**Workshop 1 - SAM Instruction Set Architecture**

Discuss and answer the following questions about the SAM Instruction

Set Architecture (ISA).

**1. List all the elements in the SAM ISA machine state. This is the list**

**of programmer-visible storage elements in the SAM.**

PC, MAR, 16B RAM, ACC, OUT, IR, Output Display

**2. Write a SAM program to perform and output the calculation ((w+x)-y) where**

**w=123, x=-1, y=3. Give the assembly language for the program along with**

**a symbol table mapping and then give the machine code translation in both**

**hexadecimal and binary in the format shown in the text. Programs must start**

**at location 0 in the SAM. Data should be placed in high memory starting at**

**location 15 and working down, although this is not a requirement.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Assembly** | **language** | **Machine code translation** | | |
| **Label** | **Instr** | **Loc** | **Hex** | **Bin** |
|  | Lda x | 0 | 0D | 0000 1101 |
|  | Add y | 1 | 1E | 0001 1110 |
|  | Sub z | 2 | 2F | 0010 1111 |
|  | Out | 3 | E0 | 1110 0000 |
|  | Hlt | 4 | F0 | 1111 0000 |
|  |  |  |  |  |
| X: | Dat 4 | 13 | 04 | 0000 0100 |
| Y: | Dat 7 | 14 | 07 | 0000 0111 |
| Z: | Dat 2 | 15 | 02 | 0000 0010 |

|  |  |  |
| --- | --- | --- |
| Symbol Table | | |
| Label | Addr | |
| x | 13 | 0xD |
| Y | 14 | 0xE |
| z | 15 | 0xF |

**3. Give an exection trace for the assembly program in the previous problem.**

Current | Next machine state

## PC instr| PC ACC OUT hex memory contents 16 locations

-- -- -----| -- --- --- --------------------------------------------------

0 | 0 - - 0D 1E 2F E0 F0 -- -- -- -- -- -- -- -- 04 07 02

1 0 Lda | 1 04 - 0D 1E 2F E0 F0 -- -- -- -- -- -- -- -- 04 07 02

2 1 Add | 2 0B - 0D 1E 2F E0 F0 -- -- -- -- -- -- -- -- 04 07 02

3 2 Sub | 3 09 - 0D 1E 2F E0 F0 -- -- -- -- -- -- -- -- 04 07 02

4 3 Out | 4 09 09 0D 1E 2F E0 F0 -- -- -- -- -- -- -- -- 04 07 02

5 4 Hlt | 5 09 09 0D 1E 2F E0 F0 -- -- -- -- -- -- -- -- 04 07 02