

CSCI-UA.0201
Computer System Organization
Homework Assignment 3

1. [5 points] Consider a computer system that has a cache with 4096 blocks. Each block can store 16 bytes. What will be the value stored in the TAG field of the cache block that holds the memory block containing the address 0xABCDEF (This hexadecimal number gives you a hint on the address length):

(i) if it is a direct-mapped cache

(ii) if it is a 16-way set-associative cache

(iii) if it is fully associative

2. Consider a small 2-way set associative cache with a total of 32 blocks and a block size of 256 bytes. The cache uses LRU replacement policy. Assume that the cache is initially empty. The CPU accesses the following memory locations, in that order: 0x55c88, 0x55774, 0x5479c, 0x54c00, 0x55784, 0x56c80, 0x56718, 0x54738.

(a) [3 points] How the address is split to do cache lookup?

(b) [8 points] For each memory reference, indicate whether it will result in hit or miss and, if miss, indicate the type of miss (compulsory, capacity, or conflict)

(c) [1 point] From your solution in part (b) above, what is the hit rate of the cache?

(d) [3 points] Assume the memory access latency is 10 cycles and the cache, mentioned in this problem, has an access latency of 3 cycles. Also assume the hit rate you calculated in part (c) above. Did this system benefit from having a cache? Justify

3. Almost all programs need external libraries.

(a) [1 point] In how many places can needed libraries be added to your code?

(b) [3 points] What are these places?

(c) [6 points] For each one of those places, state one advantage and one disadvantage.

```
4.  int array1[M][N];
    int array2[N][M];

    int copy(int i, int j)
    {
        array1[i][j] = array2[j][i];
    }
```

Suppose the above code generates the following assembly code (assume array2 and array1 are the base addresses of the corresponding arrays):

```
copy:
    movl %rdi, %ecx
    movl %rsi, %ebx
    leal (%ecx,%ecx,8), %edx
    sall $2, %edx
    movl %ebx, %eax
    sall $4, %eax
    subl %ebx, %eax
    sall $2, %eax
    movl array2(%eax,%ecx,4), %eax
    movl %eax, array1(%edx,%ebx,4)
    ret
```

What are the values of M and N (4 points)?
Show how did you reach your answer (6 points)

5. [4 points] Consider the two C functions fun1 and fun2. Which of these two functions compiled into the assembly code shown?

```
int fun1(int a, int b)
{
    if (a < b)
        return a;
    else
        return b;
}
```

```
movl %rdi, %edx
movl %rsi, %eax
cmpl %eax, %edx
jge .L9
movl %edx, %eax
.L9:
```

```
int fun2(int a, int b)
{
    if (b < a )
        return b;
    else
        return a;
}
```

6. [6 points] Fill the blanks of the following table:

Hexadecimal	binary	Decimal (assuming unsigned)	Decimal (assuming signed)
0x8A			
0x21			