EE 308

Exam 2

March 22, 2000

Name: _____

You may use any of the Motorola data books, and the overheads posted on the Internet. No calculators allowed. Show all work. Partial credit will be given. No credit will be given if an answer appears with no supporting work.

1. The following questions concern writing C code.

   (a) Write some C code which will read the byte at address 0x0400, and assign it to a variable called `x1`. Be sure to define the variable `x1`.

   (b) Write some C code which writes a 0x00 to PORTA if the TOF flag of TFLG2 register is set, and writes a 0xff to PORTA if TOF is clear.

   (c) Write some C code which sets bits 1 and 3, and clears bits 0 and 5 of the TIOS register. It should leave the other bits of TIOS unchanged.

2. The following concern the timer subsystem of the HC12.

   (a) How do you enable the HC12 timer? Write some C code to do this.

   (b) Explain the function of the TCNT register of the HC12.

   (c) A programmer uses the following C code to clear the Timer Channel 5 flag:

   ```
   TFLG1 = TFLG1 | 0x20;
   ```

   Is this a proper way to clear the flag? If not, why not?

   (d) Write some C code to clear the Real Time Interrupt Flag.

3. The following question concerns interrupts and resets. Assume the HC12 has the following in its memory:

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
1000	10	23	3B	7C	10	04	86	80	B7	10	25	3B	FC	10	18	F3
1010	12	50	FD	10	18	86	40	B7	10	23	3B	FC	10	12	DD	02
1020	86	02	B7	10	23	3B	7C	10	03	86	40	B7	10	25	3B	86
FFC0	CC	05	9F	CD	99	03	84	9C	01	9B	CC	90	66	FC	93	30
FFD0	7E	E3	4B	7E	E5	38	21	54	05	83	09	34	2A	38	3C	03
FFE0	41	38	66	F2	7C	13	37	0C	25	F2	0C	38	5F	1B	42	1A
FFF0	7A	26	21	13	6A	AA	20	1F	4B	38	33	38	45	38	10	20

(a) Explain what happens to the Program Counter when the HC12 is powered up or reset. What will be the value to the HC12's Program Counter after a reset?

(b) List at least 5 things which you need to do in a program to successfully use interrupts.

(c) Write some C code to set up the HC12 to generate an RTI interrupt about once every 4 ms.

(d) Write an RTI interrupt service routine which increments PORTA every time the RTI interrupt occurs.

(e) The HC12 registers have the following values when an enabled RTI interrupt occurs:

Reg	–		–	
CCR	S X H I N Z V C 1 1 0 0 1 0 0 1			
A:B	A3		92	
X	AABB			
Y	1234			
SP	08A3			
PC	0956			

    i. What will be the value of the HC12 stack pointer when the HC12 begins executing the first instruction of the RTI interrupt service routine?

    ii. Explain what happens to the HC12 stack when the HC12 gets the RTI interrupt. Show how the stack will be changed when the interrupt occurs – that is, show what bytes will be put into the stack area of memory, and what locations are.

    iii. What is the address of the instruction the HC12 will execute (i.e., the first instruction of the interrupt service routine) when it gets the RTI interrupt?

    iv. What happens to the condition code register when the HC12 gets an RTI interrupt? Why did the Motorola engineers have the HC12 do this?

4. The starship Enterprise is on a mission monitoring a Klingon warship. Under normal conditions the warship emits bursts of radiation at random times, but at least once every 50 ms. If the time between bursts ever exceeds 50 ms, it means that the Klingons are preparing to attack. Mr. Spock decides to use the features of an HC12 to determine if the time between bursts ever exceeds 50 ms. Mr. Spock builds a circuit so that a burst of radiation from the Klingon warship produces a rising edge on Pin 0 of Port T. The HC12 should be programmed so that if the time between bursts ever exeeds 50 ms the HC12 will bring Pin 5 of Port T high, which will energize the Enterprise's shields. Mr. Spock asks you to write the HC12 program to do this.

   (a) What value would you write to the prescaler to be able to measure time differences of at least 50 ms? Write some C code to do this. Be sure your code changes only the bits which affect the prescalar, and leave all other bits unchanged.

   (b) For this value of the prescaler, how many timer ticks will 50 ms take?

   (c) How do you set up the HC12 to capture the time and generate an interrupt when the radiation burst produces a rising edge on Pin 0 of Port T? Write some C code to do this.

   (d) When the rising edge occurs, where is the value of the time of the rising edge stored?

   (e) Using the above value, what will be the value of TCNT 50 ms later?

   (f) How do you set up the HC12 to bring Bit 5 of Port T high when TCNT equals this specific value? Write some C code to do this.

   (g) Write an interrupt service routine so that a rising edge on Bit 0 of Port T will tell the HC12 to bring Bit 5 of Port T high 50 ms after the rising edge. Thus, as long as rising edges occur with a spacing of less than 50 ms, Bit 5 will never go high, and the shields will not be energized.

5. The phaser control system on the Enterpise has burned out. Mr. Scott asks you to design a new control system using the HC12. The phaser needs a PWM signal with a 10 kHz frequency. The stun setting requires a 10% duty cycle. The vaporize setting requires an 80% duty cycle.

   (a) Set up the HC12 to produce a 10 kHz PWM signal with a 10% duty cycle on Bit 0 of Port P.

   (b) Set up the HC12 to produce a 10 kHz PWM signal with an 80% duty cycle on Bit 1 of Port P.

   (c) To which pin of the HC12 should you connect the phasers to stun the Klingons? (The answer should be a pin number for the 68HC912B32 chip, a number between 1 and 80.)

   (d) To which pin of the HC12 should you connect the phasers to vaporize the Klingons?