

1) Consider the stack of [30, 50, 120, 100, 200], where the leftmost element is the bottom of the stack, i.e., 30 and the rightmost element is the top of the stack, i.e., 200. After the following operations, POP, IADD, ISUB, and DUP were executed on this stack, what is the updated stack?

POP : [30, 50, 120, 100] -> 200

updated stack: [30, 50, 120, 100]

IADD :

1. [30, 50, 120] -> 100
2. [30, 50] -> 120
3. [30, 50, 220] <- 120 + 100

updated stack: [30, 50, 220]

ISUB :

1. [30, 50] -> 220
2. [30] -> 50
3. [30, -170] <- 50 - 220

updated stack: [30, -170]

DUP :

[30, -170, -170]

updated stack: [30, -170, -170]

2) Explain each of following terms in your own words:

- Microinstruction - an array of control signals
- Microprogram - a set of microinstructions
- IADD
- ISUB

3) What are the four steps CPUs use to execute instructions?

Here are the four steps:

- (1) Read an instruction and decode it.
- (2) Find any associated data needed to process the instruction.
- (3) Process the instruction.
- (4) Write out the results

4) Consider the following IJVM code ( $i = (j - n - 7) + (j - n - 7)$ ):

- a) Determine the number of instructions **8**
- b) Obtain the total number of cycles **38**
- c) Calculate the average CPI  **$38/8 = 4.75$**
- d) How long does a 2.5-GHz Mic-1 take to execute the code  
 **$38 * (1/2.5 \times 10^9) = 15.2 \text{ nsec}$**

ILOAD j 5 + 1 = 6  
ILOAD n 5 + 1 = 6  
ISUB 3 + 1 = 4  
BIPUSH 7 3 + 1 = 4  
ISUB 3 + 1 = 4  
DUP 2 + 1 = 3  
IADD 3 + 1 = 4  
ISTORE I 6 + 1 = 7

5) Obtain the UTF-8 representations for the following characters:

Character	Decimal	UTF-8 (in hex)
𐀀	20014	E4 B8 AE
𐀁	10014	E2 9C 9E
𐀂	1015	CF B7

6) Suppose that a 10-MB file is stored on a disk on the same track (track 50) in consecutive sectors. The disk arm is currently situated over track number 100. How long will it take to retrieve this file from the disk? Assume that it takes about 1 ms to move the arm from one cylinder to the next and about 5 ms for the sector where the beginning of the file is stored to rotate under the head. Also, assume that reading occurs at a rate of 200 MB/s.

**$1 * 50 \text{ ms (Time to move the arm over track 50)} + 5 \text{ ms (Time for the first sector to rotate under the head)} + 10/200 * 1000 \text{ ms (Read 10 MB)}$**

Hex	Mnemonic	Meaning
0x10	BIPUSH <i>byte</i>	Push byte onto stack
0x59	DUP	Copy top word on stack and push onto stack
0xA7	GOTO <i>offset</i>	Unconditional branch
0x60	IADD	Pop two words from stack; push their sum
0x7E	IAND	Pop two words from stack; push Boolean AND
0x99	IFEQ <i>offset</i>	Pop word from stack and branch if it is zero
0x9B	IFLT <i>offset</i>	Pop word from stack and branch if it is less than zero
0x9F	IF_ICMPEQ <i>offset</i>	Pop two words from stack; branch if equal
0x84	IINC <i>varnum const</i>	Add a constant to a local variable
0x15	ILOAD <i>varnum</i>	Push local variable onto stack
0xB6	INVOKEVIRTUAL <i>disp</i>	Invoke a method
0x80	IOR	Pop two words from stack; push Boolean OR
0xAC	IRETURN	Return from method with integer value
0x36	ISTORE <i>varnum</i>	Pop word from stack and store in local variable
0x64	ISUB	Pop two words from stack; push their difference
0x13	LDC_W <i>index</i>	Push constant from constant pool onto stack
0x00	NOP	Do nothing
0x57	POP	Delete word on top of stack
0x5F	SWAP	Swap the two top words on the stack
0xC4	WIDE	Prefix instruction; next instruction has a 16-bit index

Bits	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
7	0ddddddd					
11	110dddddd	10ddddddd				
16	1110dddddd	10ddddddd	10ddddddd			
21	11110dddd	10ddddddd	10ddddddd	10ddddddd		
26	111110ddd	10ddddddd	10ddddddd	10ddddddd	10ddddddd	
31	1111110xx	10ddddddd	10ddddddd	10ddddddd	10ddddddd	10ddddddd

The UTF-8 encoding scheme.