

# IN-CLASS EXERCISE (I3)

Student ID: .....

Duration: 20 mins

Date: 26/07/2023

Student name: .....

Score: ...../3

**Question 1 (1pt)** Convert the following propositional logic sentence to Conjunctive Normal Form. Apply factoring when possible.

$$(P \rightarrow (Q \rightarrow R)) \rightarrow (P \rightarrow (R \rightarrow Q))$$

.....

.....

.....

**Question 2 (2pts)** Consider the following propositional knowledge base. Please check whether **KB entails F**.

[0.5pt] Convert each sentence in the knowledge base to its CNF form.

1. ....	5. ....
2. ....	6. ....
3. ....	7. ....
4. ....	

1.  $B \wedge C \rightarrow A$

2.  $D \wedge E \rightarrow B$

3.  $B \wedge E \rightarrow G$

4.  $E \rightarrow C$

5.  $D$

6.  $E$

7.  $A \wedge G \rightarrow F$

[1.5pt] Perform inference by applying **Resolution Refutation**. Note that, for every step, state clearly which sentences your inference comes from. You don't need to exhaustively consider all pairs of clauses. Add more lines if necessary.

8. .... From required conclusion....

9. .... From .....

10. .... From .....

11. .... From .....

12. .... From .....

13. .... From .....

14. .... From .....

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**Question 2 (2pts)** Consider the following propositional knowledge base. Please check whether **KB entails G**.

[0.5pt] Convert each sentence in the knowledge base to its CNF form.

1. ....	5. ....
2. ....	6. ....
3. ....	7. ....
4. ....	8. ....

1. A
2. B
3. C
4.  $A \wedge B \rightarrow D$
5.  $B \wedge D \rightarrow F$
6.  $F \rightarrow G$
7.  $A \wedge E \rightarrow H$
8.  $A \wedge C \rightarrow E$

[1.5pt] Perform inference by applying **Resolution Refutation**. Note that, for every step, state clearly which sentences your inference comes from. You don't need to exhaustively consider all pairs of clauses. Add more lines if necessary.

9. .... From required conclusion
10. .... From
11. .... From
12. .... From
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14. .... From
15. .... From

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**Question 1 (1pt)** Convert the following propositional logic sentence to Conjunctive Normal Form. Apply factoring when possible.

$$(R \rightarrow (P \rightarrow Q)) \rightarrow (R \rightarrow (Q \rightarrow P))$$

.....

.....

.....

.....

**Question 2 (2pts)** Consider the following propositional knowledge base. Please check whether **KB entails H**.

[0.5pt] Convert each sentence in the knowledge base to its CNF form.

1. ....	5. ....
2. ....	6. ....
3. ....	7. ....
4. ....	8. ....

1. A
2. B
3. C
4.  $A \wedge B \rightarrow D$
5.  $B \wedge D \rightarrow F$
6.  $F \rightarrow G$
7.  $A \wedge E \rightarrow H$
8.  $A \wedge C \rightarrow E$

[1.5pt] Perform inference by applying **Resolution Refutation**. Note that, for every step, state clearly which sentences your inference comes from. You don't need to exhaustively consider all pairs of clauses. Add more lines if necessary.

9. .... From required conclusion
10. .... From
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14. .... From
15. .... From

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**Question 1 (1pt)** Convert the following propositional logic sentence to Conjunctive Normal Form. Apply factoring when possible.

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

.....

.....

.....

.....

**Question 2 (2pts)** Consider the following propositional knowledge base. Please check whether **KB entails G**.

[0.5pt] Convert each sentence in the knowledge base to its CNF form.

1. ....	5. ....
2. ....	6. ....
3. ....	7. ....
4. ....	8. ....

1.  $A \rightarrow E$
2.  $B \wedge F \rightarrow G$
3.  $C \wedge E \rightarrow F$
4.  $A$
5.  $B$
6.  $C$
7.  $D$

[1.5pt] Perform inference by applying **Resolution Refutation**. Note that, for every step, state clearly which sentences your inference comes from. You don't need to exhaustively consider all pairs of clauses. Add more lines if necessary.

9. ....	From required conclusion .....
10. ....	From .....
11. ....	From .....
12. ....	From .....
13. ....	From .....
14. ....	From .....
15. ....	From .....

# **SOLUTION**

# IN-CLASS EXERCISE (I3)

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**Question 1 (1pt)** Convert the following propositional logic sentence to Conjunctive Normal Form. Apply factoring when possible.

$$(P \rightarrow (Q \rightarrow R)) \rightarrow (P \rightarrow (R \rightarrow Q))$$

$\neg P \vee Q \vee \neg R$

**Question 2 (2pts)** Consider the following propositional knowledge base. Please check whether **KB entails F**.

[0.5pt] Convert each sentence in the knowledge base to its CNF form.

1. <u><math>\neg B \vee \neg C \vee A</math></u>	5. <u><math>D</math></u>
2. <u><math>\neg D \vee \neg E \vee B</math></u>	6. <u><math>E</math></u>
3. <u><math>\neg B \vee \neg E \vee G</math></u>	7. <u><math>\neg A \vee \neg G \vee F</math></u>
4. <u><math>\neg E \vee C</math></u>	

1.  $B \wedge C \rightarrow A$
2.  $D \wedge E \rightarrow B$
3.  $B \wedge E \rightarrow G$
4.  $E \rightarrow C$
5.  $D$
6.  $E$
7.  $A \wedge G \rightarrow F$

[1.5pt] Perform inference by applying **Resolution Refutation**. Note that, for every step, state clearly which sentences your inference comes from. You don't need to exhaustively consider all pairs of clauses. Add more lines if necessary.

8.  $\neg F$  From required conclusion
9.  $B$  From 2, 5, and 6
10.  $C$  From 4 and 6
11.  $A$  From 1, 9, and 10
12.  $G$  From 3, 6, and 9
13.  $F$  From 7, 11, and 12
14.  $\bullet$  From 8 and 14

Thus, KB entails F.

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**Question 1 (1pt)** Convert the following propositional logic sentence to Conjunctive Normal Form. Apply factoring when possible.

$$(Q \rightarrow (P \rightarrow R)) \rightarrow (Q \rightarrow (R \rightarrow P))$$

**P.V.-Q.V.-R.**

**Question 2 (2pts)** Consider the following propositional knowledge base. Please check whether **KB entails G**.

[0.5pt] Convert each sentence in the knowledge base to its CNF form.

1. <u>A</u> .....	5. <u><math>\neg B \vee \neg D \vee F</math></u> .....
2. <u>B</u> .....	6. <u><math>\neg F \vee G</math></u> .....
3. <u>C</u> .....	7. <u><math>\neg A \vee \neg E \vee H</math></u> .....
4. <u><math>\neg A \vee \neg B \vee D</math></u> .....	8. <u><math>\neg A \vee \neg C \vee E</math></u> .....

1. A
2. B
3. C
4.  $A \wedge B \rightarrow D$
5.  $B \wedge D \rightarrow F$
6.  $F \rightarrow G$
7.  $A \wedge E \rightarrow H$
8.  $A \wedge C \rightarrow E$

[1.5pt] Perform inference by applying **Resolution Refutation**. Note that, for every step, state clearly which sentences your inference comes from. You don't need to exhaustively consider all pairs of clauses. Add more lines if necessary.

9.  $\neg G$  ..... From required conclusion .....
10.  $\neg F$  ..... From 6 and 9 .....
11.  $\neg B \vee \neg D$  ..... From 5 and 10 .....
12.  $\neg D$  ..... From 2 and 11 .....
13.  $\neg A \vee \neg B$  ..... From 4 and 12 .....
14.  $\neg A$  ..... From 2 and 13 .....
15. • ..... From 1 and 14 .....

Thus, KB entails G.

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**Question 1 (1pt)** Convert the following propositional logic sentence to Conjunctive Normal Form. Apply factoring when possible.

$$(R \rightarrow (P \rightarrow Q)) \rightarrow (R \rightarrow (Q \rightarrow P))$$

**P ∨ -Q ∨ -R**

**Question 2 (2pts)** Consider the following propositional knowledge base. Please check whether **KB entails H**.

[0.5pt] Convert each sentence in the knowledge base to its CNF form.

16. <b>A</b> .....	20. <b>¬B ∨ ¬D ∨ F</b> .....
17. <b>B</b> .....	21. <b>¬F ∨ G</b> .....
18. <b>C</b> .....	22. <b>¬A ∨ ¬E ∨ H</b> .....
19. <b>¬A ∨ ¬B ∨ D</b> .....	23. <b>¬A ∨ ¬C ∨ E</b> .....

1. **A**
2. **B**
3. **C**
4. **A ∧ B → D**
5. **B ∧ D → F**
6. **F → G**
7. **A ∧ E → H**
8. **A ∧ C → E**

[1.5pt] Perform inference by applying **Resolution Refutation**. Note that, for every step, state clearly which sentences your inference comes from. You don't need to exhaustively consider all pairs of clauses. Add more lines if necessary.

- |                          |                                       |
|--------------------------|---------------------------------------|
| 24. <b>¬H</b> .....      | From <b>required conclusion</b> ..... |
| 25. <b>¬A ∨ ¬E</b> ..... | From <b>7 and 9</b> .....             |
| 26. <b>¬E</b> .....      | From <b>1 and 10</b> .....            |
| 27. <b>¬A ∨ ¬C</b> ..... | From <b>8 and 11</b> .....            |
| 28. <b>¬A</b> .....      | From <b>3 and 12</b> .....            |
| 29. <b>•</b> .....       | From <b>1 and 13</b> .....            |

**Thus, KB entails H.**



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**Question 1 (1pt)** Convert the following propositional logic sentence to Conjunctive Normal Form. Apply factoring when possible.

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

**-P ∨ Q**

**Question 2 (2pts)** Consider the following propositional knowledge base. Please check whether **KB entails G**.

[0.5pt] Convert each sentence in the knowledge base to its CNF form.

1.  $A \rightarrow E$
2.  $B \wedge F \rightarrow G$
3.  $C \wedge E \rightarrow F$
4.  $A$
5.  $B$
6.  $C$
7.  $D$

1.  $\neg A \vee E$

2.  $\neg B \vee \neg F \vee G$

3.  $\neg C \vee \neg E \vee F$

4.  $A$

5.  $B$

6.  $C$

7.  $D$

[1.5pt] Perform inference by applying **Resolution Refutation**. Note that, for every step, state clearly which sentences your inference comes from. You don't need to exhaustively consider all pairs of clauses. Add more lines if necessary.

8.  $\neg G$  From required conclusion
9.  $E$  From 1 and 4
10.  $\neg E \vee F$  From 3 and 6
11.  $F$  From 9 and 10
12.  $\neg B \vee \neg F$  From 2 and 8
13.  $\neg B$  From 11 and 12
14.  $\bullet$  From 5 and 13

Thus, KB entails G.