CPE355 - Real time embedded kernels - Spring'11

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Midterm #1

Date: 11am, Thursday, March 1st 2012

Question #1 - Pointers (30 points)

For the following declarations and statements,

```
// declarations
int i,j,k[10]={2,4,6,8,10,12,14,16,18,20};
int *ip;
char a,b,c[10]={11,12,13,14,15,16,17,18,19,20};
char *cp;
void *vp;

struct stst
{
    int i;
    char *p;
} x;

// assignment statements
ip  = &k[4];
vp  = ip;
cp  = &c[0];
x.p = cp+3;
x.i = 27;
```

a) Evaluate the following expressions (if the expression is an error, indicate that with "X"):

- `*(ip+2) + c[3] ;` _____
- `(*cp +1) ;` _____
- `*(ip) + 6 ;` _____
- `vp = &x ; ((st*)vp)->p ;` _____
- `*(ip-2) ;` _____

b) Using a pointer `struct stst *z;` how would you update the member **i** of the structure **x**?

Question #2 - Logical operators (20 points)

Evaluate the following C expressions:

```
#define A 0x33
#define B 0x20
#define C 0xB7

unsigned char a,b,c,d,e;

a = (A|B) & C;
b = ~(A & B);
c = A^C;
d = B<<3;
e = C | B | ~A;
```

Give answers in binary:

- a _____
- b _____
- c _____
- d _____
- e _____

Question #3 - Typical interview questions (30 points)

Write very brief answers to the following questions:

- What is does it mean for a signal to have 30% duty cycle?

- What is a universal gate? Give one example of a universal gate?

- What is the difference between a latch and a flip-flop?

- What is an watchdog timer and how does it work?

- In Arduino, give an example of a non-maskable interrupt.

- What is the difference between an interrupt request (IRQ) and interrupt service routine (ISR)?

- Assuming we are working with 8 bit quantities, convert -15_{10} into base-2 using 2's complement.

- Convert 25_{10} into base-16.

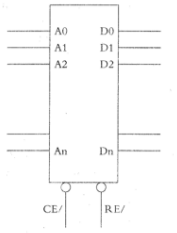
- What is a decoupling capacitor? When shall we use it?

- How does the microprocessor know where to find the ISR?

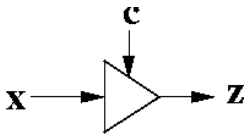
- What is an atomic section of the code?

• When shall you use polling instead of an interrupt?

• Draw the timing diagram that reads data from the following ROM cell.



• Write the truth table for the following component. What is this component called?



• When interrupts are enabled what is the problem with this code?

```
static int iTemperatures[2];

void interrupt vReadTemperatures  (void)
{
  iTemperatures[0] = !! read data from hardware
  iTemperatures[1] = !! read data from hardware
}

void main (void) {
  int iTemp0, iTemp1;
  while (TRUE) {
      iTemp0 = iTemperatures[0];
      iTemp1 = iTemperatures[1];
      if (iTemp0 != iTemp1){ !! Set off howling alarm }
  }
}
```

Question #4 - Interrupt latency (10 points)

- We have a system with 2 interrupts (intHIGH and intLOW) and 2 different task codes (taskA and taskB).
- When taskA or taskB are running, interrupts are disabled.
- The interrupt intHIGH has the highest priority.
- It takes taskA 125µsec to run, while taskB takes 250µsec.
- The interrupt intHIGH takes 300µsec to run, while intLOW requires 150µsec.
- When intHIGH is triggered, it needs finish executing its associated routine within 650µsec.

a) Assuming that interrupt nesting is allowed, is it possible to implement this system?

b) Assuming that interrupt nesting is not allowed, is it possible to implement this system?

Question #5 - Software architectures (10 points)

Complete the following table:

	Priorities available	**Worst time response for task code**	**Stability of response when code changes**	**Simplicity**
Round-robin	None.	Sum of all task code.	Poor.	Very simple.
Round-robin with interrupts				
Function queue-scheduling				
Real time operating system				