CSCI 254: *Introduction to Computer Organization*
Final exam -- open book section
13 December, 1993

The entire exam is to be turned in at 4:45PM. Work the closed book section first and turn it in before you consult your books and notes to work on the open book section.

There are two pages to the open book section of the exam!

Name: _____

Problem 1. (5 points)
Rewrite the Boolean expression $(A\,B + A)(B\,A' + C + B\,C)$ into the simplest equivalent sum-of-products form.

Problem 2. (5 points)
Reduce the function F with don't-care conditions d to its simplest sum-of-products form.

$F(A,B,C,D) = (1, 6, 9, 10, 14, 16)$
$F(A,B,C,D) = d(4, 5, 13)$

potentially useful stuff for Problems 1 and 2

Problem 3. (5 points)
If nine-bit registers `XR` and `ZR` have the following values

```
XR   111011010
ZR   001110110
```

what is the value of the following three expressions?

```
XR + ZR

XR   YR

cil XR
```

`cil` is circular shift left

Problem 4. (10 points)
Translate the following Pascal code into the textbook's assembly language:

```
IF P MOD 2 = 1 THEN
     P := P+1 ;
Z := P - C ;
```

Note: The test `P MOD 2 = 1` is true only if `P` is odd. You can make this test by loading `P` into the accumulator and checking if the rightmost bit of `P` is equal to 1.

Problem 5. (5 points)
How would you set the control inputs of the bus system shown in Figure 5-4 on page 130 of the textbook to execute the following *two* concurrent RTL statements?

```
AC    AC    DR, DR    M[AR]
```

Problem 6. (5 points)
What value would you need as the control word for the ALU organization show in Figure 8-2 on page 243 of the textbook to execute the following RTL statement?

```
R5    R7    R4
```

The meaning for the fields of the control word are given on page 245.

Problem 7. (5 points)
Translate the following expression into Reverse Polish Notation:

$(B * B - A * C) + X * Y$

Problem 8. (5 points)
Add the following instruction to the computer of Section 7-3, pages 220-231, of the text.

symbol	opcode	symbolic function		meaning
ICMM	1100	M[EA]	M[EA] + 1	Increment memory

This is similar to problem 7-16 on page 237 of the text.

Problem 9. (5 points)
A digital computer has a memory unit of 256k × 16 bits and a cache memory of 4k words. The cache uses direct mapping with a block size of 32 words. How many bits are there in the tag, block, and word fields of the address format?

Problem 10. (5 points)
On some PC's, RAM is used as a high-speed cache for the relatively slow ROM that holds the BIOS (Block Input/Output System). If the access speed of the RAM is 200 nsec, the access speed of the ROM is 800 nsec, and the cache hit ratio is 85%, what is the effective access time of ROM?

Problem 11. (5 points)
Describe how you can use one 8-to-3 priority encoder (just like the one you used in Homework #7) and up to three inverters to implement a six input AND gate. You aren't allowed to use any logic elements other than the priority encoders or inverters in your solution. However, you can tie certain inputs to 0 or 1. And, of course, you are free to ignore outputs.