MIDTERM QUIZ 1
CMPT 300
D100

NAME (PRINT) _____

STUDENT NUMBER _____

Computing Science 300

Quiz 1 (100 points)
Summer 2016

1. Consider a computer system that includes a single 800 GB internal hard disk, 1 GB of RAM and 1 DMA. The DMA is used to transfer data and instructions between RAM and internal disk. It can transfer up to 100Mb at a rate of 10Mb/ms. The DMA setup takes 0.5 ms. Time taken by context switches and ISRs can be ignored. State any assumptions you make.
    a) [5 points] Explain briefly what happens during the DMA setup.
    b) [5 points] How long would it take to transfer a 500Mb block of data?
    c) [10 points] Give a step by step description of what happens when a 10Mb block of data is transferred from the hard disk to the RAM using the DMA. Assume that the CPU busy waits while IO is being performed. (6-10 steps)

2. The C code snippet shown below is a small chunk of the code extracted from a larger application. This code snippet shows additional processes being created. The process that includes the C code snippet creates a child and a grandchild. Answer each of the questions below. **Explain each of your answers**

```
1     parentPID = getpid();
2     pid = fork();
3     if ( pid == 0 )
4     {
5           printf("I am dog %d\n ", getpid());
6           if( (pid = fork() )  == 0 )
7           {
8                 printf("I am dragon %d \n", getpid());
9                 sleep(15);  /* wait for 15 seconds */
10                exit(1);
11          }
12          else if( pid > 0 )
13          {
14                printf("who am I?\n" );
15                waitpid( pid, &status, 0); /* blocking call */
16                exit(1);
17          }
18          else
19          {
20                printf("error\n");
21          }
22    }
23    else
24    {
25          printf("Am I dog or am I dragon?\n");
26    }
```

BE SURE TO BREIFLY EXPLAIN YOUR ANSWERS.
YES, NO, OR A NUMBER WILL RECEIVE LESS THAN HALF MARKS.
Brief, clear, concise answers are preferred (Maximum of 1 short sentence per point/mark)

a) **[6 points]** Are both the child and the grandchild created within the code snippet? Which line of code, if any creates the child process? Which line of code, if any creates the grandchild process?

b) **[6 points]** Which lines in the provided code are executed only by the grandchild process? Which lines of the provided code are executed only by the parent process? Is the process that prints "I am a dog" the parent process, the child process or the grandchild process?

c) **[6 points]** The code snippet above calls fork( ) to create a new process. When does fork( ) return zero? When fork returns a positive integer? What does that integer represent? When does fork() return a negative integer? What does that integer represent?

d) **[10 points]** Consider a process created by fork(). When the process is created the memory image and the process control block of the process are both copied. Draw a diagram of the image of a C program in memory. Label each portion of the image and briefly explain what is contained in each portion of the image. For example the code is contained in the text portion of the image.

e) **[6 points]** What is the purpose of the functions in lines 15, 16 and 1? Explain briefly what the function does and why it is needed.

f) **[6 points]** A process sets a local variable to have a value 3. The process then creates a new process using fork( ), Does the global variable in the child process have the value 3 immediately after returning from the call to fork()? Briefly explain why. Will the global variable always have the same value in the parent process and the child process? Briefly explain why.

3. Consider a system that uses a 32-bit word. This system uses a 64 Mbyte cache memory on the CPU that has a 128 byte cache slot size. The system has of the 4096 Mbyte of RAM memory. For this problem assume 1 byte = 8 bits and 1Mbyte=2^{20} bytes and 1Kbyte = 2^{10} bytes. When a cache line is placed in the cache, the following rules are used.

    i. There are M cache lines in this system. The first cache line in the cache is cache line 0, the next is cache line 1, and so on. The last cache line is cache line M-1. All cache lines are the same size.)
    ii. There are N cache slots in this system. The first cache slot is cache slot 0, the next is cache slot 1, and so on. The last cache slot is cache slot N-1. All cache slots are the same size.
    iii. Consider that the cache is divided into P groups of 8 consecutive cache slots. (N=P*8)
    iv. Cache line K can be placed into any of the 8 cache slots in group Z=K%P
    v. If all cache slots in group Z are empty cache line K in group Z is placed in the first slot of group Z
    vi. If some cache slots in group Z are empty cache line K in group Z is placed in the empty slot of group Z with the lowest slot number.
    vii. If all cache slots in group Z are full the cache line will be placed in slot Q. Slot Q (in group Z) was last accessed before all other slots in group Z were last accessed.

a) **[8 points]** What is a cache line? How many cache lines would there be in this computer system? Where would the cache lines be located? How many cache slots would there be in this computer system?

b) **[6 points]** What is the purpose of a mapping function? For the system described above what would the mapping function be?

c) [6 points] What is the purpose of a replacement policy? For the system described above what would the replacement policy be?

d) [8 points] Which cache slots could hold cache line 1234.

e) [5 points] Assume that each word in the RAM memory has an address. How many addresses are needed to refer to all words in the RAM memory?

f) [7 points] Draw a diagram that shows how L1 and L2 cache might be configured in a multicore CPU with four cores (based on examples in our class notes or text). What does the acronym NUMA stand for? How does it relate to cache in multicore CPUs?