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

- Intel® Pentium® 4 processor 2.6GHz with 400MHz frontside bus
- 512MB PC2100 DDR SDRAM for multitasking power, expandable to 4.0GB
- Cache Memory 512KB L2 cache
- DVD+RW/CD-RW drive; 48x maximum speed CD-ROM drive
- 120.0GB Ultra DMA hard drive
- ATI RADEON 9200 AGP 8X graphics card with 128MB DDR video memory
- 6 high-speed USB 2.0 ports and 2 IEEE 1394 (FireWire) ports
- Integrated 10/100Base-T network interface; V.92 high-speed data/fax modem
- USB optical mouse and HP Media Center keyboard
- Windows XP Media Center Edition 2004 operating system preinstalled

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, MHz, GHz?
8) What is the role of a compiler?

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

10) Why do people program in assembly language (AL)?
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 Instr. 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.)
<table>
<thead>
<tr>
<th>Type of Instruction</th>
<th>MIPS Assembly Language</th>
<th>Register Transfer Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory Access</td>
<td>lw $4, Mem</td>
<td>$4 ← [Mem]</td>
</tr>
<tr>
<td>(Load and Store)</td>
<td>sw $4, Mem</td>
<td>Mem ← $4</td>
</tr>
<tr>
<td></td>
<td>lw $4, 16($3)</td>
<td>$4 ← [Mem at address in $3 + 16]</td>
</tr>
<tr>
<td></td>
<td>sw $4, Mem</td>
<td>[Mem at address in $3 + 16] ← $4</td>
</tr>
<tr>
<td>Move</td>
<td>move $4, $2</td>
<td>$4 ← $2</td>
</tr>
<tr>
<td></td>
<td>li $4, 100</td>
<td>$4 ← 100</td>
</tr>
<tr>
<td>Load Address</td>
<td>la $5, mem</td>
<td>$4 ← load address of mem</td>
</tr>
<tr>
<td>Arithmetic Instruction</td>
<td>add $4, $2, $3</td>
<td>$4 ← $2 + $3</td>
</tr>
<tr>
<td>(reg. operands only)</td>
<td>mul $10, $12, $8</td>
<td>$10 ← $12 * $8 (32-bit product)</td>
</tr>
<tr>
<td></td>
<td>sub $4, $2, $3</td>
<td>$4 ← $2 - $3</td>
</tr>
<tr>
<td>Arithmetic with Immediates</td>
<td>addi $4, $2, 100</td>
<td>$4 ← $2 + 100</td>
</tr>
<tr>
<td>(last operand must be an integer)</td>
<td>mul $4, $2, 100</td>
<td>$4 ← $2 * 100 (32-bit product)</td>
</tr>
<tr>
<td>Conditional Branch</td>
<td>bgt $4, $2, LABEL</td>
<td>Branch to LABEL if $4 &gt; $2</td>
</tr>
<tr>
<td></td>
<td>(bge, blt, ble, beq, bne)</td>
<td></td>
</tr>
<tr>
<td>Unconditional Branch</td>
<td>j LABEL</td>
<td>Always Branch to LABEL</td>
</tr>
</tbody>
</table>

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:

\[
\begin{align*}
\text{temp2} &= 0 \\
\text{temp3} &= 1 \\
\text{for } i = 2 \text{ to } n \text{ do} \\
\quad &\text{temp4} = \text{temp2} + \text{temp3} \\
\quad &\text{temp2} = \text{temp3} \\
\quad &\text{temp3} = \text{temp4} \\
\quad &\text{end for} \\
\text{result} &= \text{temp4}
\end{align*}
\]

<table>
<thead>
<tr>
<th>HLL variables</th>
<th>Trace of Program (time →)</th>
<th>MIPS registers</th>
</tr>
</thead>
<tbody>
<tr>
<td>temp2</td>
<td>0 → 1 → 1 → 2 → 3 → 5 → 8</td>
<td>$2 →$2</td>
</tr>
<tr>
<td>temp3</td>
<td>1 → 1 → 2 → 3 → 5 → 8 → 13</td>
<td>$3 →$3</td>
</tr>
<tr>
<td>temp4</td>
<td>1 → 2 → 3 → 5 → 8 → 13 → 21</td>
<td>$4 →$4</td>
</tr>
<tr>
<td>i</td>
<td>2 → 3 → 4 → 5 → 6 → 7 → 8</td>
<td>$1 →$1</td>
</tr>
</tbody>
</table>

A complete assembly language MIPS program to calculate the \( n \)th fibonacci number.

```assembly
.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
         add $4, $2, $3  # $4 holds temp4
         move $2, $3
         move $3, $4
         addi $6, $6, 1
         j for_loop
end_for:
         sw $4, result
         li $v0, 10  # system code for exit
         syscall  # call the operating system
```