Name_____

1. Find the weakest precondition for the following conditions and statements. (15 points)

if (a<b)
{
a = b;
}
else
{
b = a;
}
	if (a<b && b<c)
	{
	v = true;
	}
	else
	{
	v = false;
	z = 0;
	}
		if (a>b)
		{
		c=a;
		}
		else
		{
		c=b;
		}

$\{a \leq b \leq c\}$	$\{v = false \vee z > 0\}$	$\{c \geq a \wedge c \geq b\}$

2. Find reasonable loop invariants for the following loops.
   (10 points)

```
Dp = 0;
i = 0;
while (i<10)
{
        p = A[i] * B[i];
        Dp = Dp + p;
        i++;
}
```

```
i = 1; // not zero!
while (i<10)
{
        if (A[0] < A[i])
        {
                T = A[0];
                A[0] = A[i];
                A[i] = T;
        }
}
```

3. Find post-conditions that will imply the correctness of the following three code segments. To avoid confusion, the code segments are described in English rather than C++ code. Specify your post-conditions as logical formulas, *not as English statements.*
   (15 points)

Find the maximum element of the array *A* and assign its value to the variable *Q*.	Test an array to see if it is in order. If so, assign *TRUE* to the variable *Sorted*. Other wise assign *FALSE* to the variable *Sorted*.	Assign the absolute value of *X* to *Y*.

4. Translate the following statements into universally or existentially quantified statements. Assume that the arrays B and C have indexes that run from 1 to 10. The last three require nested statements.
(10 points)

   a. B contains an element divisible by 7. (x mod 7 = 0)
   b. B contains no elements greater than 100.
   c. There is an index *i* such that B[j] < B[i] if j<i and B[j] > B[i] if j>i.
   d. Every element of B is greater than some element of C.
   e. B has an element that is greater than any element of C.

5. Given the following statements and post conditions, find the weakest precondition. (10 points)

Statement	**Condition**	**Weakest Precondition**
x = 2*y + z;	$0 \le x \le 17$	
a = b + c;	z>x	
y = 3*x*x;	$y \ge 0$	
x = z+2;	$(En : 1 \le n \le x : B[x] = 30)$	
n = n+1	$(An : 1 \le n \le k : b[n] = x + n)$	

6. Prove the following propositions using truth tables. (10 points)

   a. $((a \wedge b \wedge c) \vee (a \wedge b) \vee c) = c$

   b. $((\neg a \wedge b) \vee a) = (a \vee b)$

7. Solve and turn in for 5 points extra credit, or tear off sheet, take home and solve (or whatever).

GUFOFHTOF GUF PTOJ URYBFPH BUKPP ARLF DTN K BRAV; WFUTPJ, K LROARV BUKPP XTVXFRLF, KVJ WFKO K BTV, KVJ BUKPP XKPP URB VKYF RYYKVNFP -- ATJ IRGU NB.

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