Practical Project
MIPS Pipelined Emulator

Practical Project Report:

You must write a report for the implemented emulator describing the following:

1. **Brief description of your implementation and how the code is organized.**

   Emulator divide into Classes, MIPS_Component Class for each component like Mux, Adder, Control_unit, Register_file, and ALU, Pipeline_Stages Class witch handle Pipeline_register and transfer data, and in Last MIPS main Class where each cycle controlled and move the execution forward, each stage in the main class represent as Queue.

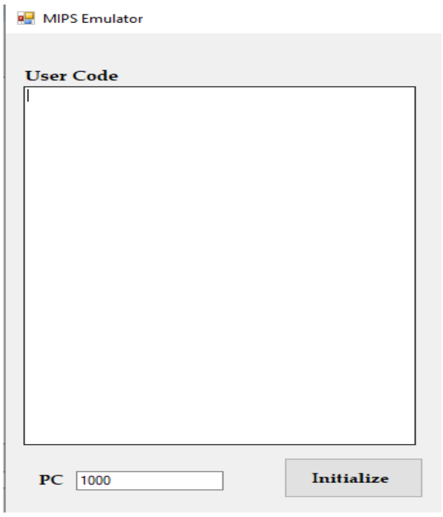
2. High-level pseudo-code or flowchart for “Run 1 cycle” function.

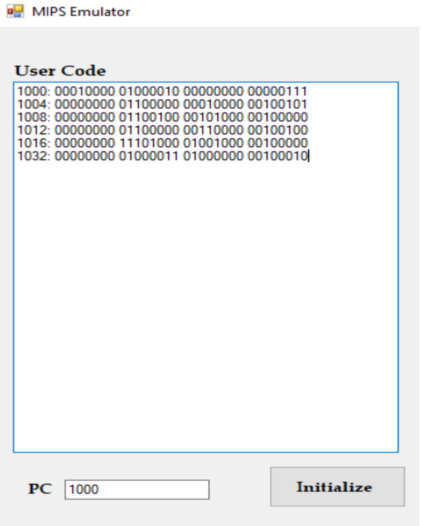
```
start execution from last stage


if Write_BackQueue not empty  then
        Dequeue from Write_BackQueue
        Call Function Write_Back() from pipeline_stage class
end if
if Memory_AccessQueue not empty  then
      check if it can be executed  then
            Dequeue from MemoryQueue and enqueue it in Write_BackQueue
            Call Memory_Access() from pipeline_stage class
end if
Repeat for ExecuteQueue and DecodeQueue
check if their instruction to be Fetch  then
     check PC_Reg equal to address to Fetch then
          Call Fetch() and dequeue from FetchQueue and enqueue in DecodeQueue
```

3. A user guide explaining how to use the emulator

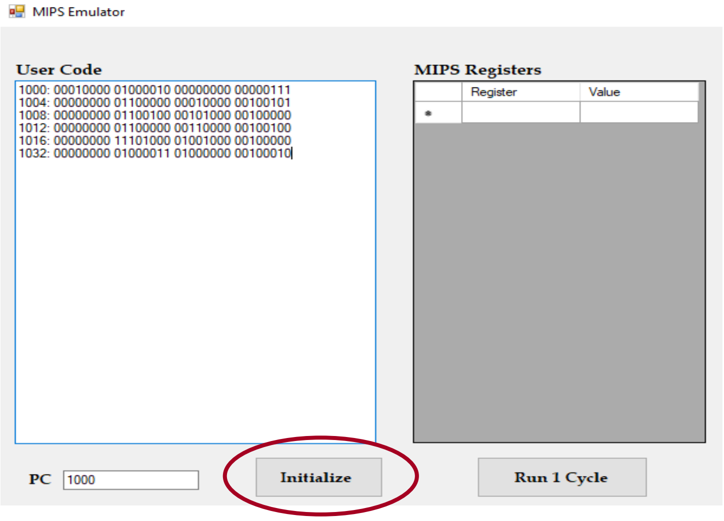
3.1. enter MIPS instruction in Machine Code in empty space





```
1000: 00010000 01000010 00000000 00000111
1004: 00000000 01100000 00010000 00100101
1008: 00000000 01100100 00101000 00100000
1012: 00000000 01100000 00110000 00100100
1016: 00000000 11101000 01001000 00100000
1032: 00000000 01000011 01000000 00100010
```

3.2. click initialize button to load default MIPS Regiters

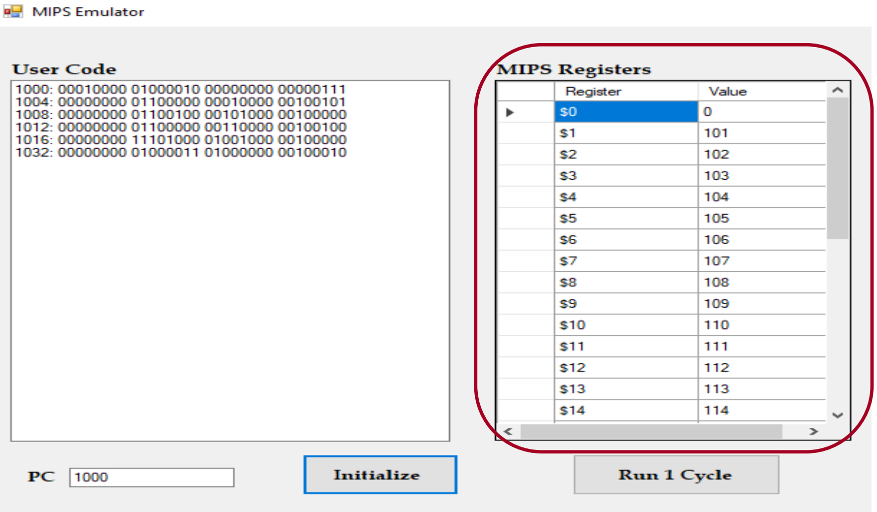


```
1000: 00010000 01000010 00000000 00000111
1004: 00000000 01100000 00010000 00100101
1008: 00000000 01100100 00101000 00100000
1012: 00000000 01100000 00110000 00100100
1016: 00000000 11101000 01001000 00100000
1032: 00000000 01000011 01000000 00100010
```

	Register	Value
*		

PC 1000

3.3. The initial values for Register will appear



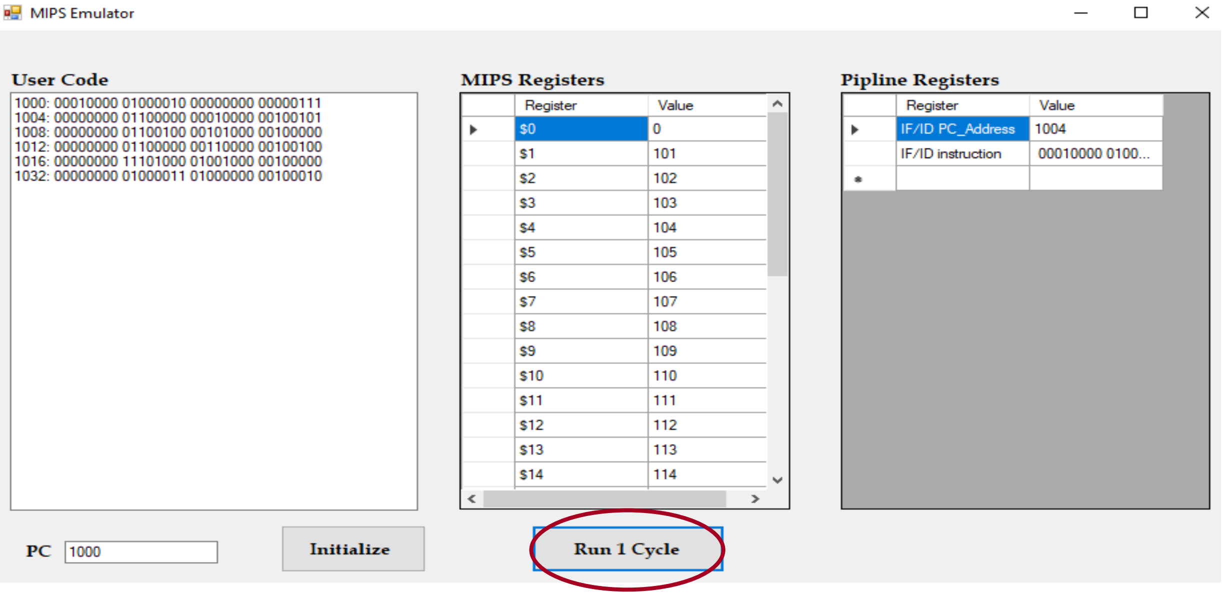
```
1000: 00010000 01000010 00000000 00000111
1004: 00000000 01100000 00010000 00100101
1008: 00000000 01100100 00101000 00100000
1012: 00000000 01100000 00110000 00100100
1016: 00000000 11101000 01001000 00100000
1032: 00000000 01000011 01000000 00100010
```

	Register	Value
▸	$0	0
	$1	101
	$2	102
	$3	103
	$4	104
	$5	105
	$6	106
	$7	107
	$8	108
	$9	109
	$10	110
	$11	111
	$12	112
	$13	113
	$14	114

PC 1000

3.4. To Display Pipeline Registers values Press (Run 1 Cycle)

3.5. To Display all Cycles, Press (Run 1 Cycle)

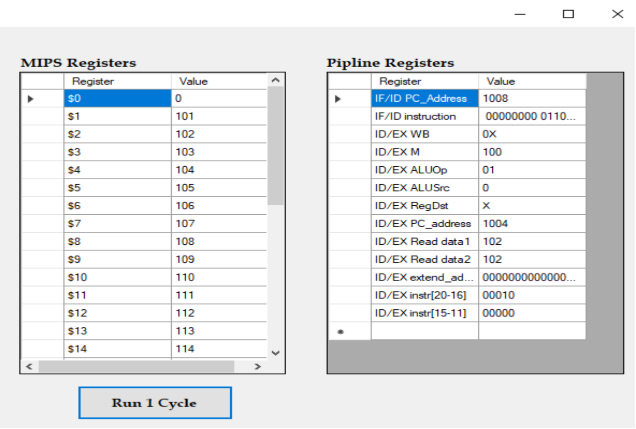


```
1000: 00010000 01000010 00000000 00000111
1004: 00000000 01100000 00010000 00100101
1008: 00000000 01100100 00101000 00100000
1012: 00000000 01100000 00110000 00100100
1016: 00000000 11101000 01001000 00100000
1032: 00000000 01000011 01000000 00100010
```

	Register	Value
▸	$0	0
	$1	101
	$2	102
	$3	103
	$4	104
	$5	105
	$6	106
	$7	107
	$8	108
	$9	109
	$10	110
	$11	111
	$12	112
	$13	113
	$14	114

	Register	Value
▸	IF/ID PC_Address	1004
	IF/ID instruction	00010000 0100...
*		

PC 1000



MIPS Registers

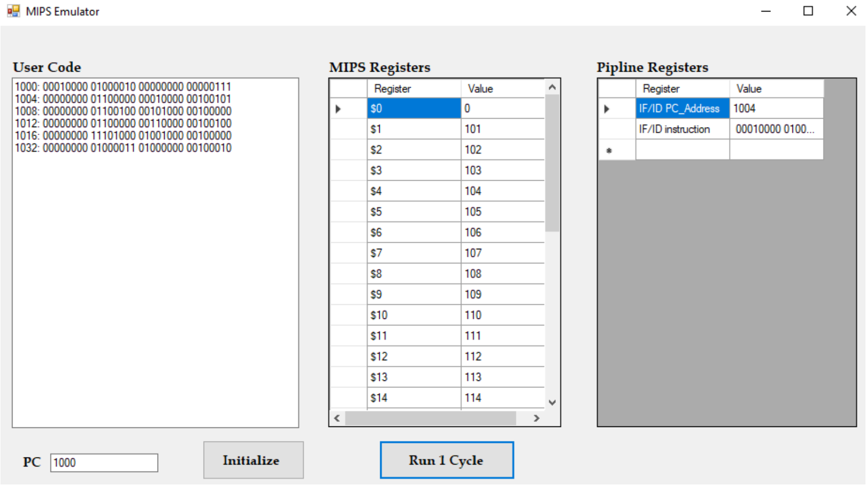
Register	Value
$0	0
$1	101
$2	102
$3	103
$4	104
$5	105
$6	106
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

Pipline Registers

Register	Value
IF/ID PC_Address	1008
IF/ID instruction	00000000 0110...
ID/EX WB	0X
ID/EX M	100
ID/EX ALUOp	01
ID/EX ALUSrc	0
ID/EX RegDst	X
ID/EX PC_address	1004
ID/EX Read data1	102
ID/EX Read data2	102
ID/EX extend_ad...	0000000000000...
ID/EX instr[20-16]	00010
ID/EX instr[15-11]	00000

4. Screenshots of emulating the MIPS code given in Task 1, one screenshot per clock cycle for 9 clock cycles

CC1



User Code

```
1000: 00010000 01000010 00000000 00000111
1004: 00000000 01100000 00010000 00100101
1008: 00000000 01100100 00101000 00100000
1012: 00000000 01100000 00110000 00100100
1016: 00000000 11101000 01001000 00100000
1032: 00000000 01000011 01000000 00100010
```

MIPS Registers

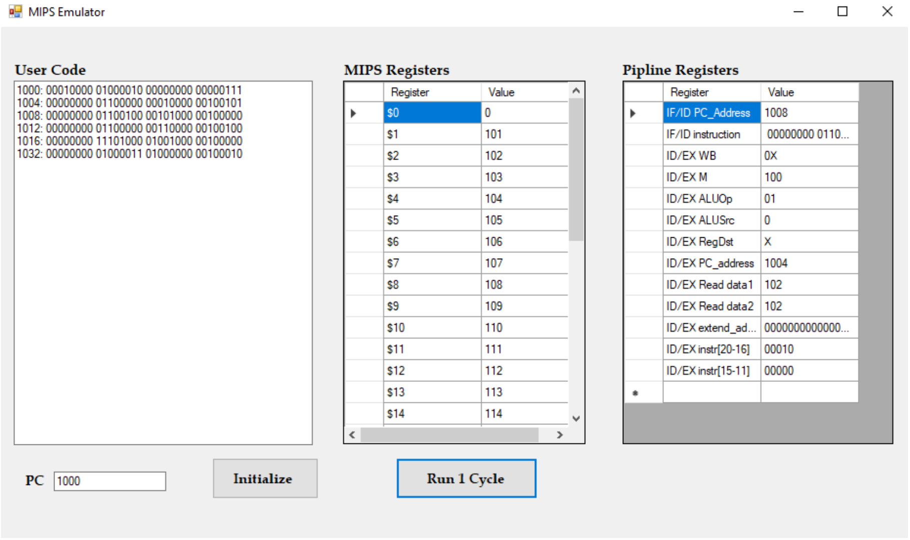
Register	Value
$0	0
$1	101
$2	102
$3	103
$4	104
$5	105
$6	106
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

Pipline Registers

Register	Value
IF/ID PC_Address	1004
IF/ID instruction	00010000 0100...

PC 1000

CC2



User Code

```
1000: 00010000 01000010 00000000 00000111
1004: 00000000 01100000 00010000 00100101
1008: 00000000 01100100 00101000 00100000
1012: 00000000 01100000 00110000 00100100
1016: 00000000 11101000 01001000 00100000
1032: 00000000 01000011 01000000 00100010
```

MIPS Registers

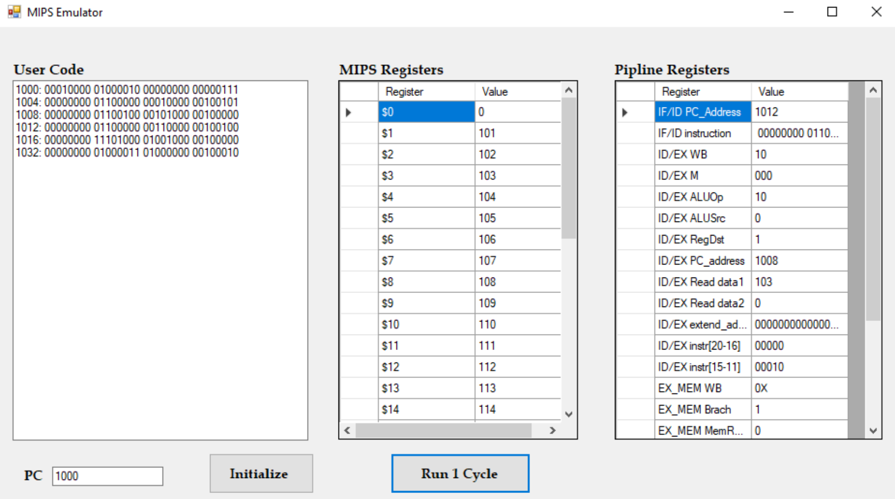
Register	Value
$0	0
$1	101
$2	102
$3	103
$4	104
$5	105
$6	106
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

Pipline Registers

Register	Value
IF/ID PC_Address	1008
IF/ID instruction	00000000 0110...
ID/EX WB	0X
ID/EX M	100
ID/EX ALUOp	01
ID/EX ALUSrc	0
ID/EX RegDst	X
ID/EX PC_address	1004
ID/EX Read data1	102
ID/EX Read data2	102
ID/EX extend_ad...	0000000000000...
ID/EX instr[20-16]	00010
ID/EX instr[15-11]	00000

PC 1000

CC3



User Code

```
1000: 00010000 01000010 00000000 00000111
1004: 00000000 01100000 00010000 00100101
1008: 00000000 01100100 00101000 00100000
1012: 00000000 01100000 00110000 00100100
1016: 00000000 11101000 01001000 00100000
1032: 00000000 01000011 01000000 00100010
```

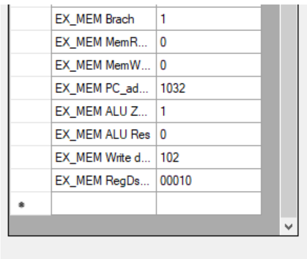
PC 1000

MIPS Registers

Register	Value
$0	0
$1	101
$2	102
$3	103
$4	104
$5	105
$6	106
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

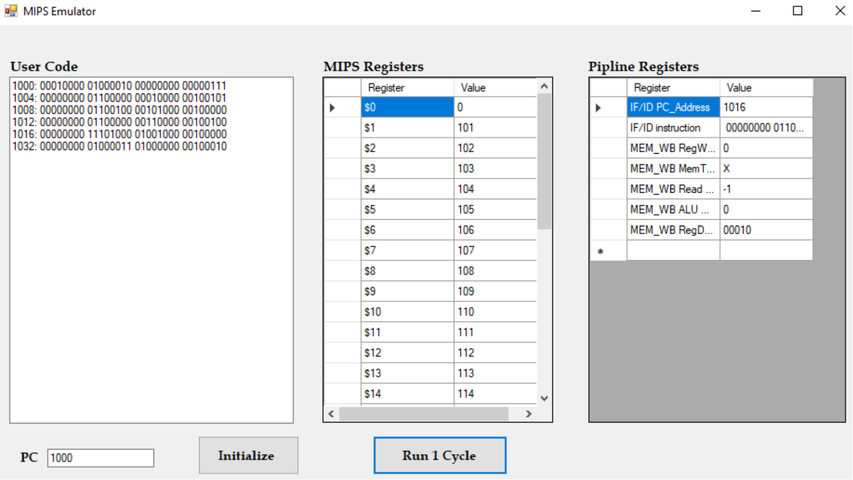
Pipline Registers

Register	Value
IF/ID PC_Address	1012
IF/ID instruction	00000000 0110...
ID/EX WB	10
ID/EX M	000
ID/EX ALUOp	10
ID/EX ALUSrc	0
ID/EX RegDst	1
ID/EX PC_address	1008
ID/EX Read data1	103
ID/EX Read data2	0
ID/EX extend_ad...	0000000000000...
ID/EX instr[20-16]	00000
ID/EX instr[15-11]	00010
EX_MEM WB	0X
EX_MEM Brach	1
EX_MEM MemR...	0



EX_MEM Brach	1
EX_MEM MemR...	0
EX_MEM MemW...	0
EX_MEM PC_ad...	1032
EX_MEM ALU Z...	1
EX_MEM ALU Res	0
EX_MEM Write d...	102
EX_MEM RegDs...	00010

CC4



User Code

```
1000: 00010000 01000010 00000000 00000111
1004: 00000000 01100000 00010000 00100101
1008: 00000000 01100100 00101000 00100000
1012: 00000000 01100000 00110000 00100100
1016: 00000000 11101000 01001000 00100000
1032: 00000000 01000011 01000000 00100010
```

PC 1000

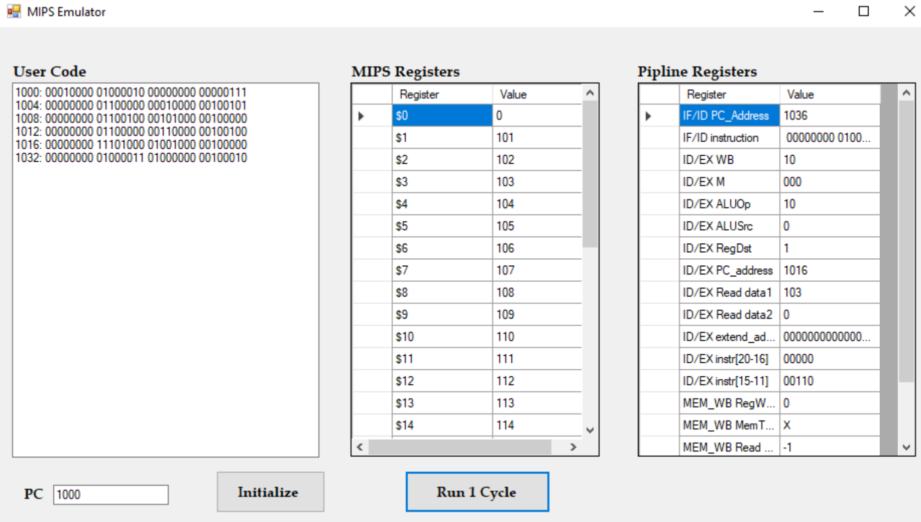
MIPS Registers

Register	Value
$0	0
$1	101
$2	102
$3	103
$4	104
$5	105
$6	106
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

Pipline Registers

Register	Value
IF/ID PC_Address	1016
IF/ID instruction	00000000 0110...
MEM_WB RegW...	0
MEM_WB MemT...	X
MEM_WB Read ...	-1
MEM_WB ALU ...	0
MEM_WB RegD...	00010

CC5



User Code

```
1000: 00010000 01000010 00000000 00000111
1004: 00000000 01100000 00010000 00100101
1008: 00000000 01100100 00101000 00100000
1012: 00000000 01100000 00110000 00100100
1016: 00000000 11101000 01001000 00100000
1032: 00000000 01000011 01000000 00100010
```

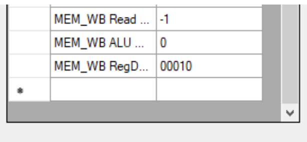
PC 1000

MIPS Registers

Register	Value
$0	0
$1	101
$2	102
$3	103
$4	104
$5	105
$6	106
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

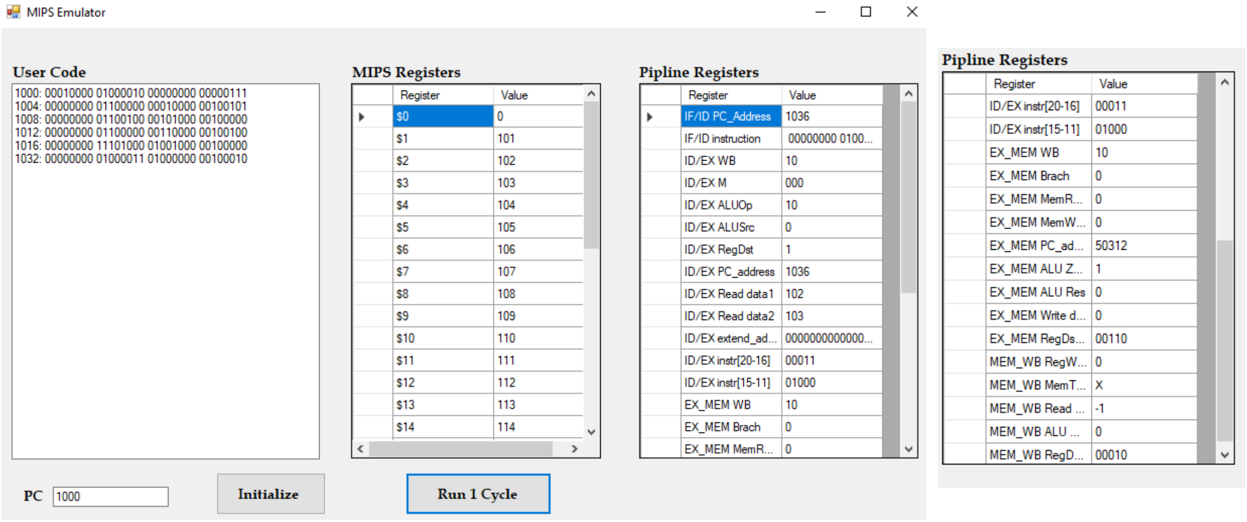
Pipline Registers

Register	Value
IF/ID PC_Address	1036
IF/ID instruction	00000000 0100...
ID/EX WB	10
ID/EX M	000
ID/EX ALUOp	10
ID/EX ALUSrc	0
ID/EX RegDst	1
ID/EX PC_address	1016
ID/EX Read data1	103
ID/EX Read data2	0
ID/EX extend_ad...	0000000000000...
ID/EX instr[20-16]	00000
ID/EX instr[15-11]	00110
MEM_WB RegW...	0
MEM_WB MemT...	X
MEM_WB Read ...	-1



MEM_WB Read ...	-1
MEM_WB ALU ...	0
MEM_WB RegD...	00010

CC6



User Code

```
1000: 00010000 01000010 00000000 00000111
1004: 00000000 01100000 00010000 00100101
1008: 00000000 01100100 00101000 00100000
1012: 00000000 01100000 00110000 00100100
1016: 00000000 11101000 01001000 00100000
1032: 00000000 01000011 01000000 00100010
```

PC 1000

MIPS Registers

Register	Value
$0	0
$1	101
$2	102
$3	103
$4	104
$5	105
$6	106
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

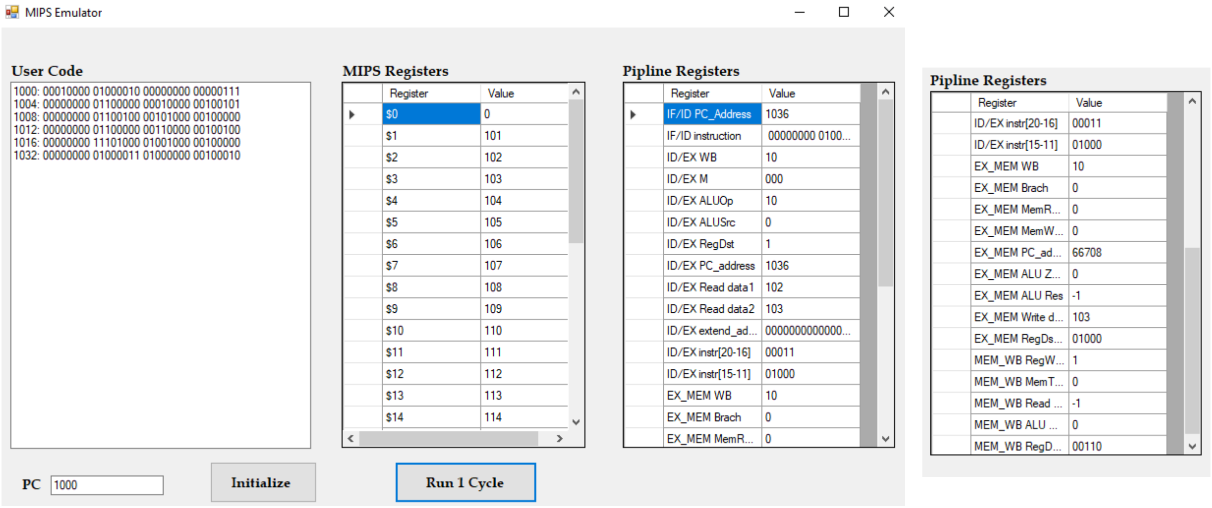
Pipline Registers

Register	Value
IF/ID PC_Address	1036
IF/ID instruction	00000000 0100...
ID/EX WB	10
ID/EX M	000
ID/EX ALUOp	10
ID/EX ALUSrc	0
ID/EX RegDst	1
ID/EX PC_address	1036
ID/EX Read data1	102
ID/EX Read data2	103
ID/EX extend_ad...	0000000000000...
ID/EX instr[20-16]	00011
ID/EX instr[15-11]	01000
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0

Pipline Registers

Register	Value
ID/EX instr[20-16]	00011
ID/EX instr[15-11]	01000
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0
EX_MEM MemW...	0
EX_MEM PC_ad...	50312
EX_MEM ALU Z...	1
EX_MEM ALU Res	0
EX_MEM Write d...	0
EX_MEM RegDs...	00110
MEM_WB RegW...	0
MEM_WB MemT...	X
MEM_WB Read ...	-1
MEM_WB ALU ...	0
MEM_WB RegD...	00010

CC7



User Code

```
1000: 00010000 01000010 00000000 00000111
1004: 00000000 01100000 00010000 00100101
1008: 00000000 01100100 00101000 00100000
1012: 00000000 01100000 00110000 00100100
1016: 00000000 11101000 01001000 00100000
1032: 00000000 01000011 01000000 00100010
```

PC 1000

MIPS Registers

Register	Value
$0	0
$1	101
$2	102
$3	103
$4	104
$5	105
$6	106
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

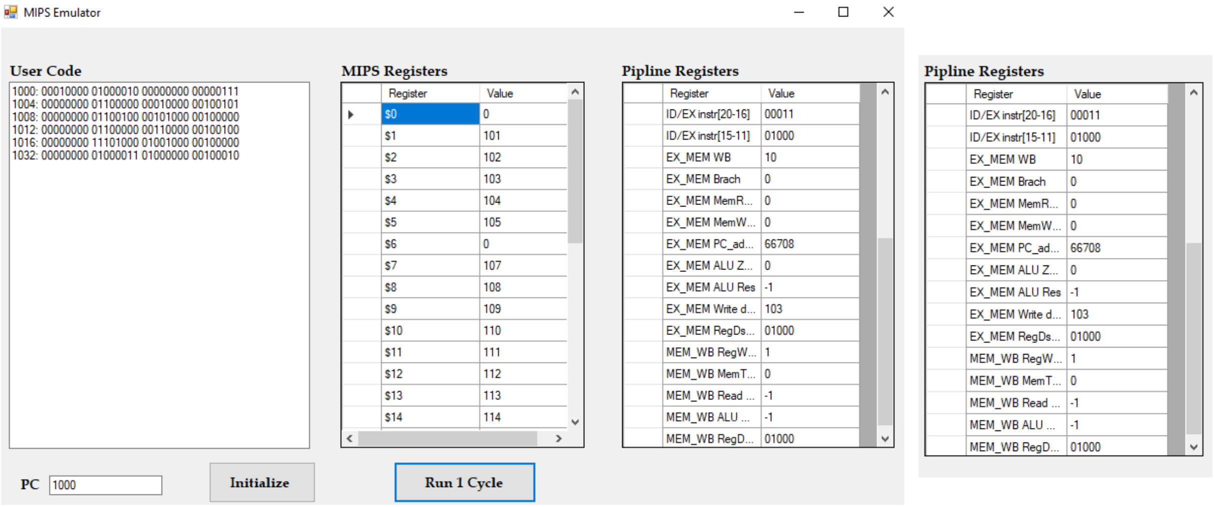
Pipline Registers

Register	Value
IF/ID PC_Address	1036
IF/ID instruction	00000000 0100...
ID/EX WB	10
ID/EX M	000
ID/EX ALUOp	10
ID/EX ALUSrc	0
ID/EX RegDst	1
ID/EX PC_address	1036
ID/EX Read data1	102
ID/EX Read data2	103
ID/EX extend_ad...	0000000000000...
ID/EX instr[20-16]	00011
ID/EX instr[15-11]	01000
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0

Pipline Registers

Register	Value
ID/EX instr[20-16]	00011
ID/EX instr[15-11]	01000
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0
EX_MEM MemW...	0
EX_MEM PC_ad...	66708
EX_MEM ALU Z...	0
EX_MEM ALU Res	-1
EX_MEM Write d...	103
EX_MEM RegDs...	01000
MEM_WB RegW...	1
MEM_WB MemT...	0
MEM_WB Read ...	-1
MEM_WB ALU ...	0
MEM_WB RegD...	00110

CC8



User Code

```
1000: 00010000 01000010 00000000 00000111
1004: 00000000 01100000 00010000 00100101
1008: 00000000 01100100 00101000 00100000
1012: 00000000 01100000 00110000 00100100
1016: 00000000 11101000 01001000 00100000
1032: 00000000 01000011 01000000 00100010
```

PC 1000

MIPS Registers

Register	Value
$0	0
$1	101
$2	102
$3	103
$4	104
$5	105
$6	0
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

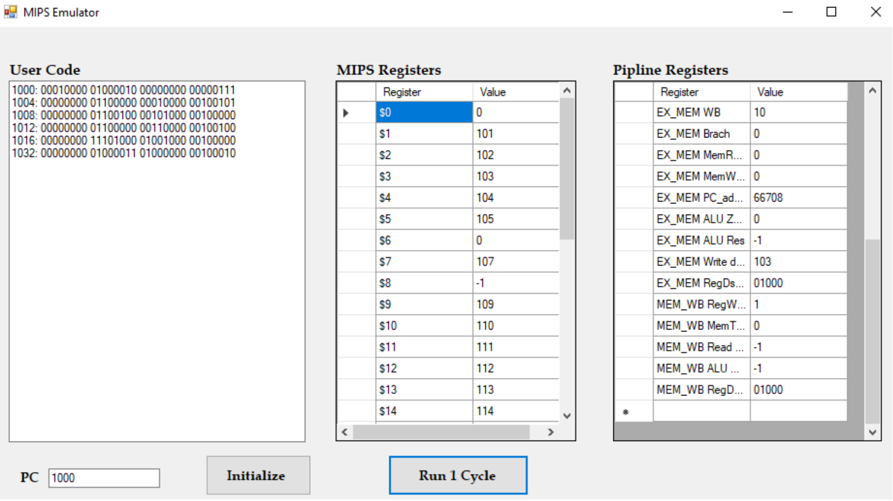
Pipline Registers

Register	Value
ID/EX instr[20-16]	00011
ID/EX instr[15-11]	01000
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0
EX_MEM MemW...	0
EX_MEM PC_ad...	66708
EX_MEM ALU Z...	0
EX_MEM ALU Res	-1
EX_MEM Write d...	103
EX_MEM RegDs...	01000
MEM_WB RegW...	1
MEM_WB MemT...	0
MEM_WB Read ...	-1
MEM_WB ALU ...	-1
MEM_WB RegD...	01000

Pipline Registers

Register	Value
ID/EX instr[20-16]	00011
ID/EX instr[15-11]	01000
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0
EX_MEM MemW...	0
EX_MEM PC_ad...	66708
EX_MEM ALU Z...	0
EX_MEM ALU Res	-1
EX_MEM Write d...	103
EX_MEM RegDs...	01000
MEM_WB RegW...	1
MEM_WB MemT...	0
MEM_WB Read ...	-1
MEM_WB ALU ...	-1
MEM_WB RegD...	01000

CC9



User Code

```
1000: 00010000 01000010 00000000 00000111
1004: 00000000 01100000 00010000 00100101
1008: 00000000 01100100 00101000 00100000
1012: 00000000 01100000 00110000 00100100
1016: 00000000 11101000 01001000 00100000
1032: 00000000 01000011 01000000 00100010
```

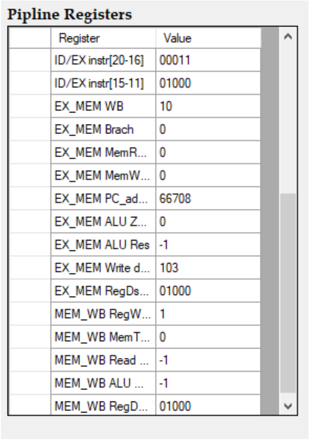
MIPS Registers

Register	Value
$0	0
$1	101
$2	102
$3	103
$4	104
$5	105
$6	0
$7	107
$8	-1
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

Pipline Registers

Register	Value
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0
EX_MEM MemW...	0
EX_MEM PC_ad...	66708
EX_MEM ALU Z...	0
EX_MEM ALU Res	-1
EX_MEM Write d...	103
EX_MEM RegDs...	01000
MEM_WB RegW...	1
MEM_WB MemT...	0
MEM_WB Read ...	-1
MEM_WB ALU ...	-1
MEM_WB RegD...	01000

PC: 1000



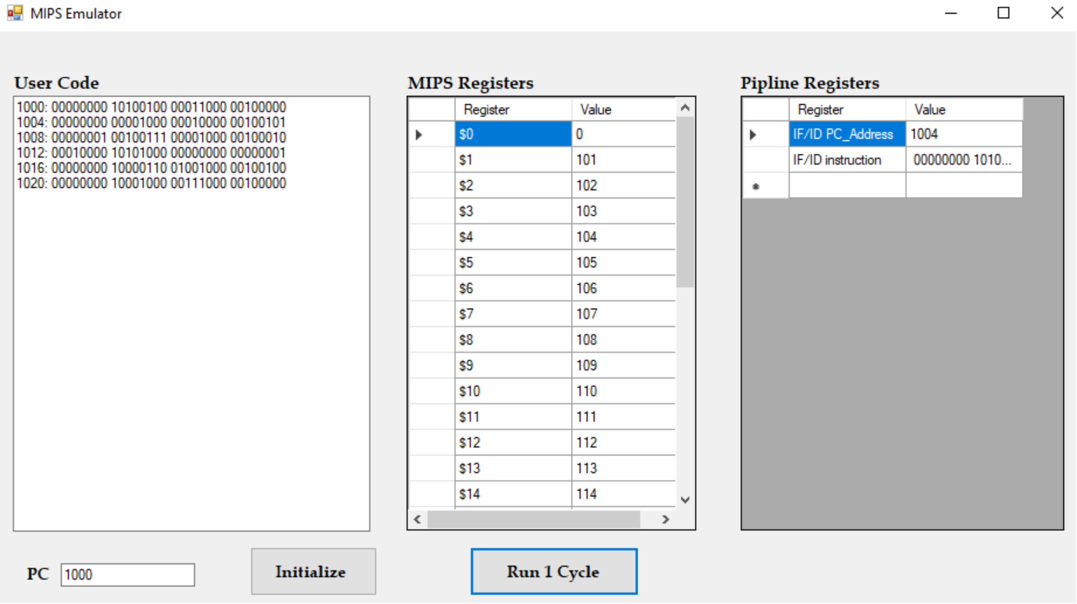
Pipline Registers

Register	Value
ID/EX instr[20-16]	00011
ID/EX instr[15-11]	01000
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0
EX_MEM MemW...	0
EX_MEM PC_ad...	66708
EX_MEM ALU Z...	0
EX_MEM ALU Res	-1
EX_MEM Write d...	103
EX_MEM RegDs...	01000
MEM_WB RegW...	1
MEM_WB MemT...	0
MEM_WB Read ...	-1
MEM_WB ALU ...	-1
MEM_WB RegD...	01000

5. Screenshots of emulating another MIPS code from your choice, one screenshot per clock cycle for 9 clock cycles

```
1000: add $3, $5, $4
1004: or $2, $Zero, $8
1008: sub $1, $9, $7
1012: beq $5, $8, 1
1016: and $9, $4, $6
1020: add $7, $4, $8
```

CC1



User Code

```
1000: 00000000 10100100 00011000 00100000
1004: 00000000 00001000 00010000 00100101
1008: 00000001 00100111 00001000 00100010
1012: 00010000 10101000 00000000 00000001
1016: 00000000 10000110 01001000 00100100
1020: 00000000 10001000 00111000 00100000
```

MIPS Registers

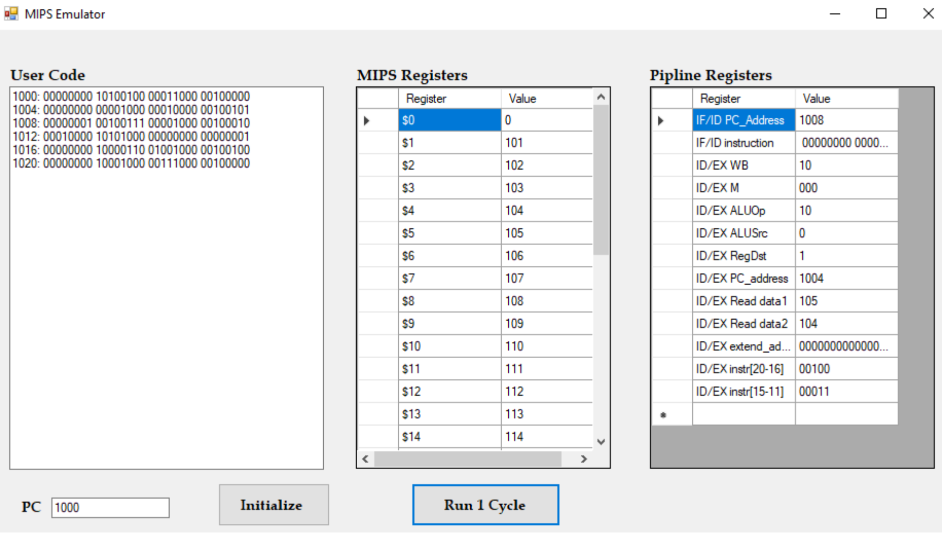
Register	Value
$0	0
$1	101
$2	102
$3	103
$4	104
$5	105
$6	106
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

Pipline Registers

Register	Value
IF/ID PC_Address	1004
IF/ID instruction	00000000 1010...

PC: 1000

CC2



User Code

```
1000: 00000000 10100100 00011000 00100000
1004: 00000000 00001000 00010000 00100101
1008: 00000001 00100111 00001000 00100010
1012: 00010000 10101000 00000000 00000001
1016: 00000000 10000110 01001000 00100100
1020: 00000000 10001000 00111000 00100000
```

MIPS Registers

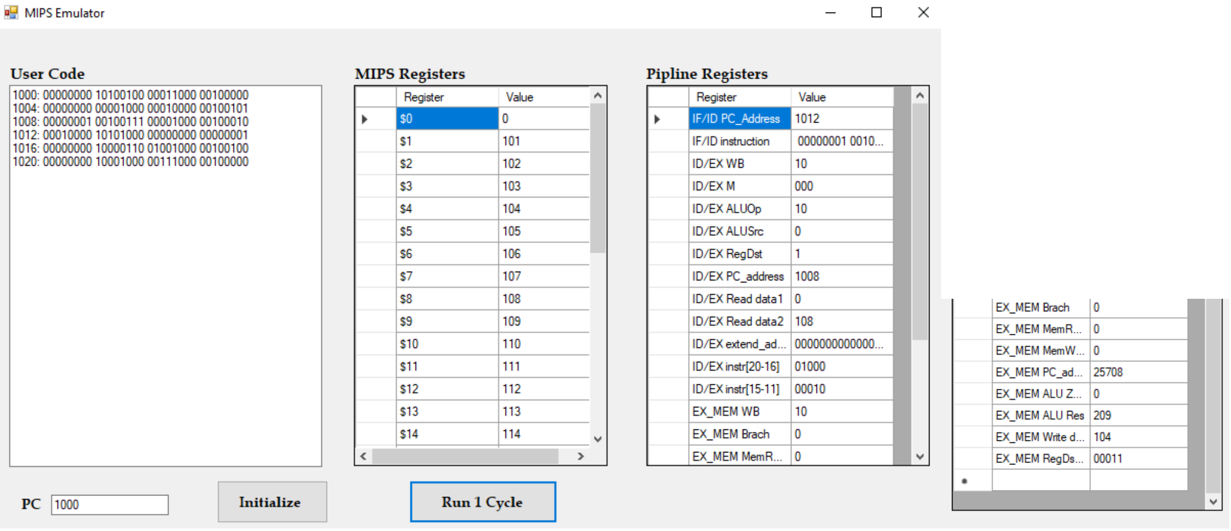
Register	Value
$0	0
$1	101
$2	102
$3	103
$4	104
$5	105
$6	106
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

Pipline Registers

Register	Value
IF/ID PC_Address	1008
IF/ID instruction	00000000 0000...
ID/EX WB	10
ID/EX M	000
ID/EX ALUOp	10
ID/EX ALUSrc	0
ID/EX RegDst	1
ID/EX PC_address	1004
ID/EX Read data1	105
ID/EX Read data2	104
ID/EX extend_ad...	0000000000000...
ID/EX instr[20-16]	00100
ID/EX instr[15-11]	00011

PC 1000

CC3



User Code

```
1000: 00000000 10100100 00011000 00100000
1004: 00000000 00001000 00010000 00100101
1008: 00000001 00100111 00001000 00100010
1012: 00010000 10101000 00000000 00000001
1016: 00000000 10000110 01001000 00100100
1020: 00000000 10001000 00111000 00100000
```

MIPS Registers

Register	Value
$0	0
$1	101
$2	102
$3	103
$4	104
$5	105
$6	106
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

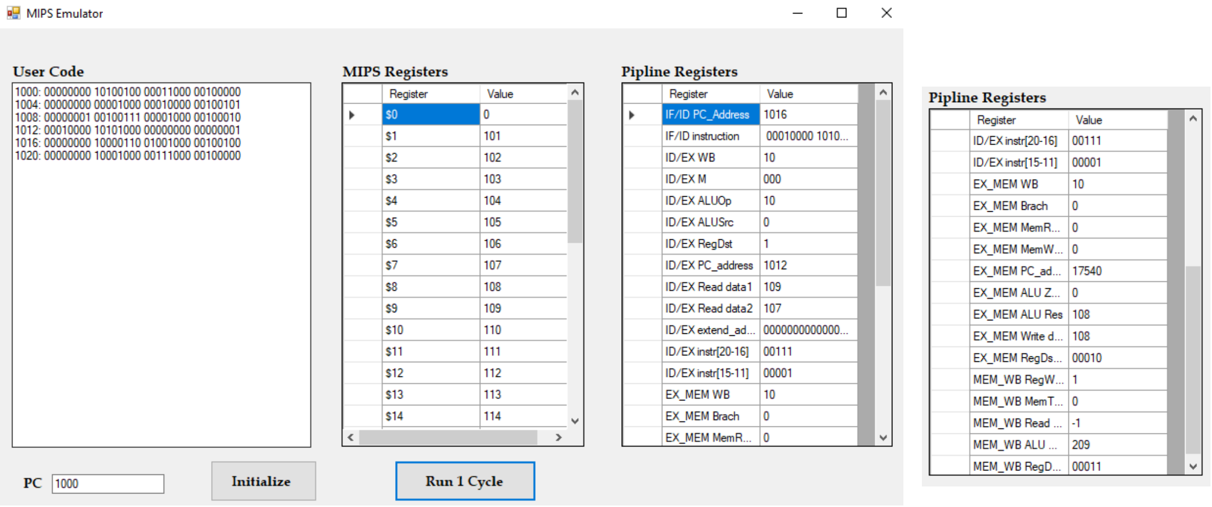
Pipline Registers

Register	Value
IF/ID PC_Address	1012
IF/ID instruction	00000001 0010...
ID/EX WB	10
ID/EX M	000
ID/EX ALUOp	10
ID/EX ALUSrc	0
ID/EX RegDst	1
ID/EX PC_address	1008
ID/EX Read data1	0
ID/EX Read data2	108
ID/EX extend_ad...	0000000000000...
ID/EX instr[20-16]	01000
ID/EX instr[15-11]	00010
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0

EX_MEM Brach	0
EX_MEM MemR...	0
EX_MEM MemW...	0
EX_MEM PC_ad...	25708
EX_MEM ALU Z...	0
EX_MEM ALU Res	209
EX_MEM Write d...	104
EX_MEM RegDs...	00011

PC 1000

CC4



User Code

```
1000: 00000000 10100100 00011000 00100000
1004: 00000000 00001000 00010000 00100101
1008: 00000001 00100111 00001000 00100010
1012: 00010000 10101000 00000000 00000001
1016: 00000000 10000110 01001000 00100100
1020: 00000000 10001000 00111000 00100000
```

MIPS Registers

Register	Value
$0	0
$1	101
$2	102
$3	103
$4	104
$5	105
$6	106
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

Pipline Registers

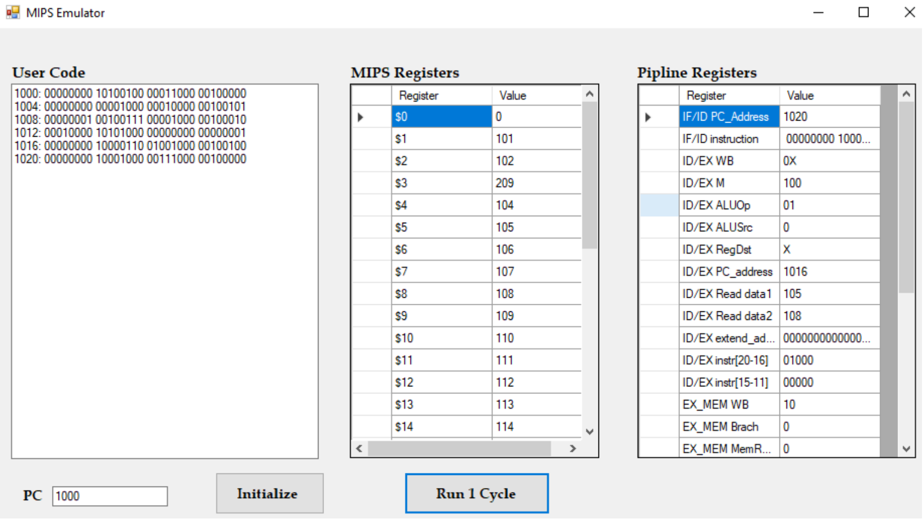
Register	Value
IF/ID PC_Address	1016
IF/ID instruction	00010000 1010...
ID/EX WB	10
ID/EX M	000
ID/EX ALUOp	10
ID/EX ALUSrc	0
ID/EX RegDst	1
ID/EX PC_address	1012
ID/EX Read data1	109
ID/EX Read data2	107
ID/EX extend_ad...	0000000000000...
ID/EX instr[20-16]	00111
ID/EX instr[15-11]	00001
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0

Pipline Registers

Register	Value
ID/EX instr[20-16]	00111
ID/EX instr[15-11]	00001
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0
EX_MEM MemW...	0
EX_MEM PC_ad...	17540
EX_MEM ALU Z...	0
EX_MEM ALU Res	108
EX_MEM Write d...	108
EX_MEM RegDs...	00010
MEM_WB RegW...	1
MEM_WB MemT...	0
MEM_WB Read ...	-1
MEM_WB ALU ...	209
MEM_WB RegD...	00011

PC 1000

CC5



User Code

```
1000: 00000000 10100100 00011000 00100000
1004: 00000000 00001000 00010000 00100101
1008: 00000001 00100111 00001000 00100010
1012: 00010000 10101000 00000000 00000001
1016: 00000000 10000110 01001000 00100100
1020: 00000000 10001000 00111000 00100000
```

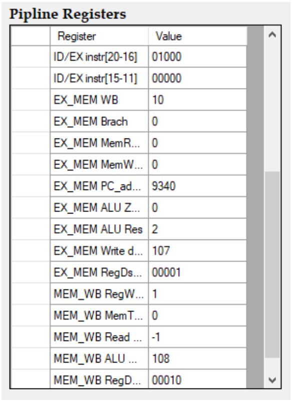
PC 1000

MIPS Registers

Register	Value
$0	0
$1	101
$2	102
$3	209
$4	104
$5	105
$6	106
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

Pipline Registers

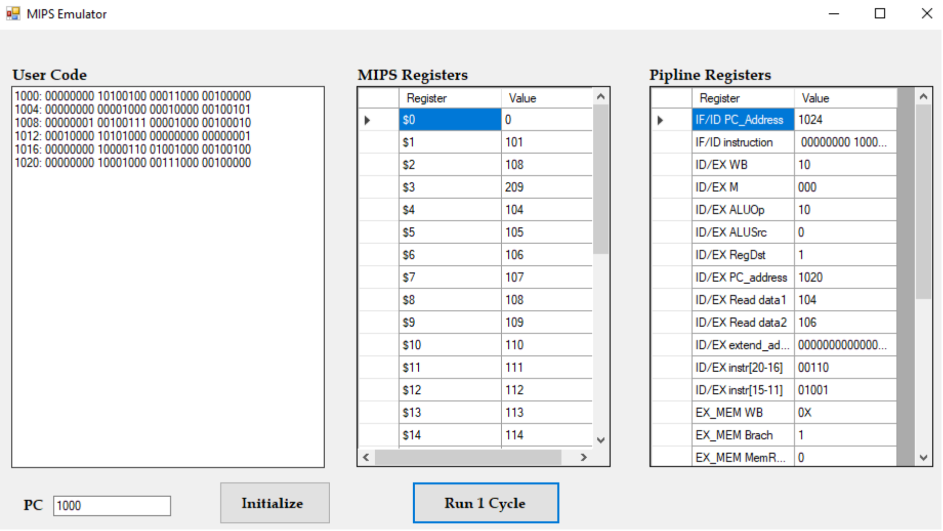
Register	Value
IF/ID PC_Address	1020
IF/ID instruction	00000000 1000...
ID/EX WB	0X
ID/EX M	100
ID/EX ALUOp	01
ID/EX ALUSrc	0
ID/EX RegDst	X
ID/EX PC_address	1016
ID/EX Read data1	105
ID/EX Read data2	108
ID/EX extend_ad...	0000000000000...
ID/EX instr[20-16]	01000
ID/EX instr[15-11]	00000
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0



Pipline Registers

Register	Value
ID/EX instr[20-16]	01000
ID/EX instr[15-11]	00000
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0
EX_MEM MemW...	0
EX_MEM PC_ad...	9340
EX_MEM ALU Z...	0
EX_MEM ALU Res	2
EX_MEM Write d...	107
EX_MEM RegDs...	00001
MEM_WB RegW...	1
MEM_WB MemT...	0
MEM_WB Read ...	-1
MEM_WB ALU ...	108
MEM_WB RegD...	00010

CC6



User Code

```
1000: 00000000 10100100 00011000 00100000
1004: 00000000 00001000 00010000 00100101
1008: 00000001 00100111 00001000 00100010
1012: 00010000 10101000 00000000 00000001
1016: 00000000 10000110 01001000 00100100
1020: 00000000 10001000 00111000 00100000
```

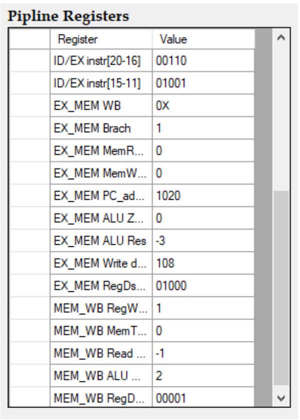
PC 1000

MIPS Registers

Register	Value
$0	0
$1	101
$2	108
$3	209
$4	104
$5	105
$6	106
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

Pipline Registers

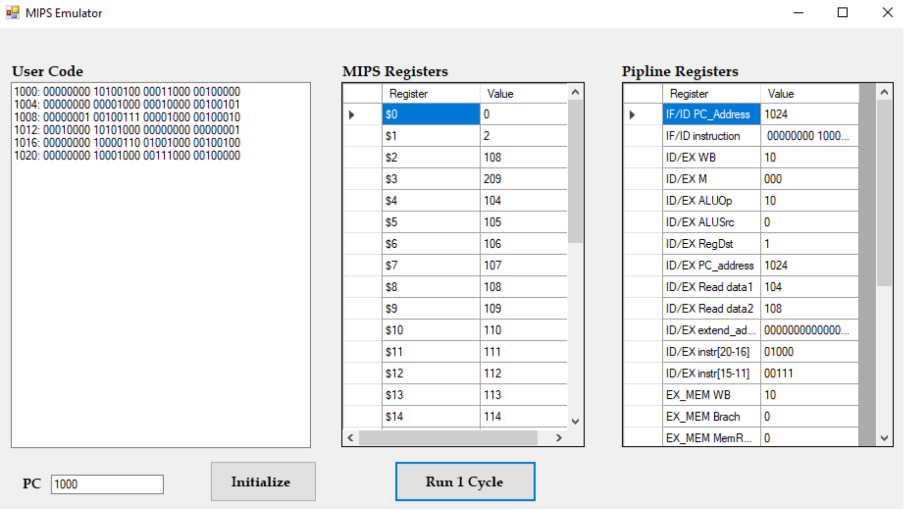
Register	Value
IF/ID PC_Address	1024
IF/ID instruction	00000000 1000...
ID/EX WB	10
ID/EX M	000
ID/EX ALUOp	10
ID/EX ALUSrc	0
ID/EX RegDst	1
ID/EX PC_address	1020
ID/EX Read data1	104
ID/EX Read data2	106
ID/EX extend_ad...	0000000000000...
ID/EX instr[20-16]	00110
ID/EX instr[15-11]	01001
EX_MEM WB	0X
EX_MEM Brach	1
EX_MEM MemR...	0



Pipline Registers

Register	Value
ID/EX instr[20-16]	00110
ID/EX instr[15-11]	01001
EX_MEM WB	0X
EX_MEM Brach	1
EX_MEM MemR...	0
EX_MEM MemW...	0
EX_MEM PC_ad...	1020
EX_MEM ALU Z...	0
EX_MEM ALU Res	-3
EX_MEM Write d...	108
EX_MEM RegDs...	01000
MEM_WB RegW...	1
MEM_WB MemT...	0
MEM_WB Read ...	-1
MEM_WB ALU ...	2
MEM_WB RegD...	00001

CC7



User Code

```
1000: 00000000 10100100 00011000 00100000
1004: 00000000 00001000 00010000 00100101
1008: 00000001 00100111 00001000 00100010
1012: 00010000 10101000 00000000 00000001
1016: 00000000 10000110 01001000 00100100
1020: 00000000 10001000 00111000 00100000
```

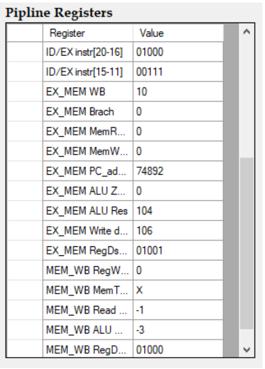
PC 1000

MIPS Registers

Register	Value
$0	0
$1	2
$2	108
$3	209
$4	104
$5	105
$6	106
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

Pipline Registers

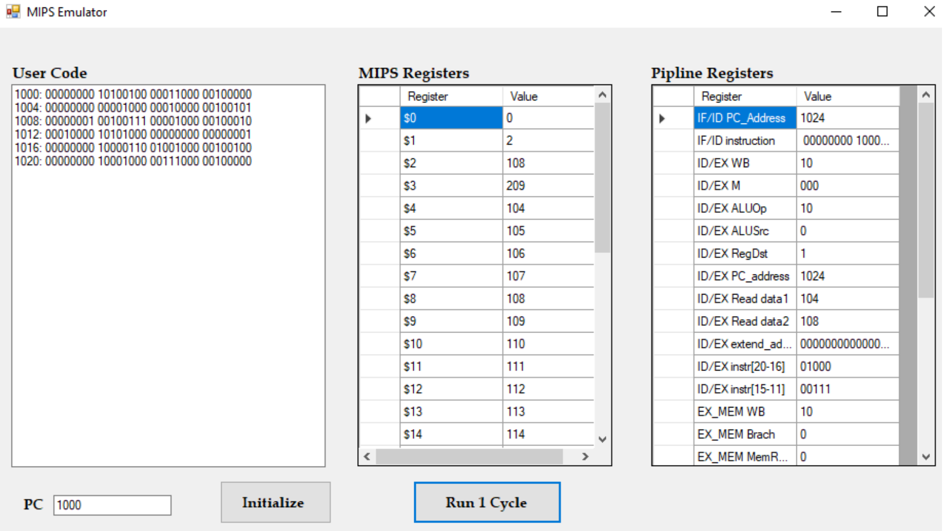
Register	Value
IF/ID PC_Address	1024
IF/ID instruction	00000000 1000...
ID/EX WB	10
ID/EX M	000
ID/EX ALUOp	10
ID/EX ALUSrc	0
ID/EX RegDst	1
ID/EX PC_address	1024
ID/EX Read data1	104
ID/EX Read data2	108
ID/EX extend_ad...	0000000000000...
ID/EX instr[20-16]	01000
ID/EX instr[15-11]	00111
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0



Pipline Registers

Register	Value
ID/EX instr[20-16]	01000
ID/EX instr[15-11]	00111
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0
EX_MEM MemW...	0
EX_MEM PC_ad...	74892
EX_MEM ALU Z...	0
EX_MEM ALU Res	104
EX_MEM Write d...	106
EX_MEM RegDs...	01001
MEM_WB RegW...	0
MEM_WB MemT...	X
MEM_WB Read ...	-1
MEM_WB ALU ...	-3
MEM_WB RegD...	01000

CC8



User Code

```
1000: 00000000 10100100 00011000 00100000
1004: 00000000 00001000 00010000 00100101
1008: 00000001 00100111 00001000 00100010
1012: 00010000 10101000 00000000 00000001
1016: 00000000 10000110 01001000 00100100
1020: 00000000 10001000 00111000 00100000
```

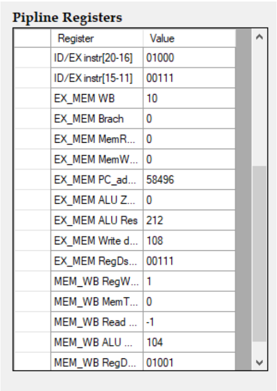
PC 1000

MIPS Registers

Register	Value
$0	0
$1	2
$2	108
$3	209
$4	104
$5	105
$6	106
$7	107
$8	108
$9	109
$10	110
$11	111
$12	112
$13	113
$14	114

Pipline Registers

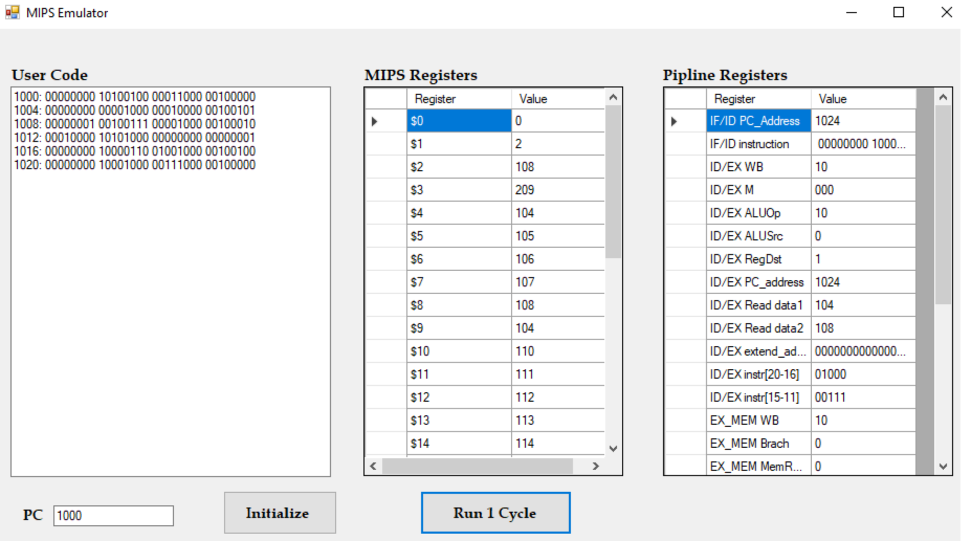
Register	Value
IF/ID PC_Address	1024
IF/ID instruction	00000000 1000...
ID/EX WB	10
ID/EX M	000
ID/EX ALUOp	10
ID/EX ALUSrc	0
ID/EX RegDst	1
ID/EX PC_address	1024
ID/EX Read data1	104
ID/EX Read data2	108
ID/EX extend_ad...	0000000000000...
ID/EX instr[20-16]	01000
ID/EX instr[15-11]	00111
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0



Pipline Registers

Register	Value
ID/EX instr[20-16]	01000
ID/EX instr[15-11]	00111
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0
EX_MEM MemW...	0
EX_MEM PC_ad...	58496
EX_MEM ALU Z...	0
EX_MEM ALU Res	212
EX_MEM Write d...	108
EX_MEM RegDs...	00111
MEM_WB RegW...	1
MEM_WB MemT...	0
MEM_WB Read ...	-1
MEM_WB ALU ...	104
MEM_WB RegD...	01001

CC9



User Code

```
1000: 00000000 10100100 00011000 00100000
1004: 00000000 00001000 00010000 00100101
1008: 00000001 00100111 00001000 00100010
1012: 00010000 10101000 00000000 00000001
1016: 00000000 10000110 01001000 00100100
1020: 00000000 10001000 00111000 00100000
```

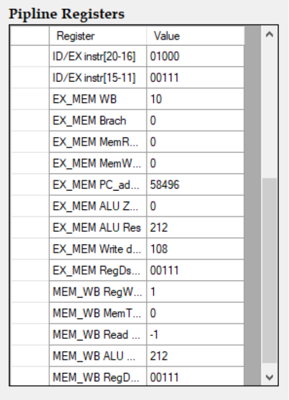
PC 1000

MIPS Registers

Register	Value
$0	0
$1	2
$2	108
$3	209
$4	104
$5	105
$6	106
$7	107
$8	108
$9	104
$10	110
$11	111
$12	112
$13	113
$14	114

Pipline Registers

Register	Value
IF/ID PC_Address	1024
IF/ID instruction	00000000 1000...
ID/EX WB	10
ID/EX M	000
ID/EX ALUOp	10
ID/EX ALUSrc	0
ID/EX RegDst	1
ID/EX PC_address	1024
ID/EX Read data1	104
ID/EX Read data2	108
ID/EX extend_ad...	0000000000000...
ID/EX instr[20-16]	01000
ID/EX instr[15-11]	00111
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0



Pipline Registers

Register	Value
ID/EX instr[20-16]	01000
ID/EX instr[15-11]	00111
EX_MEM WB	10
EX_MEM Brach	0
EX_MEM MemR...	0
EX_MEM MemW...	0
EX_MEM PC_ad...	58496
EX_MEM ALU Z...	0
EX_MEM ALU Res	212
EX_MEM Write d...	108
EX_MEM RegDs...	00111
MEM_WB RegW...	1
MEM_WB MemT...	0
MEM_WB Read ...	-1
MEM_WB ALU ...	212
MEM_WB RegD...	00111