

Answer the questions in the spaces provided on the question sheets. If you run out of room for an answer, continue on a separate sheet of paper.

1. (a) Using a truth table, show that $p \oplus q \equiv \neg(p \wedge q) \wedge (p \vee q)$.

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- (b) Using the laws of propositional logic and the result from Part (a), show that $p \oplus q \equiv (p \wedge \neg q) \vee (\neg p \wedge q)$.

2. A certain cabal (*cabal*: a secret political clique or faction) within the CS department is plotting to make the final exam *ridiculously hard*. The only way to stop their evil plan is to determine exactly who is in the cabal. The department includes Donald, Grace, Linus, Alan, Ada and Edsger. The cabal is a subset of these six. A membership roster has been found and appears below, but it is deviously encrypted in logic notation. The predicate *cabal* indicates who is in the cabal; that is, *cabal*(*x*) is true if and only if *x* is a member of the cabal. Use the following information to gather who is in the cabal.

1. $\exists x \exists y \exists z (x \neq y \wedge x \neq z \wedge y \neq z \wedge \text{cabal}(x) \wedge \text{cabal}(y) \wedge \text{cabal}(z))$
2. $\exists x (\neg \text{cabal}(x))$
3. $\text{cabal}(\text{Edsger}) \rightarrow \forall x (\text{cabal}(x))$
4. $\neg(\text{cabal}(\text{Donald}) \wedge \text{cabal}(\text{Alan})) \wedge (\text{cabal}(\text{Donald}) \vee \text{cabal}(\text{Alan}))$
5. $\text{cabal}(\text{Alan}) \rightarrow \text{cabal}(\text{Donald})$
6. $(\text{cabal}(\text{Ada}) \vee \text{cabal}(\text{Linus})) \rightarrow \neg \text{cabal}(\text{Grace})$