CSE 421 Final Examination
Spring 2003-2004

1 Memory Layout*(16 points)*

A certain 6800 system has been configured with three memory chips as shown in the table below. Each chip is selected when the address line levels are as shown. Assuming these are all the memory the system has (the CPU does not have any internal memory), answer the questions below:

Memory Chip & Type	Size	A15	A14	A13	A12
RAM 1	8K	0	0	1	X
EPROM 1	8K	1	1	1	X
EPROM 2	8K	1	0	X	X

a. Give the memory range RAM1 responds to:

b. Give the memory range EPROM1 responds to:

c. Give the memory range EPROM2 responds to:

d. Which chip contains the interrupt vector addresses?

e. Which chip or chips have mirror images in memory?

f. Is this layout a good design? If not, what is the problem?

2 Interesting Code...* *(16 points)*

Below is the listing of a subroutine written for a 6800 system, and stored in RAM starting at memory location `$2000`. Location `$200A` is known to initially contain zero.

```
ADDR  OPCODE  LABEL  MNEMONIC

2000  8D 00          BSR NEXT
2002  30      NEXT   TSX
2003  EE 00          LDX $00,X
2005  31             INS
2006  31             INS
2007  6C 08          INC $08,X
2009  39             RTS
200A  00             ???
```

a. What does this subroutine do? Give a full explanation of its operation.

b. After this subroutine is called 5 times, what does location `$200A` contain?

c. Write a shorter subroutine that has the same effect as this one, but consists of only two instructions. (Including the `RTS` at the end!)

d. Why would one write a subroutine as given, rather than the "short" way?

3 Using a Software Interrupt SWI*(16 points)*

A system has its SWI interrupt vector pointing to location `$2000`. The interrupt service routine is shown below.

```
$ADDR LABEL  MNEMONIC
2000         TSX
2001         ADDA $04,X
2003         STAA $04,X
2005         LDAA $03,X
2006         ADCA #$00
2007         STAA $03,X
2009         RTI
```

a. What does this code accomplish when a `SWI` instruction is executed?

Assume that before the `SWI` instruction is executed, accumulator A contains `$20`, accumulator B contains `$30`, and the index register X contains `$80F0`. Answer the following:

b. What is the value of accumulator A after the interrupt service routine returns?

c. What is the value of accumulator B after the interrupt service routine returns?

d. What is the value of the index register after the interrupt service routine returns?

4 Interrupt FAQ! *(16 points)*

a. Once the below two lines are executed, what kind of interrupts can make the system continue running?

```
SEI
WAI
```

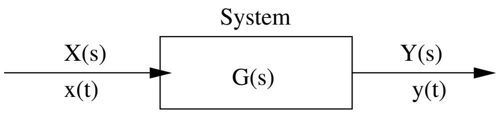
b. Given you have a total stack space of 256 bytes (which is typical) and assuming the stack is used for nothing else, how many levels of *nested* interrupts can the system handle?

c. Given the NMI interrupt is non-maskable (as the name says!), how come an interrupt does not get interrupted again, and again, and again... *even if* the NMI line is kept low?

d. A RESET signal also interrupts the CPU. How is it different from the other kinds of interrupts?

5 An LTI System *(16 points)*

ATTENTION: This question is continued on next page!



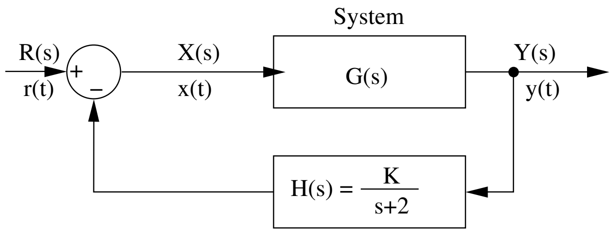
A physical system is shown above, where the input is $x(t)$, and the output is $y(t)$. The system's behavior is goverened by the following differential equation:

$$\frac{d^2y(t)}{dt^2} + 4y(t) = x(t)$$

a. Find the transfer function of the system, $G(s)$.

b. Write down the characteristic equation and find its roots. Is this system stable, marginally stable, or unstable?

6 A Feedback System *(16 points)*



Now, a feedback loop is added to the system in the previous question, as shown in the figure above. The feedback transfer function is $H(s) = K/(s+2)$, where K is a constant. (*If you were unable to solve the previous question to find $G(s)$, use $G(s) = 1/(9s^2+1)$*. If you did solve it, use your own value.)

a. Calculate the transfer function of the overall system, that is, $Y(s)/R(s)$. Simplify it and express it as a ratio of polynomials in s.

b. Determine the range of values K can take so that the overall system is **stable**.