1. [20 points] Translate each of these English sentences into a propositional calculus representation, using the dictionary below:
   A: Merlyn is busy.
   B: Merlyn has an apprentice
   C: Merlyn is wise.
   a) Merlyn is busy, and if Merlyn has an apprentice, then Merlyn is wise.
   b) If Merlyn does not have an apprentice, then Merlyn is busy.
   c) Merlyn is busy or Merlyn is wise, but not both.
   d) Merlyn is neither busy nor wise.

2. [20 points] Use truth tables to classify each of the sentences below as a tautology, a contradiction, or a contingency.
   a) \((P \rightarrow \neg Q) \lor Q\)
   b) \((P \land Q) \lor (\neg P \land \neg R)\)

3. [20 points] Verify each of the following equivalences by writing an equivalence proof. That is, start on one side and use known equivalences to get to the other side. (Do not use a truth table.)
   a) \(P \lor \neg(Q \land \neg P) \equiv Q \rightarrow P\)
   b) \((\neg P \rightarrow Q) \land (P \rightarrow Q) \equiv Q\)

4. [20 points] Given
   \(P \lor Q\) and
   \(\neg Q \lor \neg R\),
   prove \(R \rightarrow P\). You may use conditional proof or indirect proof, and you may use a subproof if you find it helpful.

5. [20 points] Given
   \(P \rightarrow Q \land R\) and
   \(R \rightarrow \neg Q\),
   prove \(\neg P\). You may use conditional proof or indirect proof, and you may use a subproof if you find it helpful.