King Fahd University of Petroleum and Minerals
Department of Computer Engineering

COMPUTER ARCHITECTURE COE 308

EXAM 1

Student Name:_____

Student ID:_____

Problems	Grading
1	
2	
3	
TOTAL/15	

QUESTION 1: TRENDS IN COMPUTER ARCHITECTURE (4 points)

The clock rate of some processor is increasing at a rate of 45% per year and at the same time the access time of the main memory is decreasing at a rate of 8% per year. Assume the ratio of access time over the processor clock time (AT/CT) is 50 this year. What will be the value of AT/CT after 5 years.

Solution:

The clock rate will be CR(+5 years)= CR(now) * (1.45)^5=CR*6.41 and the access time is AT(+5 years)= AT(now) * (1-0.08)^5=AT(now)*0.66. Since
AT (+5)/CT(+5)= (AT(now) * (1-0.08)^5)* (CR(now) * (1.45)^5)=
AT(now) * CR(now) * 0.66 *6.41 = AT(now) * CR(now) * 4.2306 = 50* 4.2306 = 211.22. Therefore, the ratio (AT/CT) = 211.22 after five years.

QUESTION 2: MIPS ASSEMBLY LANGUAGE CONSTRUCT (3 points)

1. The base address of array a[] is 2010 which is defined as a[i] for i in [0,22]. Evaluate the value of the pointer which is addressing a[22].

2. What will be the 32-bit data that results from (1) shift right logical by 8 bits, and (2) shift right arithmetic by 8 bits of the following operand:
   1111 0110 0000 1100 0101 0101 0111 0000

3. Consider the following program:

```
Lb: beq   $1,$0,ahead
      add   $3,$3,$4
      sll    $2,$2,$3
      addi  $4,$2,26
      j     Lb
ahead:
```

What will be: (1) the value of the immediate that will appear in the machine code of instruction "beq", and (2) the value of PC corresponding to label "ahead" if PC=100 at "Lb"

Solution:

1. The value of the pointer which in addressing a[22] must be 2010+ 22*4= 2098. The multiplication by 4 is needed because every word (default data type) occupies 4 bytes.

2. Shifting right logical by 8 bits, gives 0000 0000 1111 0110 0000 1100 0101 0101.
   Shifting right arithmetic by 8 bits gives: 1111 1111 1111 0110 0000 1100 0101 0101

3. The value of the immediate that will appear in the machine code of instruction "beq" is 4. The value of PC corresponding to label "ahead" if PC=100 at "Lb" is PC = (PC + 4) + 4 * 4 = PC+ 4 * 5 = 100 + 20 = 120.

QUESTION 3: MIPS ASSEMBLY LANGUAGE PROGRAMMING (8 points)

Write the **shortest possible program** in MIPS assembly language to compare two arrays a[i] and b[i] of words and exit at the first occurrence of a[i] <> b[i] (not equal) for i in [0, N].

- Initially the base address of a[] and b[] are stored in registers $t0 and $t1, respectively.
- Registers $t0 and $t1 can be used as memory pointers for the above arrays.
- Initially register $s1 contains the value N and can be used for the current value of N

When the program exits the first value of i for which a[i] <> b[i] is to be stored in register $s2.

Solution:

```
        Add   $s2,  $zero,$s1    ;  save value of N in $s2s
Loop:   Lw    $t2, 0($t0)        ; load array element a[i]
        Lw    $t3, 0($t1)        ; load array element b[i]
        Sub   $s1, $s1, 1        ; decrement N
        Add   $t0, $t0, 4        ; increment array pointer by 4
        Add   $t1, $t1, 4        ; increment array pointer by 4
        Bneq  $t2, $t3, exit     ; exit if a[i] = b[i] occurs
        Bneq  $s1, $zero, loop ;  Loop if there is still some iterations to do
        Addi  $s2, $s2, 1        ; Program visited all iterations, prepare return N+1
Exit:   Sub   $s2, $s2, $s1      ; Save pointer $t0 in $s0 as required above
```

The value of $s0 indicate the order of first value of 8 in array a[] or 8 is not found