CS3234 — Tutorial 1 questions

1. **From natural language to logic**: Find propositional logic formulas expressing the following declarative sentences:
   1. If the barometer falls, then either will rain of it will snow.
   2. If Dick met Jane yesterday, they had a cup of coffee together, or they took a walk in the park.
   3. Today it will rain or shine, but not both.

2. **Priorities**: Insert as many brackets as possible in the following formulas
   1. $\neg p \wedge q \rightarrow r$; 2. $(p \rightarrow q) \wedge \neg(r \vee p \rightarrow q)$; 3. $p \vee q \rightarrow \neg p \wedge r$

3. **Proofs**: Find natural deduction proofs for the following sequents:
   1. $p \rightarrow q, r \rightarrow s \vdash p \vee r \rightarrow q \vee s$
   2. $\vdash (p \wedge q) \rightarrow p$
   3. $p \vdash (p \rightarrow q) \rightarrow q$
   4. $\vdash (p \rightarrow q) \vee (q \rightarrow p)$
   5. $\neg(\neg p \vee q) \vdash p$
   6. $\vdash (p \rightarrow q) \vee (q \rightarrow r)$
   7. $\vdash (p \rightarrow q) \rightarrow ((\neg p \rightarrow q) \rightarrow q)$
   8. $p \rightarrow q, r \rightarrow s \vdash p \wedge r \rightarrow q \wedge s$
   9. $p \rightarrow (q \vee r), q \rightarrow s, r \rightarrow s \vdash p \rightarrow s$
   10. $(p \wedge q) \vee (p \wedge r) \vdash p \wedge (q \vee r)$
   11. $q \rightarrow (p \rightarrow r), \neg r, q \vdash \neg p$
   12. $p \rightarrow q \wedge r \vdash (p \rightarrow q) \wedge (p \rightarrow r)$
   13. $\neg(p \wedge q) \vdash \neg p \vee \neg q$
   14. $p \rightarrow (q \vee r), \neg q, \neg r \vdash \neg p$

4. **Proofs**: Let us introduce a new connective $\phi \leftrightarrow \psi$ as an abbreviation of $(\phi \rightarrow \psi) \wedge (\psi \rightarrow \phi)$. Design introduction and elimination rules for "$\leftrightarrow$" and show that they are derived rules if $\phi \leftrightarrow \psi$ is interpreted as $(\phi \rightarrow \psi) \wedge (\psi \rightarrow \phi)$.