1. What is the truth-value of the formula \((A \land C) \lor ((\neg B \land C) \rightarrow \neg A)\) for \(A = 1, B = 1, C = 0?\)

2. Construct the truth-table for the formula \(A \lor (B \land C)\).

3. Construct the truth-table for the formula \(A \land (B \rightarrow C) \land (\neg B \lor \neg A)\).

4. You have three friends: John, Paul and Mary. You are required to issue invites to a party. The following conditions must hold:

   - If you invite John, you must also invite Paul.
   - You must invite either Paul or Mary, but not both.
   - You must invite either John or Mary or both.
   - If you invite Mary, you must also invite John.

   Who do you issue party invites to?

5. Translate the given statement into propositional logic using the propositions provided:

   - You cannot edit a protected Wikipedia entry unless you are an administrator. Express your answer in terms of \(E\): “You can edit a protected Wikipedia entry” and \(A\): “You are an administrator.”

   - You are eligible to be President of the USA only if you are at least 35 years old, were born in the U.S.A, or at the time of your birth both of your parents were citizens, and you have lived at least 14 years in the country. Express your answer in terms of \(E\): “You are eligible to be President of the USA,” \(A\): “You are at least 35 years old,” \(B\): “You were born in the USA,” \(P\): “At the time of your birth, both of your parents were citizens,” and \(R\): “You have lived at least 14 years in the USA.”

6. Formalise the following argument in Boolean logic, and decide whether it is correct or not. Explain your answer.

   If the burglar is from Yorkshire, then he is tall. If he is tall, then he came through the window. The burglar is from Yorkshire, or at least he spoke with a Yorkshire accent. If he spoke with a Yorkshire accent and the evidence obtained is admissible, then he came through the window. Therefore, the burglar came through the window.

7. Determine whether the formulas \(A \land (B \oplus C)\) and \((A \land B) \oplus (A \land C)\) are equivalent, where \(\oplus\) denotes ‘exclusive OR’ (or ‘XOR’).

8. Construct a Boolean formula that realises the Boolean function given by the following truth-table:

\begin{center}
\begin{tabular}{ccc|c}
\(x_1\) & \(x_2\) & \(x_3\) & \(f(x_1, x_2, x_3)\) \\
\hline
0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 1 & 0 & 1 \\
0 & 1 & 1 & 1 \\
1 & 0 & 0 & 0 \\
1 & 0 & 1 & 1 \\
1 & 1 & 0 & 0 \\
1 & 1 & 1 & 1 \\
\end{tabular}
\end{center}

(a) use the connectives \(\lor, \land, \neg\) only; 
(b) find a simplest possible formula.
9. Consider the Boolean function \( f(x_1, x_2, x_3) \) realised by the following Boolean circuit:

\[ \begin{array}{c}
\text{\( x_1 \)} \\
\text{\( x_2 \)} \\
\text{\( x_3 \)} \\
\end{array} \begin{array}{c}
\downarrow \\
\wedge \\
\neg \\
\end{array} \begin{array}{c}
\downarrow \\
\text{\( \text{AND} \)} \\
\wedge \\
\neg \\
\end{array} \begin{array}{c}
\downarrow \\
\text{\( \text{OR} \)} \\
\end{array} \begin{array}{c}
\downarrow \\
\text{output} \\
\end{array} \]

Construct the truth-table for this function and represent it by a formula using \( \lor, \land, \neg \).

10. A 2-to-1 multiplexer has three inputs, say \( A_0, A_1 \) and \( S \); the output is \( A_0 \) if \( S = 0 \) and \( A_1 \) if \( S = 1 \).

Design a Boolean circuit for the 2-to-1 multiplexer.

11. Simplify the Boolean formula \( \neg (A \land B) \land (\neg A \lor B) \land (\neg B \lor B) \).