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## PROGRAMMING ASSIGNMENT 2

Discussion on a high level with your colleagues is encouraged. Make sure the work submitted is your own. When in doubt, ask a TA or the instructor. If you are not sure what constitutes academic dishonesty, please refer to the AISC web site: <https://aisc.uci.edu/>.

You can fill out your answers below in text, paste screenshots, and/or include images (make sure the image is right side up & legible).

This homework covers:

- LC-3 Machine Language to Assembly – Part 1

## AISC

Please initial here to indicate you understand UCI's Academic Integrity Policy and confirm that this is your own work you are submitting (this counts for points): **CPZ**

## UPDATED CODE SCREENSHOT

```
power2.bin
1 ; Purpose: Figure out if a number (positive 2's complement integer) is a power of 2 => only one 1 bit.
2 ; Code starts @ x3000
3 ; Input: positive two's complement number stored in x3050 (doesn't handle 0 case properly)
4 ; Output: 1 @ x3051 = power of two; 0 @ x3051 = not a power of two
5 ;
6
7 0011 0000 0000 0000 ;starting address of x3000
8
9 0101 010 010 1 00000 ;AND, DR=R2, SR=R2, #0 // R2<-0
10 1010 000 000000111 ;LDI, DR=R0, offset=#7 // R0<-M[x3009] == R0<-M[x3050] == R0<-(#)
11 0000 010 000000100 ;BR, NZP=010, off=#4 // If R0 = 0, store right away (not a power of 2)
12 0001 001 000 1 11111 ;ADD, DR=R1, SR=R0, #31 // R1<-R0+#31
13 0101 000 000 0 00 001 ;AND, DR=R0, SR=R0, SR=R1 // R0<-R0 AND R1
14 0000 101 000000001 ;BR, NZP=101, off=#1 // If R0 not 0, skip next line (not power of 2)
15 0001 010 010 1 00001 ;ADD, DR=R2, SR=R2, #1 // R2<-R2+#1 == R2<-1 (is power of 2)
16 1011 010 000000010 ;STI, SR=R2, off=#2 // M[M[x300A]]<-R2 == M[x3051]<-R2
17 1111 0000 0010 0101 ;TRAP, x25 // HALT
18
19 ;hardcoded values
20 0011 0000 0101 0000 ;Address x3009: value x3050
21 0011 0000 0101 0001 ;Address x300A: value x3051
```

## SCREENSHOT OF POSITIVE NUMBER THAT IS A POWER OF 2

BE SURE TO SHOW VALUES @ X3050 & X3051 AS WELL AS REGISTERS JUST BEFORE HALT INSTRUCTION

First test 4, which is a power of 2

| Registers |                   | Memory    |             |
|-----------|-------------------|-----------|-------------|
| R0        | xEC12 60434       | ! ▶ x3050 | x0004 4     |
| R1        | x3C63 15459       | ! ▶ x3051 | xB32C 45868 |
| R2        | xBA92 47762       | ! ▶ x3052 | xB0BE 45246 |
| R3        | xBC57 48215       | ! ▶ x3053 | x89FC 35324 |
| R4        | x17CA 6090        | ! ▶ x3054 | x8B52 35666 |
| R5        | x03C1 961         | ! ▶ x3055 | xFEC5 65221 |
| R6        | x5626 22054       | ! ▶ x3056 | x0E2B 3627  |
| R7        | x2138 8504        | ! ▶ x3057 | x388C 14476 |
| PSR       | x8002 32770 CC: Z | ! ▶ x3058 | xE379 58233 |
| PC        | x3000 12288       | ! ▶ x3059 | xB312 45842 |
| MCR       | x0000 0           | ! ▶ x305A | x989F 39071 |

R2 = 1 as we wanted.

| Registers |                   | Memory    |                              |
|-----------|-------------------|-----------|------------------------------|
| R0        | x0000 0           | ! ▶ x3000 | x54A0 21664 0101010010100000 |
| R1        | x0003 3           | ! ▶ x3001 | xA007 40967 1010000000000111 |
| R2        | x0001 1           | ! ▶ x3002 | x0402 1026 0000010000000010  |
| R3        | xBC57 48215       | ! ▶ x3003 | x123F 4671 0001001000111111  |
| R4        | x17CA 6090        | ! ▶ x3004 | x5001 20481 0101000000000001 |
| R5        | x03C1 961         | ! ▶ x3005 | x0A01 2561 0000101000000001  |
| R6        | x5626 22054       | ! ▶ x3006 | x14A1 5281 0001010010100001  |
| R7        | x2138 8504        | ! ▶ x3007 | xB402 46082 1011010000000010 |
| PSR       | x8001 32769 CC: P | ! ▶ x3008 | xF025 61477 1111000000100101 |
| PC        | x3008 12296       | ! ▶ x3009 | x3050 12368 0011000001010000 |
| MCR       | x0000 0           | ! ▶ x300A | x3051 12369 0011000001010001 |

The value stored in x3051 is 1, indicating it is a power of 2.

| Registers |                   | Memory    |             |
|-----------|-------------------|-----------|-------------|
| R0        | x0000 0           | ! ▶ x3050 | x0004 4     |
| R1        | x0003 3           | ! ▶ x3051 | x0001 1     |
| R2        | x0001 1           | ! ▶ x3052 | xB0BE 45246 |
| R3        | xBC57 48215       | ! ▶ x3053 | x89FC 35324 |
| R4        | x17CA 6090        | ! ▶ x3054 | x8B52 35666 |
| R5        | x03C1 961         | ! ▶ x3055 | xFEC5 65221 |
| R6        | x5626 22054       | ! ▶ x3056 | x0E2B 3627  |
| R7        | x2138 8504        | ! ▶ x3057 | x388C 14476 |
| PSR       | x8001 32769 CC: P | ! ▶ x3058 | xE379 58233 |
| PC        | x3008 12296       | ! ▶ x3059 | xB312 45842 |
| MCR       | x0000 0           | ! ▶ x305A | x989F 39071 |

## SCREENSHOT OF POSITIVE NUMBER THAT IS NOT A POWER OF 2

BE SURE TO SHOW VALUES @ X3050 & X3051 AS WELL AS REGISTERS JUST BEFORE HALT INSTRUCTION

Next test 5, which is not a power of 2

| Registers |                   | Memory |                          |
|-----------|-------------------|--------|--------------------------|
| R0        | x1E70 7792        | ! ▶    | <b>x3050</b> x0005 5     |
| R1        | xC6D4 50900       | ! ▶    | <b>x3051</b> x85C3 34243 |
| R2        | xFAFA 64250       | ! ▶    | <b>x3052</b> x9665 38501 |
| R3        | xBF40 48960       | ! ▶    | <b>x3053</b> xD725 55077 |
| R4        | xF61C 63004       | ! ▶    | <b>x3054</b> xA64C 42572 |
| R5        | xAC02 44034       | ! ▶    | <b>x3055</b> xE955 59733 |
| R6        | xEB06 60166       | ! ▶    | <b>x3056</b> x66DB 26331 |
| R7        | xD630 54832       | ! ▶    | <b>x3057</b> x968B 38539 |
| PSR       | x8002 32770 CC: Z | ! ▶    | <b>x3058</b> x50AF 20655 |
| PC        | x3000 12288       | ! ▶    | <b>x3059</b> xB4B8 46264 |
| MCR       | x0000 0           | ! ▶    | <b>x305A</b> xD901 55553 |

R2 = 0 as we wanted.

| Registers |                   | Memory |   |
|-----------|-------------------|--------|---|
| R0        | x0004 4           | ! ▶    | <b>x3001</b> xA007 40967 1010000000000111 |
| R1        | x0004 4           | ! ▶    | <b>x3002</b> x0402 1026 0000010000000010  |
| <b>R2</b> | <b>x0000 0</b>    | ! ▶    | <b>x3003</b> x123F 4671 0001001000111111  |
| R3        | xBF40 48960       | ! ▶    | <b>x3004</b> x5001 20481 0101000000000001 |
| R4        | xF61C 63004       | ! ▶    | <b>x3005</b> x0A01 2561 0000101000000001  |
| R5        | xAC02 44034       | ! ▶    | <b>x3006</b> x14A1 5281 0001010010100001  |
| R6        | xEB06 60166       | ! ▶    | <b>x3007</b> xB402 46082 1011010000000010 |
| R7        | xD630 54832       | ! ▶    | <b>x3008</b> xF025 61477 1111000000100101 |
| PSR       | x8001 32769 CC: P | ! ▶    | <b>x3009</b> x3050 12368 0011000001010000 |
| PC        | x3008 12296       | ! ▶    | <b>x300A</b> x3051 12369 0011000001010001 |
| MCR       | x0000 0           | ! ▶    | <b>x300B</b> x6F3B 28475                  |

The value stored in x3051 is 0, indicating it is not a power of 2.

| Registers |                   | Memory |                          |
|-----------|-------------------|--------|--------------------------|
| R0        | x0004 4           | ! ▶    | <b>x3050</b> x0005 5     |
| R1        | x0004 4           | ! ▶    | <b>x3051</b> x0000 0     |
| R2        | x0000 0           | ! ▶    | <b>x3052</b> x9665 38501 |
| R3        | xBF40 48960       | ! ▶    | <b>x3053</b> xD725 55077 |
| R4        | xF61C 63004       | ! ▶    | <b>x3054</b> xA64C 42572 |
| R5        | xAC02 44034       | ! ▶    | <b>x3055</b> xE955 59733 |
| R6        | xEB06 60166       | ! ▶    | <b>x3056</b> x66DB 26331 |
| R7        | xD630 54832       | ! ▶    | <b>x3057</b> x968B 38539 |
| PSR       | x8001 32769 CC: P | ! ▶    | <b>x3058</b> x50AF 20655 |
| PC        | x3008 12296       | ! ▶    | <b>x3059</b> xB4B8 46264 |
| MCR       | x0000 0           | ! ▶    | <b>x305A</b> xD901 55553 |

## SCREENSHOT OF 0 CASE

BE SURE TO SHOW VALUES @ X3050 & X3051 AS WELL AS REGISTERS JUST BEFORE HALT INSTRUCTION

Finally test 0, which is not a power of 2

| Registers |                   | Memory |                   |
|-----------|-------------------|--------|-------------------|
| R0        | x4397 17303       | ! ▶    | x3050 x0000 0     |
| R1        | xA0EA 41194       | ! ▶    | x3051 xF862 63586 |
| R2        | x64B9 25785       | ! ▶    | x3052 x91FA 37370 |
| R3        | x6685 26245       | ! ▶    | x3053 x45E3 17891 |
| R4        | xAA56 43606       | ! ▶    | x3054 xD6BA 54970 |
| R5        | x5149 20809       | ! ▶    | x3055 x3EE0 16096 |
| R6        | xF09C 61596       | ! ▶    | x3056 x11EB 4587  |
| R7        | xC16D 49517       | ! ▶    | x3057 x0862 2146  |
| PSR       | x8002 32770 CC: Z | ! ▶    | x3058 xF65C 63068 |
| PC        | x3000 12288       | ! ▶    | x3059 xB81D 47133 |
| MCR       | x0000 0           | ! ▶    | x305A x4601 17921 |

R2 = 0 as we wanted.

| Registers |                   | Memory |                                    |
|-----------|-------------------|--------|------------------------------------|
| R0        | x0000 0           | ! ▶    | x3001 xA007 40967 1010000000000111 |
| R1        | xA0EA 41194       | ! ▶    | x3002 x0404 1028 0000010000000100  |
| R2        | x0000 0           | ! ▶    | x3003 x123F 4671 0001001000111111  |
| R3        | x6685 26245       | ! ▶    | x3004 x5001 20481 0101000000000001 |
| R4        | xAA56 43606       | ! ▶    | x3005 x0A01 2561 0000101000000001  |
| R5        | x5149 20809       | ! ▶    | x3006 x14A1 5281 0001010010100001  |
| R6        | xF09C 61596       | ! ▶    | x3007 xB402 46082 1011010000000010 |
| R7        | xC16D 49517       | ! ▶    | x3008 xF025 61477 1111000000100101 |
| PSR       | x8002 32770 CC: Z | ! ▶    | x3009 x3050 12368 0011000001010000 |
| PC        | x3008 12296       | ! ▶    | x300A x3051 12369 0011000001010001 |
| MCR       | x0000 0           | ! ▶    | x300B xF380 62336                  |

The value stored in x3051 is 0, indicating it is not a power of 2.

| Registers |                   | Memory |                   |
|-----------|-------------------|--------|-------------------|
| R0        | x0000 0           | ! ▶    | x3050 x0000 0     |
| R1        | xA0EA 41194       | ! ▶    | x3051 x0000 0     |
| R2        | x0000 0           | ! ▶    | x3052 x91FA 37370 |
| R3        | x6685 26245       | ! ▶    | x3053 x45E3 17891 |
| R4        | xAA56 43606       | ! ▶    | x3054 xD6BA 54970 |
| R5        | x5149 20809       | ! ▶    | x3055 x3EE0 16096 |
| R6        | xF09C 61596       | ! ▶    | x3056 x11EB 4587  |
| R7        | xC16D 49517       | ! ▶    | x3057 x0862 2146  |
| PSR       | x8002 32770 CC: Z | ! ▶    | x3058 xF65C 63068 |
| PC        | x3008 12296       | ! ▶    | x3059 xB81D 47133 |
| MCR       | x0000 0           | ! ▶    | x305A x4601 17921 |