NCSU - ECE 306- Midterm Exam – June 25, 2003

Name: _____ User ID _____

Question	1-25	26-32	33	34	Total
Score	/100	/50	/30	/70	/250

You are permitted 110 minutes to take this test, no more. This is an open book/open notes test. You are allowed the following items for the test: calculators, books, notes, homework, labs, pencils and erasers. You are not permitted to have any of the following on your desk during the test: computer, or other electronic assistance. Failure to abide by this policy will result in a zero for the test and a visit to the NCSU judicial board. Put your answers on this paper. Use only this paper.

Please read and sign this statement: I have not received from anyone nor assisted others while taking this test. I have also notified the test proctor of any of these violations noted above.

Signature: _____

Multiple Choice - Questions 1-15: Each of these multiple choice questions is worth 4 points for a correct answer, 0 points for an incorrect answer. Circle the correct answer. Multiple circles will be marked as incorrect.

1) According the ECE 306 programming standards, which of the following should be included in the header of a subroutine?
   a. Your name
   b. Assumptions
   c. Inputs/Outputs
   d. Interfaces
   e. All should be included

2) One of the major differences between programs developed for embedded software and those written for computer platforms is that the embedded programs almost always end with
   a. an interrupt routine to service loose ends left from the main function call
   b. a display to the screen to let the user know that the program has completed
   c. an infinite loop, a significant part of a program's functionality, as embedded software is intended to run continually
   d. a user-encoded hardware interrupt at the end of the main program to remove all local variables from the stack
   e. a user-encoded software interrupt at the end of the main program to increment the frame base pointer.

3) In order for the processor to execute correct Interrupt Service Routines (ISRs), a mapping must exist between interrupt pins and ISRs. This mapping usually takes the form of
   a. an interrupt vector table
   b. an interrupt service routine graph
   c. memory map
   d. translation table between ISR timing and the processor
   e. a frame base pointer table

4) A common way to recover from unexpected software hangs that occur after a system is released is a special piece of hardware that protects the system. It is called a
   a. RS232 port
   b. Hyperterminal
   c. Auxiliary processor
   d. Watchdog timer
   e. Embedded debugger

5) Which of the following operators is NOT considered to be a Bitwise Operator?
   a. &
   b. |
   c. ^
   d. ~
   e. None of these choices

6) Which of the following instructions are not considered data transfer instructions?
   a. MOVA
   b. PUSH
   c. XCHG
   d. POP
   e. JMP

7) Which of the following phases of a software project occurs first?
   a. Coding
   b. Verification
   c. High-level design
   d. Low-level design
   e. Requirements gathering

8) Which of these is not a correct addressing mode for the Renesas M16C?
   a. Static Base Pointer Relative
   b. Immediate
   c. Address Register Relative
   d. Address Register Absolute
   e. Frame Base/Stack Pointer Relative

9) In which file would you define (or find the definition of) the variable vector table?
   a. sect30.inc
   b. sfr262.h
   c. ncrt0.a30
   d. skp26.h
   e. both a and c

10) Which one of the following data types is NOT considered to be a mathematical integer?
   a. char
   b. int
   c. long
   d. double
   e. None of these choices

11) Choose the command which will allocate the appropriate amount of space for the following subroutine? (Assume i,j, and k have already been pushed onto the stack)

```
int problem(int g, int h, int i, int j, int k);
```

   a. enter #02h
   b. enter #04h
   c. enter #06h
   d. enter #08h
   e. enter #10h

12) For the 30262 SKP board, the internal RAM area begins and ends at what value:
   a. x00400 - x0FFFF
   b. x00BFF – x0F000
   c. x00400 – x00BFF
   d. x0F800 – x10000
   e. x0F000 – xFFFFF

13) The Mitsubishi controller we use in labs has….
   a. 64K flash and 2K RAM
   b. 2K flash and 64K RAM
   c. 4K flash and 64K RAM
   d. 32K flash and 2K RAM
   e. 2K flash and 128K RAM

14) Which of the following statements does NOT show how to correctly use a Bitwise Operator?
   a. expression 1 & expression 2
   b. expression 1 | expression 2
   c. expression 1 ^ expression 2
   d. ~expression
   e. expression 1 << expression 2

15) The reset feature of a processor is important because…..
   a. every program will mess up and need to be reset
   b. resets are not ever important
   c. it will reset the processor to a predicable state
   d. sometimes catastrophic events happen and the reset will put the processor in a know state
   e. answers d and c

16) Which instruction below uses the addressing mode type Address Register Relative?
   a. mov.w 2[SB], R3
   b. mov.B #32, R1H
   c. mov.w 2[A1], R2
   d. mov.w 85Abh, R2
   e. mov.w [A0], R1

17) According to the reading "Introduction to Interrupts", what is interrupt latency?
   a. The interval of time measured from the instant an interrupt is asserted until the corresponding ISR begins to execute.
   b. The time it would take to execute all higher priority interrupts if they occurred simultaneously
   c. The time it takes the specific ISR to service all of its interrupt requests
   d. The time it takes to finish the program instructions in progress and save the current program state and begin the ISR.
   e. The interval of time from the end of one interrupt until the beginning of the next.

18) What is this equivalent to: (a<<2)+(a<<1) + a
   a. 3a * 2
   b. a* 2
   c. a* 5
   d. a* 7
   e. a*9

19) Which assembly language has a similar execution as the following

   i: Copy FB to SP
   ii: Pop FB from Stack
   iii:, Return from subroutine (pop return address from stack)

   a. FUNTION main
   b. REGISTER ARG
   c. exitd
   d. enter #n
   e. $compute

20) Which of the following registers is not a special function register (SFR) in our MCU
   a. Watchdog timer control register
   b. Flash control register
   c. A-D conversion IRR
   d. Static base register
   e. None of these choices

21) Which one of the following ASCII characters represents a space?
   a. x40
   b. x31
   c. x60
   d. x20
   e. x30

22) Which addressing mode can use negative displacement?
   a. Address register direct
   b. Address register relative
   c. Static base pointer relative
   d. Frame base/Stack pointer relative
   e. None of these choices.

23) What is the correct way to cast a float to an int?
   a. a = (int) b
   b. a = (float:int) b
   c. a = b (int)
   d. a = integer b
   e. a = (float) b

Consider the following function declaration in C code for problems 24 and 25:

```
long  FooBar(int var_one, long var_two, int var_three){
      return (var_one * var_two * var_three );
}
```

24) During compilation, where will each function argument be stored in memory for function calls?

a. R1 ß var_one
   R2 ß var_two
   R3 ß var_three

b. R1 ß var_one
   stack ß var_two
   stack ß var_three

c. R1 ß var_three
   stack ß var_two
   stack ß var_one

d. stack ß var_one
   stack ß var_two
   stack ß var_three

e. R1 ß var_one
   R2 ß var_two
   stack ß var_three

25) The return value will be passed back using which data location(s):

a. R1R0
b. R3R2R1R0
c. R0
d. stored address passed via stack
e. R2R0

Short Answer

26) (15 points) Write a segment of assembly code that will count down to zero. Assume the initial number is already in the stack offset from FB by -6. At the end of the count down the number should be stored in -6[FB].

27) (5 points) A cellular phone has a 1500 mAhr battery, and has an average phone current of 4mA. How many days will this phone stay powered-on if it consumes the entire capacity of the battery?

28) (5 points) Describe the relationship between the following items: dynamic link, symbol table, and activation record

29) (5 points) Explain the features of the M16C that make it difficult to write self-modifying code.

30) (5 points) Discuss the pros and cons for using a microcontroller over an ASIC.

31) (5 points) Why do we use C instead of Java or another programming language with embedded systems?

32) (10 points) Match the packaging description below with the labeled picture.

____ DIP (Dual In-Line Package)

____ DFP (Dual Flat Pack)

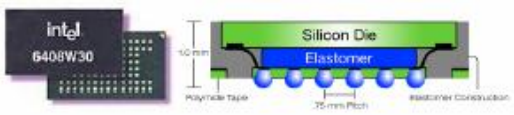
____ QFP (Quad Flat Pack)

____ BGA (Ball Grid Array)

A

B

C



D

Long Problem

33) (30 points) Consider the following code.

```
char array[10][10];
float coefficients[33];
int x[15]={3,1,4,1,5,9,2,6,5,3,5,8,9,7,9};
const char toggle_val = 79;

void f1(int arg1, int arg2) {
      int j, k, l, m;
      j = arg1 – 13;
      k = arg2 * toggle_val;
      if (j<k)
            f1(j,k);
      else
            array[j,k] = 1;
}
void main() {
      unsigned char a, b;
      long d, e, f;
      a = 0;
      b = 14;
      f1(x[a], x[b]);
      while (1);
}
```

a. How large is a stack frame (activation record) for function f1? Assume that although arg1 and arg2 are passed by register, they are also allocated stack space. Assume that registers R3, A0 and A1 are also saved on the stack. Show full detail/show your work.(15 points)

b. How large is a stack frame for function main? Assume it has no arguments, and that no registers are saved on the stack. Show full detail/show your work. (15 points)

34) (15 points algorithm, 50 points code, 5 points other) Consider an embedded system application with the following requirements:

Req 1: It will use the Renesas 30262 SKP board.
Req 2: A globally available unsigned integer variable is used for Req. 3, 4, and 5, and will start at 0.
Req 3: SW2, when pressed, will cause the variable to count up one for every press.
Req 4: SW3, when pressed, will cause the variable to count down one for every press.
Req 5: The three LEDs will represent the value of the variable modulo 8. The order of the LEDs is red-yellow-green (MSB to LSB).
Req 6: The switches must use interrupts.
Req 7: Follows the ECE 306 programming standards (i.e. comments).

a. Write the algorithm for the interrupt service routine.
b. Write the full program, including the main, ISR, data definitions, defines used, and comments, similar to Notes 8.
c. What other file will need to change to change and why? (be specific)