2. (a) $M \models_p A$. $\because$ A is valid

$\therefore$ $\forall p \in pset$ A is true.

$\therefore$ $\forall p \in pset$ $\neg A$ is false.

$\therefore$ $\neg \exists p \in pset$ $M \models_p \neg A$

$\therefore$ $\neg A$ is not satisfiable.

(b) Build a truth table for the formula's negation.

if it is satisfiable, then the formula itself is not satisfiable.

(c) 1. $(p \to q) \wedge (q \to r) \wedge \neg(r \to p)$

$\Leftrightarrow (\neg p \vee q) \wedge (\neg q \vee r) \wedge \neg(\neg r \vee p)$

$\Leftrightarrow (\neg p \vee q) \wedge (\neg q \vee r) \wedge (r \wedge \neg p)$

$\Leftrightarrow \neg p \wedge (\neg p \vee q) \wedge r \wedge (\neg q \vee r)$

$\Leftrightarrow (\neg p \wedge r)$

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

p	q	r	
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

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

3. $\neg(p \to p)$

$\neg(\neg p \vee p)$ false.

d. 1. $\forall n \in D$, $R(n) \vee B(n)$.

2. $\forall x \forall y$ $E(x,y) \to (R(x) \wedge B(y)) \vee (R(y) \wedge B(x))$.

3. $\exists x \forall y$ $(E(x,y) \vee E(y,x)) \wedge B(x) \wedge R(y)$.

e. 1. I

2. II

3. I

4. I

f. 1. $B \rightleftarrows R$ 2. impossible.