

Name: _____

Directions: Work only on this sheet (on both sides, if needed); do not turn in any supplementary sheets of paper. There is actually plenty of room for your answers, as long as you organize yourself BEFORE starting writing. In order to get full credit, SHOW YOUR WORK.

1. In class, we mentioned that some OS features are impossible to implement without certain hardware. Fill in the blanks:

(a) (10) Timesharing is impossible without _____.

(b) (5) Protection of one program's memory from writing by another program is impossible without _____.

2. Fill in the following blanks with powers of 2. Write, for example, 2^7 , not 128. (The various parts of this problem are completely independent of each other.)

(a) (5) The maximum number of C **int** variables which could fit in an Intel page is _____.

(b) (10) Assume the page-table format on p.15 of the OS unit in our PLN. Then a page table could occupy as many as _____ bytes in memory.

(c) (5) In 12-bit 2s complement storage, the largest value of a signed integer is _____ - 1.

(d) (5) In 12-bit 2s complement storage, the largest value of an unsigned integer is _____ - 1.

(e) (10) The size, in bytes, of the stack space assigned to a program by the OS on an Intel machine will likely be a multiple of _____.

3. (5) MIPS programmers usually pass subroutine arguments via registers, not via a stack. Sometimes we even do this on Intel. Cite an example from our PLN of this.

4. Suppose we wish to set up a stack data structure (not necessarily related to subroutine calls) on a MIPS machine. Say the stack grows toward 0, and we use \$28 as our stack pointer.

(a) (10) Give MIPS assembly code, at most three instructions or pseudoinstructions, which would push the value 7 onto the stack. (Don't worry about changing register contents.)

(b) (5) Give a real MIPS assembly instruction which will copy \$12 to the next-to-top element of the stack.

5. (10) Give a single Intel assembly language instruction which will replace $c(\text{EAX})$ by $c(\text{EAX}) \bmod 32$.

6. (10) In our Java example, Minimum.java, suppose the assignment to X in main() had been

```
X = Integer.parseInt(Args[4]);
```

Show what JVM assembly language code would be generated by the compiler.

7. (10) Look at the program at the top of p.17 in the OS unit in our PLN. Give a single C **printf()** statement, to be placed somewhere in main(), which will print out the contents of ESP.

Solutions:

1.a. The timer.

1.b. Virtual memory hardware.

2.a. 2^{10} .

2.b. 2^{22} .

2.c. 2^{11} .

2.d. 2^{12} .

2.e. 2^{12} .

3. The example of system calls in the OS unit of the PLN.

4.a.

```
subu $28,$28,4
li $4,7
sw $4,0($28)
```

4.b.

```
sw $12,4($28)
```

5.

```
andl $0x1f, %eax
```

6.

```
aload_0
iconst_4
aaload
```

7.

```
printf("%d\n",&i);
```