1 Formalising natural-language sentences

Give formulas of first-order predicate logic that represent the truth conditions of the following sentences as closely as possible. Please ignore tense. You can use a single predicate symbol to represent several words where appropriate. Definite descriptions (*e.g.*, "the sea") can be treated like proper names as constants.

1. It is raining.
2. John doesn't love Mary.
3. Nobody is loved by no one.
4. Bill has a degree.
5. Bill has a degree in LST.
6. Bill don't has a degree in LST.
7. Bill don't has a degree.
8. All students are intelligent.
9. Every intelligent student is successful.
10. If all students are successful, then Mary is successful, too.
11. If a student is successful, then Mary.

2 Truth conditions

The following two formulas both represent the truth-conditions of the sentence "Bill is annoyed if someone is noisy." Compute the truth-conditions of the two formulas, and show that they are equivalent.

1. $\forall x(N(x) \rightarrow A(b))$
2. $\exists x N(x) \rightarrow A(b)$

3 Status of logical formulas I

Compute the truth conditions of the following two logical sentences, and decide whether they are valid, unsatisfiable, or contingent (neither valid nor unsatisfiable). Give a model and a countermodel for contingent sentences.

1. $\forall x(P(x) \rightarrow \exists x \neg P(x))$
2. $\forall x P(x) \rightarrow \exists x \neg P(x)$

4 Status of logical formulas II

For each of the following logical sentences, decide whether it is logically valid, unsatisfiable, or contingent. You don't have to compute truth conditions, but you should explain why you believe it is valid or unsatisfiable. For contingent sentences, give a model and a countermodel.

1. $\forall x P(x) \wedge \forall y Q(y) \wedge (\exists z \neg P(z) \vee \exists x \neg Q(x))$
2. $(\forall x P(x) \wedge \forall y Q(y)) \rightarrow \forall x (P(x) \wedge Q(x))$
3. $\forall x (\mathsf{student}(x) \rightarrow \mathsf{person}(x))$

To be turned in by Thursday, 2009-05-07, 10:00