Comp. Org. CS 1410 Name:_____

Below is the description of the hardware features of a desktop PC:

- Intel® 2nd Generation Core™ i3 (3.4GHz, L2 Cache Memory 3MB)
- System Memory: (RAM) 8GB DDR3 SDRAM
- Hard Drive: 1.5TB SATA (7200 rpm)
- Intel® HD Graphics 2000 (Video Memory Up to 4GB shared)
- Network Card: Built-in 10/100/1000Base-T Ethernet LAN
- Wireless Networking: Built-in 802.11b/g/n wireless LAN
- Recordable DVD Drive: 8x DVD+R DL; 8x DVD-R DL; 16x8x16 DVD+RW; 16x6x16 DVD-RW; 5x DVD-RAM; 40x24x40 CD-RW
- Digital Media Card Reader
- Available Expansion Bays: External: 1 (3.5"), 1 (5.25"); Internal: 1 (3.5")
- Available Expansion Slots: 1 PCI Express x1, 1 PCI Express x16
- USB 2.0 Ports: 2 USB 3.0 (front); 4 USB 2.0 (rear)
- Wireless Keyboard with volume control
- Wireless optical mouse
- 20" widescreen flat panel monitor
- Operating System Windows 8

1) What does the processor do?

2) What is stored in main memory (RAM)?

3) What is stored on the hard disk?

4) What is the purpose of cache memory?

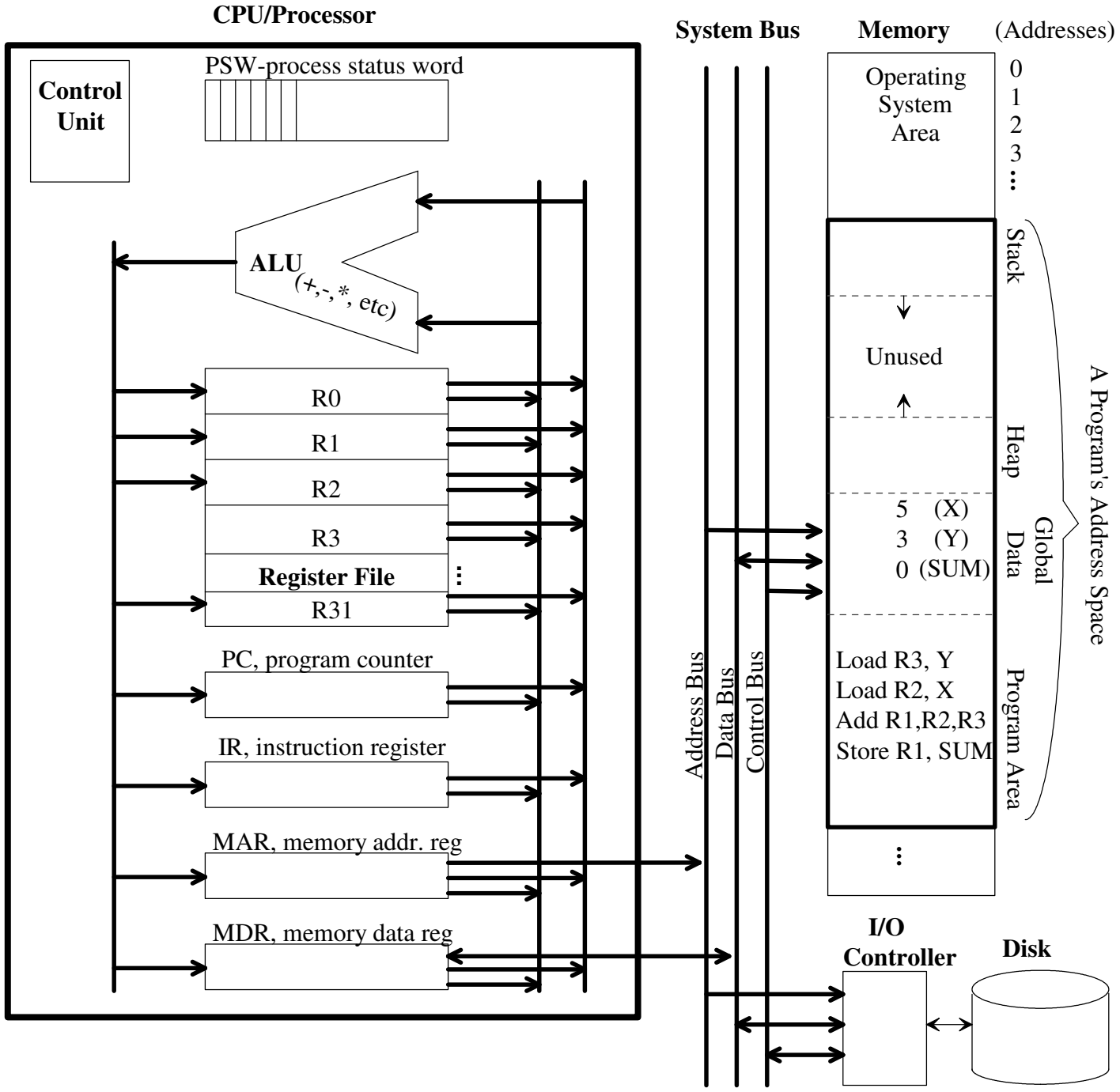
5) What terms relate to interconnection of internal PC components?

6) What terms relate to interconnection of external PC components?

7) What is a KB, MB, GB, Gigabit, MHz, GHz?

8) What is the role of the operating system?

High-level lang. (HLL)	**Assembly Lang. (AL)**	**Machine Lang. (ML) (three-addr. RISC format)**
`SUM = X + Y`		



***Processing* (*/Instruction/Machine*) *Cycle* of stored-program computer - repeat all day**

1. Fetch Instruction - read instruction pointed at by the program counter (PC) from memory into Instruction Reg. (IR)
2. Decode Instruction - figure out what kind of instruction was read
3. Fetch Operands - get operand values from the memory or registers
4. Execute Instruction - do some operation with the operands to get some result
5. Write Result - put the result into a register or in a memory location

(Note: Sometime during the above steps, the PC is updated to point to the next instruction.)

9) What is the role of a compiler?

10) What advantages do high-level languages (Ada, C, C++, Java, Python, etc.) have over assembly language?

11) Why do people program in assembly language (AL)?

Type of Instruction	MIPS Assembly Language	Register Transfer Language Description
Memory Access (Load and Store)	lw $4, Mem	$4← [Mem]
	sw $4, Mem	Mem←$4
	lw $4, 16($3)	$4← [Mem at address in $3 + 16]
	sw $4, Mem	[Mem at address in $3 + 16]← $4
Move	move $4, $2	$4← $2
	li $4, 100	$4← 100
Load Address	la $5, mem	$4← load address of mem
Arithmetic Instruction (reg. operands only)	add $4, $2, $3	$4← $2 + $3
	mul $10, $12, $8	$10← $12 * $8 (32-bit product)
	sub $4, $2, $3	$4← $2 - $3
Arithmetic with Immediates (last operand must be an integer)	addi $4, $2, 100	$4← $2 + 100
	mul $4, $2, 100	$4← $2 * 100 (32-bit product)
Conditional Branch	bgt $4, $2, LABEL (bge, blt, ble, beq, bne)	Branch to LABEL if $4 > $2
Unconditional Branch	j LABEL	Always Branch to LABEL

Fibonacci Sequence:	0	1	1	2	3	5	8	13	21
Position in Sequence:	0	1	2	3	4	5	6	7	8

A high-level language program to calculate the n^{th} fibonacci number would be:

```
temp2 = 0
temp3 = 1

for i = 2 to n do
    temp4 = temp2 + temp3
    temp2 = temp3
    temp3 = temp4
end for

result = temp4
```

Trace of Program (time →)

HLL variables								MIPS registers
temp2	0	1	1	2	3	5	8	$2
temp3	1	1	2	3	5	8	13	$3
temp4	1	2	3	5	8	13	21	$4
i	2	3	4	5	6	7	8	$6

(n in $5)

A complete assembly language MIPS program to calculate the n^{th} fibonacci number.

```
                .data
n:              .word  8          # variable in memory
result:         .word  0          # variable in memory


                .text
                .globl main
main:       li    $2, 0           # $2 holds temp2
            li    $3, 1           # $3 holds temp3
for_init:   li    $6, 2           # initialize i ($6) to 2
            lw    $5, n           # load "n" into $5
for_loop:   bgt   $6, $5, end_for # if $6 >= $5, then branch to end_for label
            add   $4, $2, $3      # $4 holds temp4
            move  $2, $3          # shift temp3 to temp2
            move  $3, $4          # shift temp4 to temp3
            addi  $6, $6, 1       # increment i ($6)
            j     for_loop        # unconditionally jump to for_loop label
end_for:
            sw    $4, result      # store the result to memory
            li    $v0, 10         # system code for exit
            syscall               # call the operating system
```