Workshop on Microcontrollers
Wadhwani Electronics Laboratory
Electrical Engineering IIT Bombay

Problem set: 4 Date: June 8, 2023

I/O ports and Array indexing

1. Write a program which will read the binary value which is set on the port pins P1.0 to P1.3 . The program should display this value on the Port Pins P1.4 to P1.7 for 5 seconds. Two successive 4 bit values read like this should be combined to form a byte, which should be stored as an element of an array. The program should read in 10 bytes this way, storing them in an array in memory starting from 60H.

   After doing this, the program should read another 4 bit value from the port pins P1.0 to P1.3. If this value is greater than 09, the program should clear the pins P1.4 to P1.7 and stop. Otherwise, this value should be used as an index in the stored array. The corresponding byte value should be displayed on Pins P1.4 to P1.7 with higher nibble first followed by lower nibble with a delay of 2 seconds.

2. **Additional Program: MAC Unit**
   In a fully connected neural network, forward propagation involves the Multiply and Accumulate (MAC) operation. The neuron input is multiplied with the weight attributed to the path between that neuron and the neuron to the next layer. Then, all such products coming from different source neurons to the same destination neuron are added.

   Let us consider the neuron inputs to be a_1, a_2, a_3. Let the corresponding weights be b_1, b_2, b_3. The result after the MAC operation will be

   $$x = a_1b_1 + a_2b_2 + a_3b_3$$

   Write an assembly language program to generate the result x, when a_1, a_2, a_3 are three 8-bit neuron inputs present in the memory locations 70H to 72H and b_1, b_2, b_3 are 8-bit weights present in the memory locations 73H to 75H.

   Since the result x can be 18 bits long, store the result in memory locations 60H, 61H, 62H. For $x = x_{17}x_{16}x_{15}...x_3x_2x_1x_0$, the memory location 60H should have $000000x_{17}x_{16}$, the memory location 61H should have the bits $x_{15}x_{14}...x_8$, and the memory location 62H should have the bits $x_7x_6...x_0$.

   Use the following program as a starting point. Use the ADD16 subroutine done in problem set 1‘to implement the MAC operation.