Time: 30 minutes   Max. Marks: 10

Name and Roll No.: _____

Instructions:
- Do not plagiarize. Do not assist your classmates in plagiarism.
- Show your full solution for the questions to get full credit.
- Attempt all questions that you can.
- True / False questions will get full credit only if the justification and answer are both correct.
- A multiple choice question may have one or more correct answers. Credit will only be awarded if all correct answers are marked and none of the incorrect answers are marked.
- In the unlikely case that you find a question ambiguous, discuss it with an invigilating TA/invigilator. Please ensure that you clearly write any assumptions you make, even after clarification from the invigilator.
V. Imp.: If you do not write your **Name and Roll No.**, you will get a zero.

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1. $(1 \times 3 = 3$ points) State True or False with justification. In case a statement is False, provide a counter-example.

   (a) Entailment can be established by solving some satisfiability (SAT) problem.
   Solution:
   True. To show $A \vDash B$, we can solve the satisfiability problem of $A \land \neg B$. If it is unsatisfiable, then $A \models B$, else $A \nvDash B$.

   (b) Forward Chaining is *sound* for propositional logic.
   Solution:
   True. Since forward chaining uses modus ponens, i.e., it builds upon affirmations from what it knows (from the knowledge-base for example), every deduction is a true deduction. Therefore it is sound.

   (c) Forward Chaining is *complete* for propositional logic.
   Solution:
   False. Consider the following example where you have two sentences in the $KB \equiv \{(P \lor Q), (\neg P)\} \equiv \{C_1, C_2\}$ and we want to query Q.
   Here, we see that Q can be inferred by resolution, but not by forward chaining. We can start with the initial fact $\neg P$ but we cannot use forward chaining (modus ponens) to infer anything from the C_1 clause because it is not a Horn clause (more than one positive literal). Therefore, forward chaining can not infer all sentences. It is complete *only if* the KB comprises of Horn clauses and if it has to infer a single literal.

2. (2 points) A resolution step that can be applied to a definite clause will result in a goal clause (i.e., a Horn clause that is not a definite clause). State True or False with an appropriate justification.

   > **Solution: False**. Definite clauses are clauses with exactly one positive literal. Since the resolution step resolves a pair of complementary literals, the resovent clause will have one positive literal resolved, thus generating a clause with exactly one literal again. Therefore, the resolvent will *NOT* be a goal clause.

3. (2 points) Draw the `AND-OR` graph for the following set of sentences. A car's headlights are on. The car's indicator lights are also on. When both, the indicator lights and the headlights are on, the car is in hazard mode. The car is also in hazard mode if the headlights are on and the horn is blaring. If the

car is in hazard mode and the indicator lights are on, then the car is at the service station. If the car is being serviced and the car is in hazard mode, then the horn is blaring.

Solution:

Interpretation:

1. $A \equiv$ Car's headlights are on.
2. $B \equiv$ Car's indicator lights are on.
3. $L \equiv$ Car is in hazard mode.
4. $P \equiv$ Car's horn is blaring.
5. $M \equiv$ Car is at the service station being serviced.

The Knowledge-Base:

1. A
2. B
3. $A \wedge B$
4. $A \wedge B \Rightarrow L$
5. $A \wedge P \Rightarrow L$
6. $B \wedge L \Rightarrow M$
7. $L \wedge M \Rightarrow P$
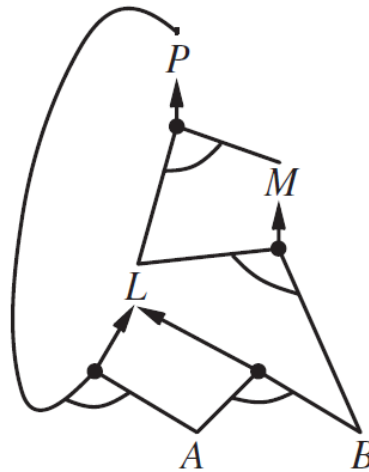
The And-Or graph is shown in Fig. 1.

Figure 1: And-Or Graph for Q3

4. (3 points) If either Chhetri or Bhutia score a goal, then India makes it to the finals. India was knocked out before reaching the final. Prove by resolution that Bhutia did not score a goal.

Solution:

See solution to Q1 in `Quiz-2-v0-Solution.pdf`. The question is exactly the same with the symbol interpretations changed.