REVIEW EXERCISE 05

Question 1. Given a knowledge base KB as follows, $\{\mathbf{P \rightarrow R},\ \mathbf{\neg S \rightarrow P},\ \mathbf{\neg S},\ \mathbf{R \rightarrow Q}\}$. Consider the pseudo-code function PL-RESOLUTION given in the lecture to check whether **KB entails Q**.

Present your work to the table below, in which the first column contains KB $\wedge \neg\alpha$ in CNF, and every of the next columns includes new sentences added to KB after each loop. Note that

- Duplicated sentences are omitted from the table
- *Circle the unit clauses that lead to the contradiction and hence the function ends successfully, if possible*
- Process the clauses in order, that is first pair clause 1 with clause 2, 3, 4… then pair clause 2 with clause 3, 4,… and so on.

CNF sentences	Loop 1	Loop 2	Loop 3	Loop 4
1) $\neg P \vee R$	6) $R \vee S$	10) R		
2) $P \vee S$	7) $\neg P \vee Q$	11) $\neg P$		
3) $\neg S$	8) P	12) $S \vee Q$		
4) $Q \vee \neg R$	9) $\neg R$	13) S		
5) $\neg Q$		14) Q		

Circle the correct option, IS or IS NOT.
Following the result of resolution, the sentence Q **IS** / **IS NOT** entailed by KB.

Question 2. Repeat Question 1. but this time you check whether **KB entails ¬Q**.

CNF sentences	Loop 1	Loop 2	Loop 3	Loop 4
1) $\neg P \vee R$	6) $R \vee S$	9) R		
2) $P \vee S$	7) $\neg P \vee Q$	10) $S \vee Q$		
3) $\neg S$	8) P	11) Q		
4) $Q \vee \neg R$				
5) Q				

There is no new clause generated after Loop 2. There is no contradiction, either. Thus, **KB does not entails ¬Q.**

Question 3. Are the above problems solved by using Forward chaining or Backward chaining? Give your reason.

NO, there exists a sentence that is not a definite clause, i.e $\neg S \Rightarrow P$

Question 4. Consider the following text. "*Heather attended the meeting* or Heather was not invited. If *the boss wanted Heather at the meeting*, then *she was invited*. Heather did not attend the meeting. If the boss did not want Heather there, and the boss did not invite her there, then *she is going to be fired*."
Use resolution to prove that **Heather is going to be fired**. *Hint: clauses in italic are good candidates for propositions.*

Let each of following propositions denote the facts represented in the corresponding clause.

- Proposition A represents for "Heather attended the meeting."
- Proposition I represents for "Heather was invited."
- Proposition W represents for "The boss wanted Heather at the meeting."
- Proposition F represents for "Heather is going to be fired."

Then the propositional KB in CNF will be

1) $A \vee \neg I$
2) $\neg W \vee I$
3) $\neg A$
4) $W \vee I \vee F$

Apply resolution to $KB \wedge \neg\alpha$

5) **$\neg F$** Negation of conclusion
6) $W \vee I$ from sentences 4 and 5
7) I from sentences 2 and 6
8) A from sentences 1 and 7
9) • from sentences 3 and 8

Conclusion: Therefore, Heather is going to be fired.

Question 5. Consider the following knowledge base of definte clauses.

1. $C \wedge D \rightarrow Y$
2. $R \wedge Z \rightarrow C$
3. $\neg B \vee D$
4. $\neg D \vee \neg R \vee Z$
5. B
6. $R \rightarrow D$
7. $D \rightarrow R$

Prove **Y** using backward chaining

Y requires two sub-goals, C and D (from 1)

D requires the sub-goal B (from 2). B is given (from 5). Thus **D is satisfied.**

C requires two sub-goals, R and Z (from 2). R requires D (from 6), which is proved. Z requires two sub-goals, D and R, which are both proved. Thus, **C is satisfied**.

Finally, Y can be proved because all required propositions can be obtained from KB.

Prove **Y** using forward chaining (only trigger a rule once for simplicity).

8. D is obtained from 3 and 5.
9. R is obtained from 7 and 8.
10. Z is obtained from 4 and 8-9 (rewrite 4 in implication form)

10'. D is obtained **again** from 6 and 9.

11. C is obtained from 2 and 9-10
12. Y is obtained from 1 and 5-11.

Finally, Y can be proved because it is generated from KB.