

# Digital & Embedded Systems

## ELEC4314

### Lab Assignment 2 – CPU Design

Points: 10

**EQUIPMENT:** PC/Mac with ReTrO simulation system

#### EXPERIMENT 1 (8 points)

Build a working CPU with 16-bit data bus (8-bit op-codes, and 8-bit operands / 8-bit addresses). Use a 16-bit wide RAM module. Implement the following ALU/CU functions:

0 v	<b>LOADC</b>	load constant into accum.	acc := v
1 a	<b>LOADM</b>	load memory value into accum.	acc := mem[a]
2 v	<b>ADDC</b>	add constant to accumulator	acc := acc + v
3 a	<b>ADDM</b>	add memory value to accumulator	acc := acc + mem[a]
4 a	<b>STORE</b>	store accumulator to memory (high byte 0)	mem[a] := acc
5 a	<b>BZ</b>	branch cond. if acc = 0 to address a	if acc=0 then pc := a
6 a	<b>BRA</b>	branch unconditionally to address a	pc := a
7 *	<b>NOP</b>	no operation	—

#### 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 ( $m \neq 0$ ) **branch to loop**  
**done:** **branch to done** /\* finished: endless loop \*/

**Example:**

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