Exam 2 Study Sheet

1. What is it that makes one condition weaker than another.
   a. Condition A is true whenever B is true, but B is true when A is not. B is weaker.
      \[ A < 1, A < 0 \quad A < B, A \leq B \quad A, A \wedge B \quad A, A \vee B \quad A \Rightarrow B \]
   b. Condition A includes more states than condition B.
   c. If two conditions are mutually exclusive, then technically neither is weaker.
   d. If one condition is not contained in another, then technically neither is weaker.
   e. Universally Quantified conditions, if the range of A is larger but contains the range of B and the conditions are the same then B is weaker.
   f. Existentially Quantified conditions, if the range of A is larger but contains the range of B and the conditions are the same then A is weaker.
   g. All else being equal, an existential quantifier is weaker than a universal quantifier.

2. Converting English statements to quantified statements.
   a. Given a set of jars numbered from 1 to k, each jar has at least one penny and no jar has more than three pennies. Use Content(k) to symbolize the number of pennies in jar K.
   b. Given the same set of jars, at least one jar has two pennies.
   c. In every consecutive range of four integers or more integers, there is at least one multiple of 4.
   d. There is a computer science professor who has holes in all of his shoes.

3. The variable x appears in each of the following. Is x bound or free (or both) in each expression.
   a. x+1
   b. f(x)=x+1
   c. (Ax: 1<x<n : x+1<y+1)
   d. (Ex: 1<x<n: y+1=2)
   e. (Ay: 1<y<n : x+1<y+1)
   f. (Ax: a<x<b: (En: 1<n<x: y+1=n))

4. Given the following expression, perform the following substitutions, if possible.
   \[ (Ax: a \leq x < y : b > x \wedge (Ec : q \leq c < m : q + p = c + x)) \]
   a. \( E^a_z \)
   b. \( E^x_m \)
   c. \( E^p_d \)
   d. \( E^q_r \)
   e. \( E^x_y \)

5. Given the following statements and the following conditions, find the weakest precondition.
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a. x:=x+1; x>0
b. x:=x-1; y>0
c. x:=x*x; (E_h:1<y<n:y=x+1)
d. x:=a+b+c; x>a

6. Know how to simplify array assignments.