Exercise 4.1: (4 P)
Convert the following formulas to equivalent formulas in CNF using ⇒_{ECNF}:

1. \[ ((P \to S) \land \neg Q) \iff [R \lor (\neg S \to Q)] \]
2. \[ \neg ((\neg P \lor (Q \land R))] \to [P \land (\neg Q \leftrightarrow \neg R)] \]

Exercise 4.2: (4 P)
Convert the following formulas to equisatisfiable formulas in CNF using ⇒_{ECNF}, but before applying this procedure introduce fresh variables for subformulas like in Step 2 of OCNF for given positions. (This is essentially Step 2 of OCNF without computing \( \nu \) and doing subformula renaming only at given positions.)

1. \[ \neg ((\neg P \lor (Q \land R))] \to [P \land (\neg Q \leftrightarrow \neg R)] \] positions: \( \{1, 22\} \)
2. \[ [P \lor (\neg Q \leftrightarrow \neg R)] \to [\neg (\neg P \land (Q \lor R))] \] positions: \( \{12, 212\} \)

Exercise 4.3: (3 P)
Prove Proposition 2.10 for the case of polarity zero. You can assume that in the formula \( \psi \) only connectives \( \land, \lor \) and \( \neg \) are present.

Exercise 4.4: (4 Bonus Points)
Prove Proposition 2.10 for the case of positive and negative polarity. You can assume that in the formula \( \psi \) only connectives \( \land, \lor \) and \( \neg \) are present.

Submit your solution in lecture hall 001 during the lecture on May 14. Please write your name and the date of your tutorial group on your solution.

Note: Joint solutions are not permitted (work in groups is encouraged).