Theorem 1.1.1 - Epp Textbook p. 14

Given any statement variables p, q, and r, a tautology t and a contradiction c, the following logical equivalences hold:		
1. Commutative laws:	$p \wedge q \equiv q \wedge p$	$p \vee q \equiv q \vee p$
2. Associative laws:	$(p \wedge q) \wedge r \equiv p \wedge (q \wedge r)$	$(p \vee q) \vee r \equiv p \vee (q \vee r)$
3. Distributive laws:	$p \wedge (q \vee r) \equiv (p \wedge q) \vee (p \wedge r)$	$p \vee (q \wedge r) \equiv (p \vee q) \wedge (p \vee r)$
4. Identity laws:	$p \wedge t \equiv p$	$p \vee c \equiv p$
5. Negation laws:	$p \vee \sim p \equiv t$	$p \wedge \sim p \equiv c$
6. Double Negative law:	$\sim(\sim p) \equiv p$	
7. Idempotent laws:	$p \wedge p \equiv p$	$p \vee p \equiv p$
8. DeMorgan's laws:	$\sim(p \wedge q) \equiv \sim p \vee \sim q$	$\sim(p \vee q) \equiv \sim p \wedge \sim q$
9. Universal bounds laws:	$p \vee t \equiv t$	$p \wedge c \equiv c$
10. Absorption laws:	$p \vee (p \wedge q) \equiv p$	$p \wedge (p \vee q) \equiv p$
11. Negations of t and c:	$\sim t \equiv c$	$\sim c \equiv t$

Table 1.3.1 - Epp Textbook p. 40

Modus Ponens $p \to q$ p Therefore q	Modus Tollens $p \to q$ $\sim q$ Therefore $\sim p$		Disjunctive Syllogism	$p \vee q$ $\sim q$ Therefore p	$p \vee q$ $\sim p$ Therefore q
Conjunctive Addition	p q Therefore $p \wedge q$		Hypothetical Syllogism	$p \to q$ $q \to r$ Therefore $p \to r$	
Disjunctive Addition	p Therefore $p \vee q$	q Therefore $p \vee q$	Dilemma: Proof by Division into Cases	$p \vee q$ $p \to r$ $q \to r$ Therefore r	
Conjunctive Simplification	$p \wedge q$ Therefore p	$p \wedge q$ Therefore q	Rule of Contradiction	$\sim p \to c$ Therefore p	
Closing C.W. without contradiction	$\mid p$ Assumed $\mid q$ derived Therefore $p \to q$		Closing C.W. with contradiction	$\mid p$ Assumed $\mid x \wedge \sim x$ derived Therefore $\sim p$	

Other Equivalences and Other Rules of Inference

Definition of Implication	$p \to q$ $\sim(p \to q)$	$\equiv$ $\equiv$	$\sim p \vee q$ $p \wedge \sim q$
Definition of Biconditional	$A \leftrightarrow B$ $\sim(A \leftrightarrow B)$	$\equiv$ $\equiv$	$(A \to B) \wedge (B \to A)$ $(A \wedge \sim B) \vee (B \wedge \sim A)$
Negation of Quantifiers	$\sim \forall x\ P(x)$ $\sim \exists x\ P(x)$	$\equiv$ $\equiv$	$\exists x\ \sim P(x)$ $\forall x\ \sim P(x)$
Universal Modus Ponens	$\forall x \in D, P(x) \to Q(x)$ $P(a)$	 $\to$	 $Q(a)$
Universal Modus Tollens	$\forall x \in D, P(x) \to Q(x)$ $\sim Q(a)$	 $\to$	 $\sim P(a)$
Universal Instantiation	$\forall x \in D, P(x)$	$\to$	$P(a)$
Existential Generalization	$P(a)$ where $a \in D$	$\to$	$\exists x \in D, P(x)$
Universal Generalization**	$P(a)$ where $a \in D$	$\to$	$\forall x \in D, P(x)$
Existential Instantiation **	$\exists x \in D, P(x)$	$\to$	$P(a)$ where $a \in D$

** NOTE: Remember the special circumstances required for the rules marked by the stars.

Table 5.2.1 - Subset Relations

Given any sets A, B, and C:	
1. Inclusion for Intersection:	$(A \bigcap B) \subseteq A$ $(A \bigcap B) \subseteq B$
2. Inclusion for Union:	$A \subseteq (A \bigcup B)$ $B \subseteq (A \bigcup B)$
3. Transitive Property of Subsets:	$(A \subseteq B) \wedge (B \subseteq C) \rightarrow A \subseteq C$

Theorem 5.2.2 - Set Identities

Given any sets A, B, and C, the universal set U and the empty set $\emptyset$:	
1. Commutative laws:	$A \bigcap B = B \bigcap A$ $A \bigcup B = B \bigcup A$
2. Associative laws:	$(A \bigcap B) \bigcap C = A \bigcap (B \bigcap C)$ $(A \bigcup B) \bigcup C = A \bigcup (B \bigcup C)$
3. Distributive laws:	$A \bigcup (B \bigcap C) = (A \bigcup B) \bigcap (A \bigcup C)$ $A \bigcap (B \bigcup C) = (A \bigcap B) \bigcup (A \bigcap C)$
4. Intersection with U (Identity):	$A \bigcap U = A$
5. Double Complement law:	$(A')' = A$
6. Idempotent laws:	$A \bigcap A = A$ $A \bigcup A = A$
7. De Morgan's laws:	$(A \bigcup B)' = A' \bigcap B'$ $(A \bigcap B)' = A' \bigcup B'$
8. Union with U (Universals Bounds):	$A \bigcup U = U$
9. Absorption laws:	$A \bigcup (A \bigcap B) = A$ $A \bigcap (A \bigcup B) = A$
10. Alternative Representation for Set Diff:	$A - B = A \bigcap B'$

Table 5.2.3 - Subset Intersection and Union

Given any sets A, B :	
1. $A \subseteq B \rightarrow (A \bigcap B = A)$	Intersection with Subset
2. $A \subseteq B \rightarrow (A \bigcup B = B)$	Union with Subset

Table 5.3.3 (plus others) - Properties of $\emptyset$ and Universal set

Given any sets A, B, and C, the universal set U and the empty set $\emptyset$:	
1. Union with $\emptyset$:	$A \bigcup \emptyset = A$
2. Intersection and Union with Complement	$A \bigcap A' = \emptyset$ $A \bigcup A' = U$
3. Intersection with $\emptyset$:	$A \bigcap \emptyset = \emptyset$
4. Complement of Union and $\emptyset$:	$U' = \emptyset$ $\emptyset' = U$
5. Every set is subset of Universal	$\forall A \in \{Sets\}, A \subseteq U$
6. Empty set is subset of every set	$\forall A \in \{Sets\}, \emptyset \subseteq A$
7. Definition of Empty Set	$\forall A \in \{Sets\}, A = \emptyset \leftrightarrow \forall x \in U, x \notin A$

Things from Ch. 4

Theorem 4.1.1	$\sum_{k=m}^{n} a_k + \sum_{k=m}^{n} b_k = \sum_{k=m}^{n} (a_k + b_k)$
Theorem 4.1.1	$c \cdot \sum_{k=m}^{n} a_k = \sum_{k=m}^{n} (c \cdot a_k)$
Theorem 4.1.1	$\prod_{k=m}^{n} a_k \cdot \prod_{k=m}^{n} b_k = \prod_{k=m}^{n} (a_k \cdot b_k)$
Theorem 4.2.2	$\sum_{i=1}^{m} i = \frac{m(m+1)}{2}$
Theorem 4.2.3	$\sum_{i=0}^{n} r^i = \frac{r^{n+1}-1}{r-1}$