1. (4 marks) Determine whether the statement \((\sim p) \land q) \lor (\sim r)\) is logically equivalent to the statement \((\sim p) \land (q \land r)\).

2. (4 marks) In each case, determine whether the statement is a tautology or a contradiction. Please verify your answers carefully, by using a truth table.

   (i) \(\sim (p \rightarrow (q \land r)) \leftrightarrow p \land (\sim q \lor \sim r)\)
   (ii) \(((p \rightarrow q) \land (q \rightarrow r)) \rightarrow (p \rightarrow r)\)

3. (3 marks) Determine the validity of the argument:

\[((p \rightarrow q) \land (q \rightarrow r)) \rightarrow (\sim r \rightarrow \sim p).\]

4. (5 marks) The logical connective “nor” \(\downarrow\) satisfies \(p \downarrow q\) is \textit{true} if and only if \(p\) and \(q\) are both false. The logical connective “nand” \(\uparrow\) satisfies \(p \uparrow q\) is \textit{false} if and only if \(p\) and \(q\) are both true.

   (i) First, for safety, write out truth tables for “nor” \(\downarrow\) and for “nand” \(\uparrow\).
   (ii) Now verify the following are tautologies:

   (a) \(\sim p \leftrightarrow (p \downarrow p)\)  (b) \(\sim p \leftrightarrow (p \uparrow p)\)
   (c) \((p \lor q) \leftrightarrow ((p \downarrow q) \downarrow (p \downarrow q))\)  (d) \((p \lor q) \leftrightarrow ((p \uparrow p) \uparrow (q \uparrow q))\).

5. (4 marks) Write the following argument in symbolic form, and then carefully determine whether the argument is valid or invalid.

   If it rains or there is a cyclone, the tourist trade suffers. If the Australian dollar is high, then the tourist trade does not suffer. If the Australian dollar is high, the numbers of overseas tourists at the Gold Coast drop, and Gold Coast hotels are almost empty. The Australian dollar is high. Therefore the tourist trade suffers.

   Please use the following variables (to help the markers!).

   \(p\) it rains
   \(q\) there is a cyclone
   \(r\) the tourist trade suffers
   \(s\) the Australian dollar is high
   \(t\) Gold Coast hotels are practically full
   \(u\) numbers of overseas tourists at the Gold Coast drop

   Note: Do not attempt to draw a truth table; you’d need \(2^6\) lines! You will have to argue directly, as illustrated in lectures.

This assignment is worth 2\%. Marked out of 20; marks allocated as indicated above.