ASSESSMENT-2

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1)DIVISION OPERATION

AIM:

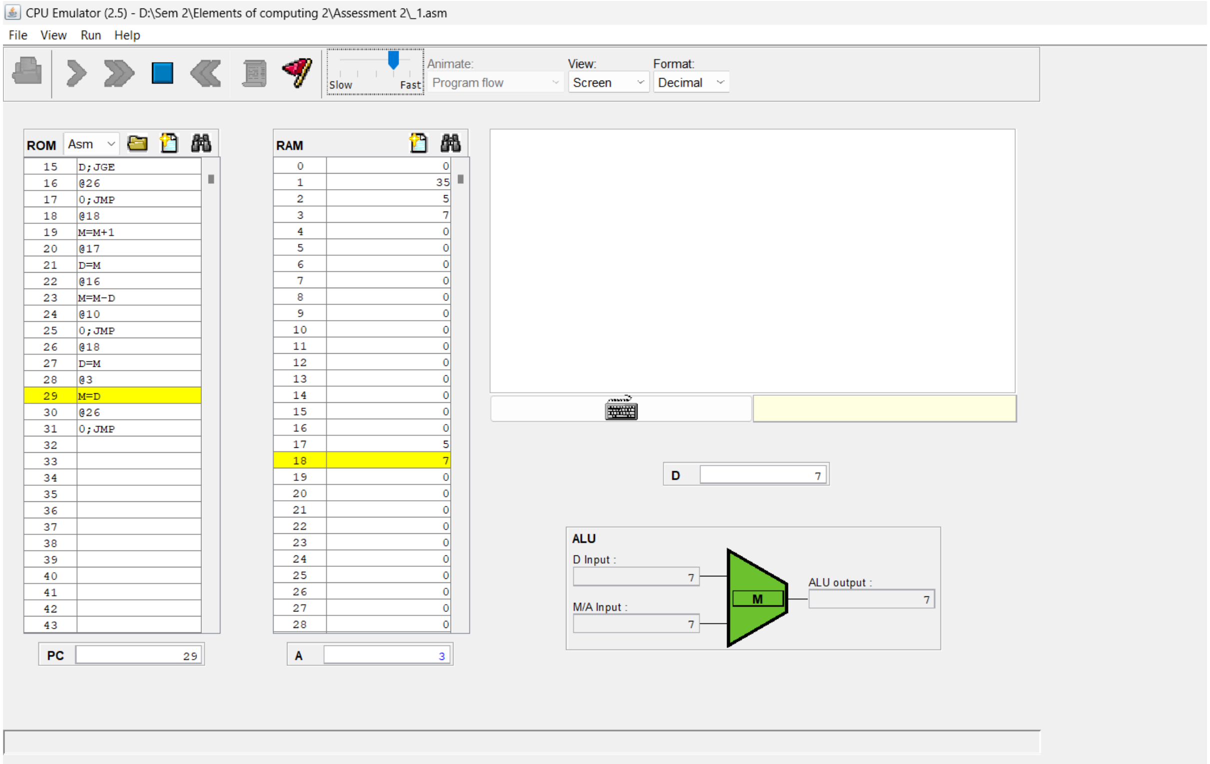
To execute division operation in CPU emulator using Hack Assembly Language.

HACK ASSEMBLY CODE:

```
0   @1
1   D=M
2   @16
3   M=D
4   @2
5   D=M
6   @17
7   M=D
8   @18
9   M=0
10 @16
11 D=M
12 @17
13 D=D-M
14 @18
15 D;JGE
16 @26
17 0;JMP
18 @18
19 M=M+1
20 @17
21 D=M
22 @16
23 M=M-D
24 @10
25 0;JMP
26 @18
27 D=M
```

```
28 @3
29 M=D
30 @26
31 0;JMP
```

VERIFICATION SCREENSHOT:



CPU Emulator (2.5) - D:\Sem 2\Elements of computing 2\Assessment 2_1.asm

Animate: Program flow
View: Screen
Format: Decimal

ROM: Asm

15	D;JGE
16	@26
17	0;JMP
18	@18
19	M=M+1
20	@17
21	D=M
22	@16
23	M=M-D
24	@10
25	0;JMP
26	@18
27	D=M
28	@3
29	M=D
30	@26
31	0;JMP
32	
33	
34	
35	
36	
37	
38	
39	
40	
41	
42	
43	

PC: 29

RAM

0	0
1	35
2	5
3	7
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	5
18	7
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0

A: 3

D: 7

D Input : 7

M/A Input : 7

ALU output : 7

RESULT:

The Division operation is executed successfully using CPU emulator in Nand2tetris using Hack Assembly Language.

2) THE GREATEST AMONG TWO NUMBERS

AIM:

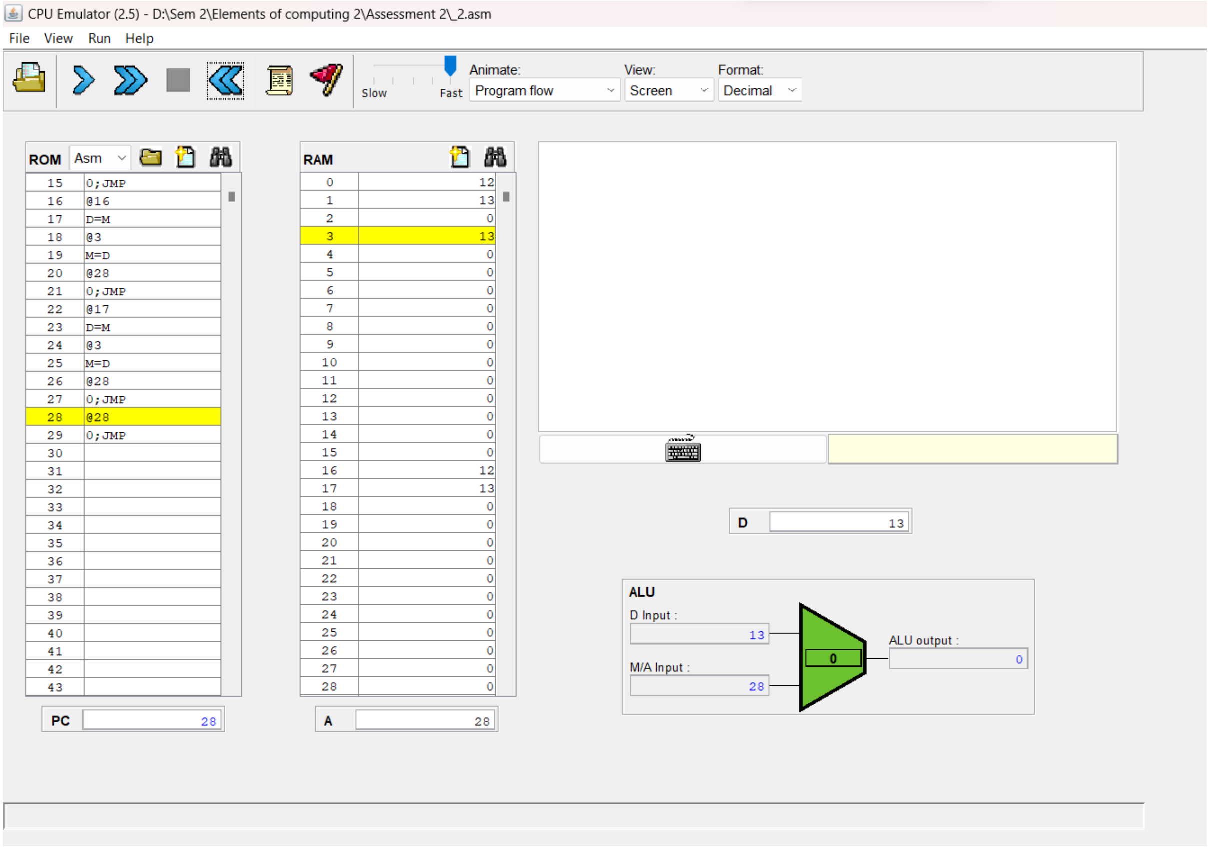
To execute greatest among two numbers in CPU emulator using Hack Assembly Language.

HACK ASSEMBLY CODE:

```
 0   @0
 1   D=M
 2   @16
 3   M=D
 4   @1
 5   D=M
 6   @17
 7   M=D
 8   @16
 9   D=M
10 @17
11 D=D-M
12 @16
13 D;JGT
14 @22
15 0;JMP
16 @16
17 D=M
18 @3
19 M=D
20 @28
21 0;JMP
22 @17
23 D=M
24 @3
25 M=D
26 @28
27 0;JMP
28 @28
```

29 0;JMP

VERIFICATION SCREENSHOT:



CPU Emulator (2.5) - D:\Sem 2\Elements of computing 2\Assessment 2_2.asm

Animate: Program flow

View: Screen

Format: Decimal

ROM Asm

ROM	
15	0;JMP
16	@16
17	D=M
18	@3
19	M=D
20	@28
21	0;JMP
22	@17
23	D=M
24	@3
25	M=D
26	@28
27	0;JMP
28	@28
29	0;JMP
30	
31	
32	
33	
34	
35	
36	
37	
38	
39	
40	
41	
42	
43	

RAM	
0	12
1	13
2	0
3	13
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	12
17	13
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0

PC 28

A 28

D 13

ALU

D Input : 13

M/A Input : 28

ALU output : 0

RESULT:

Find the greatest among the two numbers is executed successfully using CPU emulator in Nand2tetris using Hack Assembly Language.

3) Create an array of size 10 with values -1

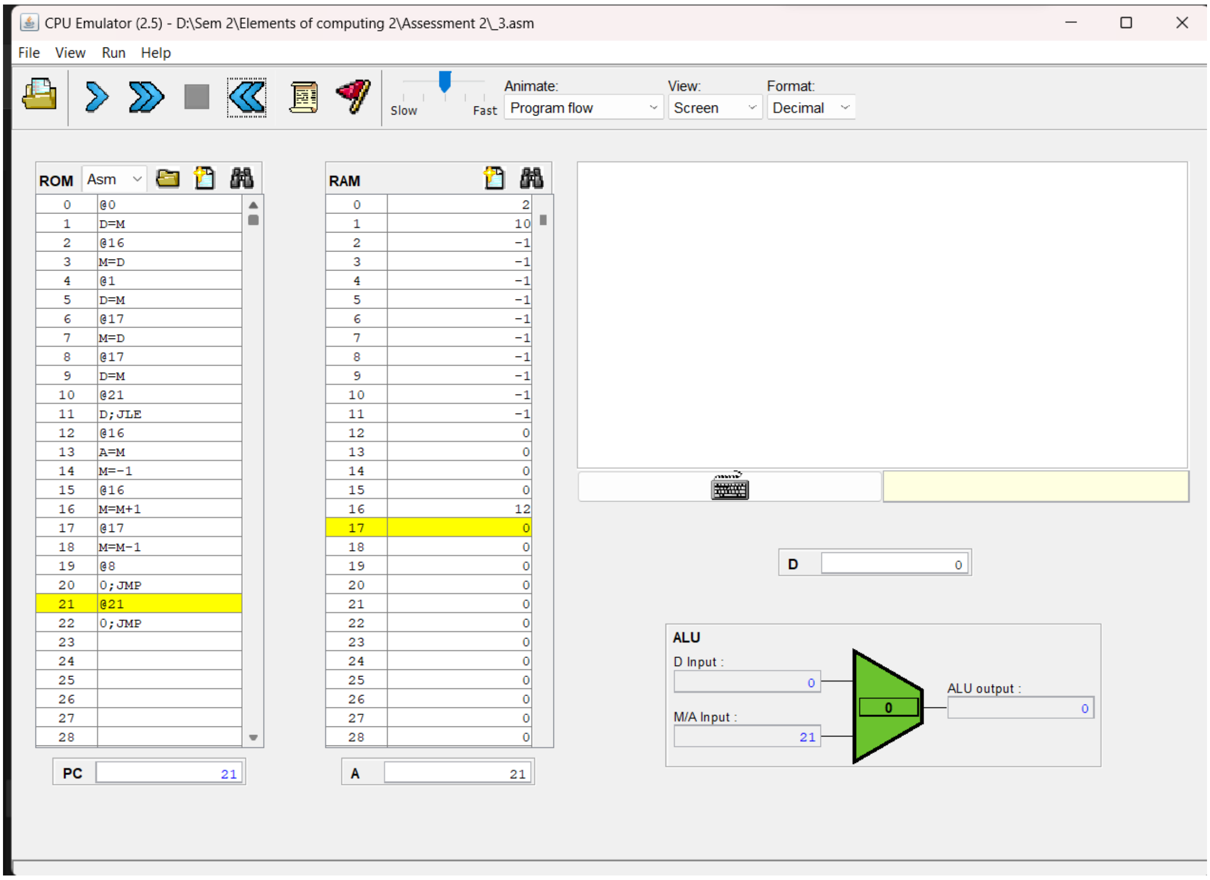
AIM:

To execute an array of size 10 with values -1 in CPU emulator using Hack Assembly Language.

HACK ASSEMBLY CODE:

```
0   @0
1   D=M
2   @16
3   M=D
4   @1
5   D=M
6   @17
7   M=D
8   @17
9   D=M
10 @21
11 D;JLE
12 @16
13 A=M
14 M=-1
15 @16
16 M=M+1
17 @17
18 M=M-1
19 @8
20 0;JMP
21 @21
22 0;JMP
```

VERIFICATION SCREENSHOT:



CPU Emulator (2.5) - D:\Sem 2\Elements of computing 2\Assessment 2_3.asm

Animate: Program flow

View: Screen

Format: Decimal

ROM Asm

ROM	
0	@0
1	D=M
2	@16
3	M=D
4	@1
5	D=M
6	@17
7	M=D
8	@17
9	D=M
10	@21
11	D;JLE
12	@16
13	A=M
14	M=-1
15	@16
16	M=M+1
17	@17
18	M=M-1
19	@8
20	0;JMP
21	@21
22	0;JMP
23	
24	
25	
26	
27	
28	

RAM	
0	2
1	10
2	-1
3	-1
4	-1
5	-1
6	-1
7	-1
8	-1
9	-1
10	-1
11	-1
12	0
13	0
14	0
15	0
16	12
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0

PC 21

A 21

D 0

ALU

D Input : 0

M/A Input : 21

ALU output : 0

RESULT:

Creating an array with size 10 with values -1 is executed successfully using CPU emulator in Nand2tetris using Hack Assembly Language.

4) DRAW A RECTANGLE AT THE UPPER RIGHT CORNER OF THE SCREEN.

AIM:

To execute a rectangle at the upper right corner of the screen in CPU emulator using Hack Assembly Language.

HACK ASSEMBLY CODE:

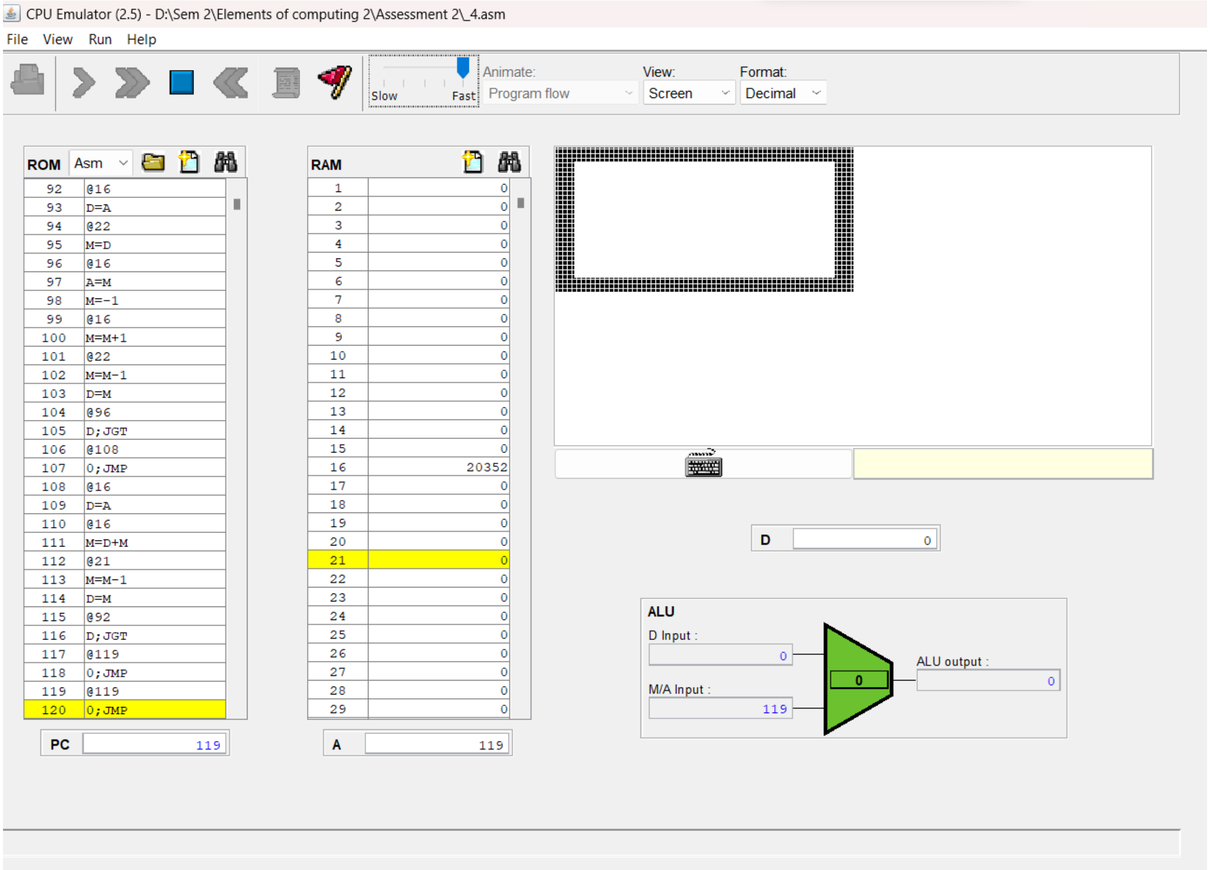
```
0    @16384
1    D=A
2    @16
3    M=D
4    @12
5    D=A
6    @17
7    M=D
8    @16
9    D=A
10   @18
11   M=D
12   @16
13   A=M
14   M=-1
15   @16
16   M=M+1
17   @18
18   M=M-1
19   @18
20   D=M
21   @12
22   D;JGT
23   @25
24   0;JMP
25   @16
26   D=A
```

```
27  @16
28  M=D+M
29  @17
30  M=M-1
31  @17
32  D=M
33  @8
34  D;JGT
35  @37
36  0;JMP
37  @100
38  D=A
39  @19
40  M=D
41  @1
42  D=A
43  @20
44  M=D
45  @16
46  A=M
47  M=-1
48  @16
49  M=M+1
50  @20
51  M=M-1
52  D=M
53  @45
54  D;JGT
55  @57
56  0;JMP
57  @14
58  D=A
59  @16
60  M=D+M
61  @1
62  D=A
63  @20
64  M=D
65  @16
66  A=M
67  M=-1
```

```
68  @16
69  M=M+1
70  @20
71  M=M-1
72  D=M
73  @65
74  D;JGT
75  @77
76  0;JMP
77  @16
78  D=A
79  @16
80  M=D+M
81  @19
82  M=M-1
83  D=M
84  @41
85  D;JGT
86  @88
87  0;JMP
88  @12
89  D=A
90  @21
91  M=D
92  @16
93  D=A
94  @22
95  M=D
96  @16
97  A=M
98  M=-1
99  @16
100 M=M+1
101 @22
102 M=M-1
103 D=M
104 @96
105 D;JGT
106 @108
107 0;JMP
108 @16
```

```
109 D=A
110 @16
111 M=D+M
112 @21
113 M=M-1
114 D=M
115 @92
116 D;JGT
117 @119
118 0;JMP
119 @119
120 0;JMP
```

VERIFICATION SCREENSHOT:



CPU Emulator (2.5) - D:\Sem 2\Elements of computing 2\Assessment 2_4.asm

Animate: Program flow
View: Screen
Format: Decimal

ROM (Asm)

ROM	Asm
92	@16
93	D=A
94	@22
95	M=D
96	@16
97	A=M
98	M=-1
99	@16
100	M=M+1
101	@22
102	M=M-1
103	D=M
104	@96
105	D;JGT
106	@108
107	0;JMP
108	@16
109	D=A
110	@16
111	M=D+M
112	@21
113	M=M-1
114	D=M
115	@92
116	D;JGT
117	@119
118	0;JMP
119	@119
120	0;JMP

PC: 119

RAM

RAM	
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	20352
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0
29	0

A: 119

D: 0

ALU

D Input : 0

M/A Input : 119

ALU output : 0

RESULT:

Draw a rectangle at the upper right corner of the screen is executed successfully using CPU emulator in Nand2tetris using Hack Assembly Language.

5) Blacken the entire pixels on the screen on a keypress by the user.

AIM:

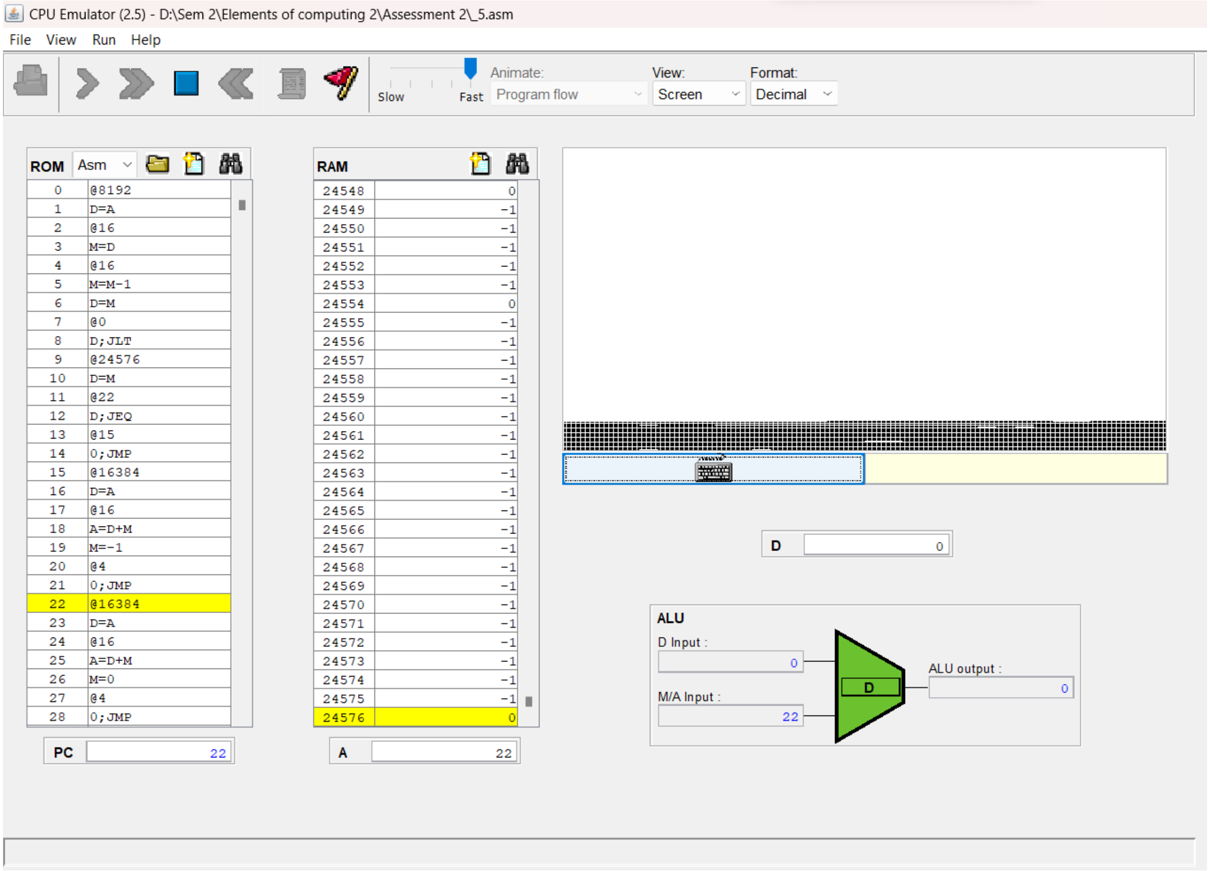
To execute blacken the entire pixels on the screen on a keypress by the user in CPU emulator using Hack Assembly Language.

HACK ASSEMBLY CODE:

```
0   @8192
1   D=A
2   @16
3   M=D
4   @16
5   M=M-1
6   D=M
7   @0
8   D;JLT
9   @24576
10 D=M
11 @22
12 D;JEQ
13 @15
14 0;JMP
15 @16384
16 D=A
17 @16
18 A=D+M
19 M=-1
20 @4
21 0;JMP
22 @16384
23 D=A
24 @16
25 A=D+M
26 M=0
27 @4
```

28 0;JMP

VERIFICATION SCREENSHOT:



CPU Emulator (2.5) - D:\Sem 2\Elements of computing 2\Assessment 2_5.asm

Animate: Program flow

View: Screen

Format: Decimal

ROM (Asm)

```
0   @8192
1   D=A
2   @16
3   M=D
4   @16
5   M=M-1
6   D=M
7   @0
8   D;JLT
9   @24576
10  D=M
11  @22
12  D;JEQ
13  @15
14  0;JMP
15  @16384
16  D=A
17  @16
18  A=D+M
19  M=-1
20  @4
21  0;JMP
22  @16384
23  D=A
24  @16
25  A=D+M
26  M=0
27  @4
28  0;JMP
```

RAM

```
24548   0
24549  -1
24550  -1
24551  -1
24552  -1
24553  -1
24554   0
24555  -1
24556  -1
24557  -1
24558  -1
24559  -1
24560  -1
24561  -1
24562  -1
24563  -1
24564  -1
24565  -1
24566  -1
24567  -1
24568  -1
24569  -1
24570  -1
24571  -1
24572  -1
24573  -1
24574  -1
24575  -1
24576   0
```

PC 22

A 22

D 0

D Input : 0

M/A Input : 22

ALU output : 0

RESULT:

blacken the entire pixels on the screen on a keypress by the user is executed successfully using CPU emulator in Nand2tetris using Hack Assembly Language.