1. State the distributivity laws

2. Show that $(p \to (q \to r)) \to (q \to (p \to r))$ is a tautology.

3. Show that $\neg p \oplus (q \vee r)$ and $p \rightarrow (q \oplus r)$ are not logically equivalent.

4. Give the reasons for each step needed to show that the following argument is valid
   Premises: $p \wedge q, \neg r \rightarrow \neg q, (r \vee s) \rightarrow v$
   Conclusion: v.

Steps	Reasons
1. $p \wedge q$	
2. q	
3. $\neg r \rightarrow \neg q$	
5. $q \rightarrow r$	
6. r	
7. $r \vee s$	
8. $(r \vee s) \rightarrow v$	
9. v	

5. Give two methods of proving an existential statement.

6. Given the premises
   "All cats are black"
   "Black cats are evil or just dirty"
   "Jack is a good cat"
   infer the conclusion
   "Jack is just dirty"

7. Given the premises
   "All cats are black"
   "Black cats are evil"
   infer the conclusion
   "All cats are evil"

8. Determine whether the following argument is valid or not. If it is valid provide a formal inference with steps and reasons. If it is not, explain why.

   "All chickens come home to roost."
   "When a chicken comes home to roost, they lay an egg."
   "Therefore, eventually I will have an egg."

9. Express the statement "For every action, there is an equal and opposite reaction, unless that action is performed by Michelle Yeoh or the limit does not exist" in logic.

10. Express the statements "It is not the case that being a turle implies you are slow" and "There does not exist a turtle who is fast and walks on land" without negation.

11. Show that $\forall x\ (P(x) \to Q(x))$ is not logically equivalent to $(\forall x\ P(x)) \to (\forall x\ Q(x))$.

12. Let $A = \{eggs, bacon\}$ and the universe U be $\{eggs, bacon, sausage\}$. Find the complement $\overline{A}$ of A in universe U. Find the difference $U - A$ and symmetric difference $A \triangle U$.

13. Find the power set of $A = \{\{A\}, \{\{\}\}, \emptyset\}$. [12]