1. Prove the following sequents using natural deduction. If possible, use only constructive rules, reserving other rules for when it seems necessary. Give both a tabulation and a tree format proof for the first 3 examples. For the remainder, use the format of your choice. (You may use JAPE to format your tabulations, if desired.)

   a. \( \Gamma \vdash \neg p \rightarrow (p \rightarrow (p \rightarrow q)) \)

   b. \( \Gamma \vdash p \lor q, \neg q \lor r \vdash p \lor r \)

   c. \( \Gamma \vdash (p \rightarrow r) \land (q \rightarrow r) \vdash (p \lor q) \rightarrow r \)

   d. \( \Gamma \vdash (p \lor q) \rightarrow r \vdash (p \rightarrow r) \land (q \rightarrow r) \)

   e. \( \Gamma \vdash \neg p \land \neg q \vdash \neg (p \lor q) \)

   f. \( \Gamma \vdash \neg (p \land q) \vdash \neg p \lor \neg q \)

   g. \( \Gamma \vdash (p \rightarrow q) \lor (q \rightarrow r) \)

2. Give tableau proofs for sequents a, d, f, g above.

3. Use a tableau to find the interpretations that show that the following is not valid: \( (p \rightarrow (q \rightarrow r)) \rightarrow ((p \rightarrow q) \rightarrow r) \).

4. Show that, given only one of the rules RAA (reductio ad absurdum), LEM (law of the excluded middle), DNE (double not elimination), the other two rules can be derived using only constructive rules in addition.