**CS 720 Spring 2003**
**Homework 1**

**Due Date: February 19**

1. Huth and Ryan, Exercises 3.1, Number 1f.
2. Huth and Ryan, Exercises 3.2, Number 1b.
3. Huth and Ryan, Exercises 3.3, Numbers 3, 5.
4. Huth and Ryan, Exercises 3.4, Number 1e,f.
5. Huth and Ryan, Exercises 3.15, Number 1.
6. Show in a step-by-step manner, using the definition of $\models$, that $Ff \equiv$ *True* $Uf$ for any path formula $f$.
7. Justify the equivalence $A[fUg] \equiv \neg E[\neg gU(\neg f \wedge \neg g)] \wedge AFg$.
8. Give a simpler formula that is equivalent to $A[pUEFr]$.
9. (a) Why are the formulas $qRp$ as defined in Clarke, Grumberg and Peled and $pWq$ as defined in Huth and Ryan, page 201, not equivalent?

   (b) Express $W$ using $R$.
10. (a) Show that the formula $AFGp$ implies the formula $AGEFp$ (that is, if $AFGp$ is true in a state, then $AGEFp$ is true in that state).

    (b) On page 30, Clarke, Grumberg and Peled state that $AFGp \vee AGEFp$ is not expressible in either CTL or LTL. Explain why this is false. [Hint: Use part (a).]
11. Show that $\{AG, AU, AX\}$ is an adequate set of operators for CTL.
12. Show that $EGFp$ is not expressible in LTL.