

Instruction: You must show your work clearly for credit.

1. (10) Let p , q , and r be the propositions

p : You have the flu.

q : You miss the final examination.

r : You pass the course.

Express each of the following propositions as an English sentence.

(a) $\neg q \leftrightarrow r$,

(b) $q \rightarrow \neg r$,

(c) $p \vee q \vee r$,

(d) $(p \rightarrow \neg r) \vee (q \rightarrow \neg r)$,

(e) $(p \wedge q) \vee (\neg q \wedge r)$.

2. (10) Let p , q , and r be the propositions

p : You get an A on the final exam.

q : You do every exercise in this book.

r : You get an A in this class.

Rewrite the following propositions using p , q , and r and the six basic logical connectives.

(a) You get an A in this class, but you do not do every exercise in this book.

(b) You get an A on the final, you do every exercise in this book, and you get an A in this class.

(c) You get an A on the final, but you don't do every exercise in this book; nevertheless, you get an A in this class.

(d) Getting an A on the final and doing every exercise in this book is sufficient for getting an A in this class.

(e) You will get an A in this class if and only if you either do every exercise in this book or you get an A on the final.

3. (10) Let p , q , r , s , and t be propositions with $p = q = s = T$ and $r = t = F$. Fully parenthesize the following propositions according to the hierarchy of connectives involved and then compute their values.

(a) $p \rightarrow q \vee \neg r \leftrightarrow s \vee t \wedge \neg p \vee r \wedge t$,

(b) $\neg p \vee r \wedge t \leftrightarrow p \rightarrow q \oplus \neg r \leftrightarrow s \vee t \rightarrow q$.

4. (20) Construct a truth table for the following compound propositions. When done compute its corresponding DNF and CNF if exists.

(a) $(p \wedge q) \rightarrow (\neg p \vee \neg q)$,

(b) $(q \rightarrow p) \leftrightarrow (p \leftrightarrow q)$.

5. (20) Prove the following logical equivalences by using Direct Proof technique.
- (a) $q \wedge (p \rightarrow q) \equiv q$,
 - (b) $(p \rightarrow r) \vee (q \rightarrow r) \equiv (p \wedge q) \rightarrow r$.
6. (10) Given two propositions $P(p,q,r) = (p \wedge q) \rightarrow r$ and $Q(p,q,r) = (p \rightarrow r) \wedge (q \rightarrow r)$. Prove without using truth table that these two propositions are not logically equivalence.
7. (20) Prove or disprove the following logical equivalences by using The Laws of Logical Equivalence.
- Remark: You must give the names of the laws of logical equivalence in your proof for credit.
- (a) $p \vee \neg(p \vee \neg q) \equiv p \vee q$,
 - (b) $(p \wedge \neg(\neg p \vee q)) \vee (p \wedge q) \equiv p$.

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