D \vee A)$
$\wedge [(\neg C \vee \neg E) \vee F] \wedge E \wedge D \wedge \neg C$

FLATTENING:

$$(\neg A \vee B) \wedge (\neg B \vee A) \wedge (\neg B \vee C) \wedge (\neg D \vee A)$$
$$\wedge (\neg C \vee \neg E \vee F) \wedge E \wedge D \wedge \neg C$$

Resolving:

$\neg D \vee A$, D : A

Resolving

$\neg A \vee B$, A : B

Resolving

$\neg B \vee C$, B : C

Resolving

C, $\neg C$: — (Empty Clause)

So $KB \wedge \neg\alpha$ is contradiction.

So $KB \models C$

PROB 5

(a.)

R : Rains on May 1, 2017.

J : John gives Mary Check for 10 K on May 2, 2017.

M : Mary Mows Lawn on May 3, 2017

So the contract becomes.

$$R \Rightarrow J.$$

$$J \Rightarrow M.$$

(b) Actual sequence of events is given by

$$\neg R \wedge J \wedge M.$$

(c).

The model for the events of those days is.

$R =$ False, $J =$ True & $M =$ True

In this model,

none of statements in contract are False. So contract is NOT violated.

PROB 6

CONSTANTS: Shadow, John, Mary, smartphone, laptop,

Predicates:

Dog (x) : x is a dog

Male (x) : X is Male.

Gave (X, y, z) : x gave y to z

Functions: None.

Variables: x, y, z.

The KB is,

- Dog(Shadow)
- Gave(John, Shadow, Mary)
- $Male(Shadow) \Rightarrow Gave(Mary, Smartphone, John)$
- $\neg Male(Shadow) \Rightarrow Gave(Mary, Laptop, John)$
- $(\forall x)(\forall y)\left[Gave(John, x, y) \Rightarrow Dog(x) \wedge Male(x)\right]$
- Gave(Mary, laptop, John)

PROB 7

1. There are 2 predicates.

taller (x, y), tall(x)

There are 2 constants

John, Bill

So we need 4+2 = 6 symbols.

taller(John, John) = taller_J_J

taller(John, Bill) = taller_J_B

taller (Bill, John) = taller_B_J

taller(Bill, Bill) = taller_B_B

tall(Bill) = tall_B

tall(John) = tall_J

2.

The KB is.

$$taller(John, Bill)$$
$$(\forall x)\ taller(x, Bill) \Rightarrow tall(x)$$

Which can be expanded to.

$$taller(John, Bill)$$
$$taller(John, Bill) \Rightarrow tall(John)$$
$$taller(Bill, Bill) \Rightarrow tall(Bill)$$

Converting to propositional logic,

taller_J_B

taller_J_B $\Rightarrow$ tall_J

taller_B_B $\Rightarrow$ tall_B.

Prob 8

(i) Taller(John, y), Taller(x, Son(x))

$\{x/John, \; y/Son(John)\}$

(ii)

$\{x/Barry, \; y/Barry\}$

(iii) $\{x/Bob\}$

(iv) No Unification possible

(v) $\{x/Barry, \; y/John\}$