

Embedded Systems

ELEC3020

Lab Assignment 2 – CPU Design

Points: 10

NO TEAMS: This lab is an individual assignment.

EQUIPMENT: PC/Mac with ReTrO simulation system
<https://roblab.org/retro/>

EXPERIMENT 1 (8 points)

Build a working CPU with a **ROM** for program code (11-bit wide; 3-bit opcodes and 8-bit operands) and a **RAM** for data (8-bit wide data with 8-bit addresses).

- Only use two registers: accumulator and program counter
- Increment the program counter only once per instruction cycle

Implement the following ALU/CU functions:

0 v	LOADC	load constant into accumulator	$acc \leftarrow v$
1 a	LOADM	load memory value into accumulator	$acc \leftarrow mem[a]$
2 v	ADDC	add constant to accumulator	$acc \leftarrow acc + v$
3 a	ADDM	add memory value to accumulator	$acc \leftarrow acc + mem[a]$
4 a	STORE	store accumulator to memory	$mem[a] \leftarrow acc$
5 *	CLEAR	set accumulator to zero	$acc \leftarrow 0$
6 a	JMP	jump always to address a	$pc \leftarrow a$
7 a	JZ	jump only if (acc==0) to address a	if (acc==0) then $pc \leftarrow a$

EXPERIMENT 2 (2 points)

Write a program to calculate $1 + 2 + 3 \dots + m$,
 for a given value m with $m \geq 1$.

$$result = \sum_{i=1}^m i$$

Data locations: value m in location \$A0
 result in location \$A1

Algorithm: clear result
loop: add mem[m] to result
 decrement mem[m]
 if ($m \neq 0$) **jump to loop**
done: **jump to done** /* finished: endless loop */

Example:

m in mem[A0]	result in mem[A1]
3	3
2	5
1	6
0	6