Homework 1
Analysis of Software Artifacts
Due Date: Feb 1, 2000 (Tuesday)

Question 1 (Review, 10 points): Please give an English description of the path operators (modalities) and path quantifiers given below. Also express each operator/quantifier in terms of **X**, **U**, and **E** (use the duality equations here).
Path operators: **X**, **U**, **R**, **F**, **G**.
Path quantifiers: **A**, **E**.

Question 2 (Review, 40 points):
Part A: Classify each formula given below as $CTL^\star$, CTL, or LTL. Give a short justification for your answer.
$\mathbf{A}(\neg \mathbf{F} p \vee \mathbf{G} q)$, **AG EF AF**$p$, or $\mathbf{A}(\neg \mathbf{F} p \vee \mathbf{EG} q)$.

Part B: The path formula $f \mathbf{U_w} g$ ($\mathbf{U_w}$ is called the *weak until*) is true on a path if f remains true until g becomes true, but we allow g to be false on the entire path. Express weak until $\mathbf{U_w}$ as a combination of until **U** and globally **G**.

Question 3 (Modeling, 50 points): Express the following English descriptions in $CTL^\star$. Also write the negation of the formula and provide English description of that.

Part A: It is not possible to reach a state that is faulty (where the atomic proposition *faulty* is true).

Part B: If a transaction is started (denoted by truth of the atomic proposition *started*), it always finishes (denoted by the truth of the atomic proposition *finished*).

Things to think about: Down load `NuSMV` or `SMV` from the web-site provided on the course home page. Start looking at some examples provided with `NuSMV` or `SMV` distribution.