Lab 2 – Nikita Berezyuk

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Part 1

Intent: This program adds b and c, stores it in %r0. Then adds a to the %r0 (equal to zero). But, it subtracts b with the previous sum, ultimately making %r2 equal to b - a. Thus, stores %r2 value in variable y and returns.

Qs 1:

! Program 1
! Hint: op3 for subcc is 010100
.begin
!Starts assembling

.org 2048	**!Changes location counter to address 2048**
dstart .equ 4000	**!Tells assembler to equate 4000 to dstart**

ld [a], %r1	**!Loads data from variable a to register 1**	11 00001 000000 00000 1 0111110100000
ld [b], %r2	**!Loads data from variable b to register 2**	11 00010 000000 00000 1 0111110100100
ld [c], %r3	**!Loads data from variable c to register 3**	11 00011 000000 00000 1 0111110101000
addcc %r2, %r3, %r0	**!Adds binary value data of register 2 and 3, storing the result in register 0**	10 00000 010000 00010 0 0000000000011
addcc %r1, %r0, %r4	**!Adds binary value data of register 1 and 0, storing the result in register 4**	10 00100 010000 00001 0 0000000000000
subcc %r2, %r4, %r2	**!Adds binary value data of register 2 and 4, storing the result in register 2**	10 00010 010100 00010 0 0000000000100
st %r0, [a]	**!Stores (writes) data from register 0 into a.**	11 00000 000100 00000 1 0111110100000
st %r2, [y]	**!Stores (writes) data from register 2 into y.**	11 00010 000100 00000 1 0111110101100
jmpl %r15 + 4, %r0	**!Return**	10 00000 111000 01111 1 0000000000100

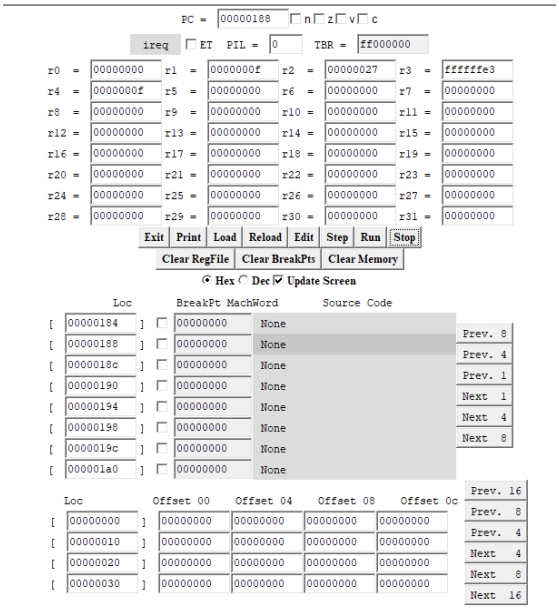
.org dstart	**!Changes location counter to address of dstart**
a: 15	**!Declare a as 15 (0000000001111)**
b: 54	**!Declare b as 54 (0000000110110)**
c: -29	**!Declare c as -29 (1111111100011)**
y: 0	**!Declare y as 0 (0000000000000)**

!Stops assembling
.end

Qs 3:

%r4 = **0000000001111)$_2$ or 15)$_{10}$**

- Operation: %r4 = %r1 + %r0 = %r1



Part 2

Intent: Subtracts the value of x and y. If difference is negative, does a logical or operation of the binary values. If difference is positive, does a logical and operation of the binary values. Then, stores this result in variable a.

Qs 1:

! Program 2
.begin
!Starts assembling

.org 2048	**!Changes location counter to start at address 2048**

m_start: ld [x], %r1	**!m_start label, Loads memory address of variable x into register 1**	11 00001 000000 00000 1 01000
ld [y], %r2	**!Loads memory address of variable y into register 2**	11 00010 000000 00000 1 01000
subcc %r1, %r2, %r0	**!Subtracts data from register 1 with register 2 into register 0 (discard)**	10 00000 010100 00001 0 00000
bneg else	**!If subtraction results in negative value (N flag), jumps to else label**	00 0 0110 010 0000000000000
andcc %r1, %r2, %r3	**!If subtraction is positive, does an logic and operation with register 1 and register 2 into register 3**	10 00011 010001 00001 0 00000
ba done	**!Branch always, will always jump to the done label**	00 0 1000 010 0000000000000
else: orcc %r1, %r2, %r3	**!else label, When subtraction is negative, performs logic or operation with register 1 and register 2 into register 3**	10 00011 010010 00001 0 00000
done: st %r3, [a]	**!done label, Always branches to this, stores data from register 3 into variable a**	11 00001 000100 00000 1 01000
jmpl %r15+4, %r0	**!Return**	10 00000 111000 01111 1 00000

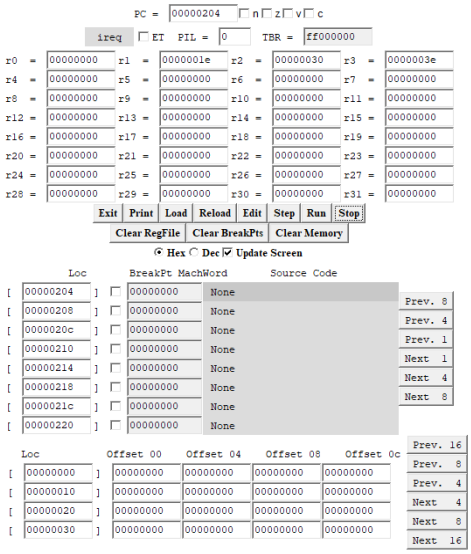
x: 30	**!Declare x as 30 (0000000011110)**
y: 48	**!Declare y as 48 (0000000110000)**
a: 0	**!Declare a as 0 (0000000000000)**

!Stops assembling
.end

Qs 3:

%r3 = **000000111110)2 or 62)10**

- Operation: %r3 = %r1 or %r2



Part 3

Intent: This program runs through a loop that divides value x in half each time for 4 iterations. It divides value x by shifting it to the right by 1 bit and adding 1 to %r1 each time. After the 4th iteration, stores %r3 in the y variable and returns.

Qs 1:

! Program 3
.begin
!Starts assembling

.org 2048	**!Changes location counter to start at address 2048**

main: ld [x], %r2	**!Main label, Loads memory address of variable x into register 2**	11 00010 000000 00000 1 0101110111000
top: subcc %r1, 4, %r0	**!Top label, Subtracts register 1 with constant 4 into register 0**	10 00000 010100 00001 1 0000000000100
be done	**!Branch to label done if equal to zero**	00 0 0001 010 00000000000000000000100
srl %r2, 1, %r2	**!Shifts register 2 to the right by 1 bit and stores into register 2**	10 00010 100110 00010 1 0000000000001
addcc %r1, 1, %r1	**!Adds content of register 1 with constant 1 storing it in register 1**	10 00001 010000 00001 1 0000000000001
ba top	**!Branches always back to label top (loop) until be condition is met**	00 0 1000 010 11111111111111111100
done: st %r3, [y]	**!Done label, branches once equal to zero, stores register 3 into memory location y**	11 00011 000100 00000 1 0101110111100
jmpl %r15+4, %r0	**!Return**	10 00000 111000 01111 1 0000000000100

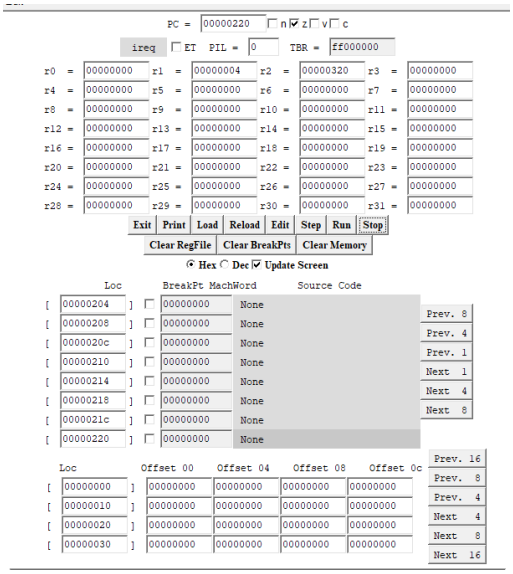
.org 3000	**!Changes location counter to start at address 3000**
x: 800	**!Declare x as 800 (0001100100000)**
y: 0	**!Declare y as 0 (0000000000000)**

!Stops assembling
.end

Qs 3:

%r1 = **0000000000100)$_2$ or 4)$_{10}$**

- Operation: %r1 = %r1 + 1 * 4 times



Part 4

Intent: The purpose of this program is to loop manipulate register 1 three times. %r2 and %r3 do not change, but are used to either perform a logic and/or operation. When %r5 - %r6 is negative, performs "and" operation and adds 1 to %r5 counter. If its not negative, it will perform "or" operation and add 1 to %r6 counter. Will then add 1 top %r4 each time and jump back to top to loop. Once %r4 is 3 / top function three times, program will save %r3 in y and return / break the loop.

- %r4 keeps count of bottom label iterations, %r5 keeps count of else label iterations (and logic), and %r6 tracks amount of times the top program loops (or logic).

Qs 1:

! Program 4
!Starts assembling
.begin

.org 2048	**!Changes location counter to start at address 2048**

main: ld [a], %r1	**!Main label, loads memory address of variable a into register 1**	11 00001 000000 00000 1 0101110111000
ld [b], %r2	**!Loads memory address of variable b into register 2**	11 00010 000000 00000 1 0101110111100
ld [c], %r3	**!Loads memory address of variable c into register 3**	11 00010 000000 00000 1 0101111000000
top: subcc %r4, 3, %r0	**!Top label, subtracts content from register 4 with constant 3, storing it in register 0 (discard)**	10 00000 010100 00100 1 0000000000011

be done	**!When equal to zero, branches to done label**	00 0 0001 010 00000000000000000001010
subcc %r5, %r6, %r0	**!If not, subtracts content from register 5 and register 6 into register 0**	10 00000 010100 00101 0 0000000000110
bneg else	**!If subtraction raises negative flag, branches into else label**	00 0 0110 010 00000000000000000100
orcc %r1, %r2, %r1	**!If not, logic or operation between register 1 and 2, storing it into register 1**	10 00001 010010 00001 0 0000000000010
addcc %r6, 1, %r6	**!Then, adds register 6 with constant 1 into register 6**	10 00111 010000 00111 1 0000000000001
ba bottom	**!Branches always to bottom label**	00 0 1000 010 00000000000000000011
else: andcc %r1, %r3, %r1	**!Else label, performs logic and operation between register 1 and 3 into register 1**	10 00001 010001 00001 0 0000000000011
addcc %r5, 1, %r5	**!Also, adds content of register 5 with constant 1, storing it into register 5**	10 00101 010000 00101 1 0000000000001
bottom: addcc %r4, 1, %r4	**!Bottom label, performs addition of content in register 4 with constant 1 into register 4**	10 00100 010000 00100 1 0000000000001
ba top	**!Will always branch to top label**	00 0 1000 010 11111111111111111010
done: st %r3, [y]	**!Done label, stores content from register 3 into variable y**	11 00011 000100 00000 1 0101111000100
jmpl %r15+4, %r0	**!Return**	10 00000 111000 01111 1 0000000000100

.org 3000	**!Changes location counter to start at address 3000**
a: 0xa0	**!Declare a as 0xa0 (0000010100000 or 160)**
b: 0x33	**!Declare b as 0x33 (0000000110011 or 51)**
c: 0x52	**!Declare c as 0x52 (0000001010010 or 82)**
y: 2	**!Declare y as 2 (0000000000010)**

!Stops assembling
.end

Qs 3:

%r4 = **0000000000011)$_2$ or 3)$_{10}$**

- Operation: %r4 = %r4 + 1 * 3 times