University of Washington
EE 472: Microcomputer Systems Exam
Autumn 2015

November 26, 2015

Name: ____________________________ Student ID: ____________

Exam Information:

• The test is closed book, and no calculators/devices are allowed.

• There are 30 questions worth 175 points. Do not get hung up on a question, move on to the next problem, and come back to problems you are unsure of.

• Please show all work unless specified. Partial credit will be given to partial work. Make sure to state all assumptions made.

• Return this exam (with signature below).

Honor Code:

This exam represents only my own work. I did not give or receive help on this exam.

Signature: ____________________________ Date: ______________

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1. Define the characteristics of a **microprocessor** and **microcontroller**. Explain the difference between a microprocessor and microcontroller. (Note: Simply stating one processes and the other controls does not suffice and will result in no credit). *(5 points)*

2. What is meant by memory mapped I/O? *(3 points)*

3. Suppose you have an `uint32_t` variable `y` that you have some value in. Write some C code fragments to perform the following operations on `y`.
   a) Clear (make zero) bits 0, 2, and 31 without changing any of the other bits. *(3 points)*

   b) Set (make one) bits 8, 13, and 23 without changing any of the other bits. *(3 points)*

   c) Negate all bits (all 1’s become 0’s and all 0’s become 1’s). *(3 points)*

4. Explain the concept and significance of a watchdog timer. *(5 points)*

5. Why is the use of an `int` frowned upon, especially in embedded systems development? *(5 points)*
6. What does the C volatile type qualifier do? (3 points)

7. What does the C static storage class specifier do? (3 points)

8. Are pointers in C and references in Java the same thing? Give an example to illustrate your answer. (3 points)

9. What will be output of following program? (5 points)

```c
#include<stdio.h>
int main()
{
  int a = 320;
  char *ptr;
  ptr = (char *)&a;
  printf("%d , *ptr);
  return 0;
}
```

10. What does the following C code print? (5 points)

```c
uint32_t SomeNum = 0x11223344;
uint8_t * BytePtr = (uint8_t *) &SomeNum;
printf("0x%x\r\n", *BytePtr);
```

Why does or does not endianess apply?
11. What does the following C code print on a big endian processor? What does it print on a little endian processor? Comment on your responses. (5 points)

```c
uint32_t SomeNum = 0x11223344;
uint32_t NewNum = SomeNum >> 16;
printf("0x%x\n", NewNum);
```

a) Big endian processor:

b) Little endian processor:

c) Why does or does not endianess apply?

12. Write a C code fragment that shows how the memory is allocated. (8 points)

a) stack:

b) heap:

c) global:
13. Name a typical use for each kind of storage and why it is a reasonable use of the storage. (9 points)
   a) stack:

   b) heap:

   c) global:

14. What do you use to retain the state of a register in your program for write-only register bits? (5 points)

15. When would a read modify-write operation on a register be appropriate? When would it not be appropriate? (5 points)
16. Write a `#define` for a pointer to `SOME REGISTER` at address 0xDEADBEEF that is 32-bits wide. (3 points)

17. Suppose you want to use a timer interrupt. List the things required for this to work. (10 points)

18. Draw a block diagram of how source code is translated to object code. (5 points)

19. Draw a top-level block diagram of the RoboTank system. Only include the major functional blocks that should be used (one block is not sufficient). for this to work. (10 points)
20. Draw a top-level UML data/control flow diagram for the RoboTank. Include the ISR’s, main(), and shared data. (10 points)

21. What is the difference between a hard, soft, and firm real time operating system? Are there any time constraints on the RoboTank and can this system meet them? (10 points)

22. Suppose an ISR runs at a periodic rate of 1024 Hz and places one 32-bit sample in a queue each time it runs. The OS has a tick rate of 100Hz (10 ms). Meanwhile the task runs every OS tick, is the highest priority task in the system, consumes all the samples until it is empty, and then pends until the next OS tick. What is the minimum size of the queue required in bytes? (5 points)
23. Describe how semaphores are used. What is the purpose of a semaphore? Discuss binary semaphores and counting semaphores. (10 points)

24. Write some pseudo-code which creates a deadlock using semaphores. Fix the deadlock. (10 points)
25. Write some pseudo-code which creates priority inversion. Fix the code using priority inheritance. (10 points)
26. What is the difference between RAM and ROM memory? (2 points)

27. What is the difference between a preemptive and a non preemptive system? (3 points)

28. What is the difference between System Specifications and System Requirements? (3 points)

29. What are the differences between macros and inline functions? (3 points)

30. What are the advantages and disadvantages of global variables? (3 points)