This homework assignment has 5 problems, for a total of 36 points.

1. (8 points) Which of the following statements are true about the distributed truth maintenance system that we discussed in class?
   A. Well-foundedness means that beliefs may not depend upon rules
   B. Well-foundedness means that rules must be believed as premises, and cannot be given a justification
   C. Well-foundedness means that beliefs of one or more agents cannot be circular
   D. Well-foundedness means that if agent Charles has a belief (externally) justified based on agent Diane, then Diane may not hold a belief (externally) justified based on Charles

2. (8 points) Identify all of the following statements that are true about rules
   A. Rules are executable but not inspectable
   B. Rules can be written up quickly and achieve a lot more than traditional languages; this is why there is never a need to create them incrementally
   C. We can use description logics and rules together to represent knowledge
   D. Rules ensure that if a transaction has been initiated, then it will complete

3. (8 points) We are given four agents: Arvind, Brian, Carolyne, and Julius. As discussed in class, the agents communicate via asynchronous messaging: the send and receive of a message are separate events. We know that
   - Arvind sent a message to Brian on Monday.
   - Carolyne sent a message to Julius the following Tuesday.

   To fix the terminology, consider two vectors, \( v_1 \) and \( v_2 \), of equal dimensions.
   - We say that \( v_1 \) is smaller than or equal to \( v_2 \) (or \( v_1 \preceq v_2 \)) if and only if each element of \( v_1 \) is smaller than or equal to the corresponding element of \( v_2 \).
   - We say that \( v_1 \) is smaller than \( v_2 \) (or \( v_1 \prec v_2 \)) if and only if \( (v_1 \preceq v_2 \) and \( v_1 \neq v_2 \)).
   - We say that \( v_2 \) is greater than \( v_1 \) if and only if \( v_1 \) is smaller than \( v_2 \).

   Identify all of the following statements that are true with reference to vector clocks:
   A. The timestamp of Carolyne’s message must be greater than the timestamp of Arvind’s message
   B. The timestamp of Carolyne’s message may be smaller than the timestamp of Arvind’s message
   C. The timestamp of Carolyne’s message would be greater than the timestamp of Arvind’s message if Brian sent a message to Carolyne before she sent her message to Julius
   D. The timestamp of Carolyne’s message would be greater than the timestamp of Arvind’s message if Brian sent a message to Carolyne after he received Arvind’s message, and before Carolyne sent her message to Julius

4. (6 points) Which of the following statements are true about the Hohfeldian concepts?
   A. The privilege to do \( p \) means the absence of a duty prohibiting \( p \)
   B. Privilege is a correlate of duty
   C. Liability is a correlate of power
5. (6 points) An agent, Alice, sold and delivered some goods to another agent, Bob. Alice conditionally committed to giving a refund to Bob if Bob returned the goods within 30 days. Bob paid Alice. He then returned the goods, but they arrived damaged. Assume that commitments cannot be canceled, delegated, or assigned in this scenario. Which of the following statements are true?

   A. Alice is now definitely committed to giving Bob a refund
   B. Alice is now definitely committed to giving Bob a refund provided the goods were returned by Bob within 30 days of purchase
   C. Alice is now definitely committed to giving Bob a refund provided the goods were returned by Bob within 30 days of purchase and the organization (or sphere of commitment) within which Alice and Bob were interacting didn’t release Alice based on the goods being damaged