Computer System

The goal is to comprehend how a machine code instruction directs various parts of a Hack computer to carry out specific functions. This entails dissecting the fetch-execute cycles of particular instructions in an assembly programme written in Hack form that adds up all the numbers between one and one hundred and puts the result in register R1.

```
//Calculates the sum of numbers 1 to
100 and store the result in R1
//Initializing the variables
@i
M=0
@sum
M=0
@100
D=A
@n
M=D
//The loop that calculates the sum
(LOOP)
@i
D=M
@n
D=D-M
@STOP
D;JEQ // if i == n goto STOP
@sum
D=M
@i
M=M+1 // i = i +1
D=D+M
@sum
M=D // sum = sum + i
@LOOP
0;JMP
(STOP)
@sum
```

```
D=M
@R1
M=D     // RAM[1] = sum
```

Symbol	Value
R0	0
R1	1
R2	2
…	…
R15	15
SCREEN	16384
KBD	24576
SP	0
LCL	1
ARG	2
THIS	3
THAT	4
LOOP	8
STOP	23
i	16
sum	17
n	18

Program Memory

Address	Instruction
0	@i
1	M=0
2	@sum
3	M=0
4	@100
5	D=A
6	@n
7	M=D
8	(LOOP)
9	@i
10	D=M
11	@n
12	D=D-M
13	@STOP
14	D;JEQ
15	@sum
16	D=M
17	@i
18	M=M+1
19	D=D+M
20	@sum
21	M=D
22	@LOOP
23	0;JMP
24	(STOP)
25	@sum
26	D=M
27	@R1
28	M=D

@i
Fetch: The instruction is fetched from the program memory at address PC.
Execute: The A register is loaded with the value of i (0).

D=M
Fetch: The instruction is fetched from the program memory at address PC+1.
Execute: The D register is loaded with the value stored in the memory address specified by the A register (0).

@n
Fetch: The instruction is fetched from the program memory at address PC+2.
Execute: The A register is loaded with the value of n (100).

D=D-M
Fetch: The instruction is fetched from the program memory at address PC+3.
Execute: The D register is updated by subtracting the value stored in the memory address specified by the A register (100) from the current value in the D register (0). The result is stored in the D register (-100).

@STOP
Fetch: The instruction is fetched from the program memory at address PC+4.
Execute: The A register is loaded with the value of STOP (26).

D;JEQ
Fetch: The instruction is fetched from the program memory at address PC+5.
Execute: The value in the D register (-100) is checked. Since it is not equal to 0, the JEQ condition is false, and the PC is incremented by 1.

@sum
Fetch: The instruction is fetched from the program memory at address PC+6.
Execute: The A register is loaded with the value of sum (17).

D=M
Fetch: The instruction is fetched from the program memory at address PC+7.
Execute: The D register is loaded with the value stored in the memory address specified by the A register (17) (0).

@i
Fetch: The instruction is fetched from the program memory at address PC+8.
Execute: The A register is loaded with the value of i (16).

M=M+1
Fetch: The instruction is fetched from the program memory at address PC+9.
Execute: The value in the memory address specified by the A register (16) is incremented by 1. The result is stored in the memory address (1).

D=D+M
Fetch: The instruction is fetched from the program memory at address PC+10.
Execute: The D register is updated by adding the value stored in the memory address specified by the A register (1) to the current value in the D register (0). The result is stored in the D register (1).

@sum
Fetch: The instruction is fetched from the program memory at address PC+11.
Execute: The A register is loaded with the value of sum (17).

M=D
Fetch: The instruction is fetched from the program memory at address PC+12.
Execute: The value in the D register (1) is stored in the memory address specified by the A register (17).

@LOOP
Fetch: The instruction is fetched from the program memory at address PC+13.
Execute: The A register is loaded with the value of LOOP (10).

0;JMP
Fetch: The instruction is fetched from the program memory at address PC+14.
Execute: The PC is set to the value in the A register (10).

Buses
Control bus: Carries control signals from the control unit to various components in the computer.
Address bus: Carries memory addresses from the CPU to the memory unit.
Data bus: Carries data between the CPU and the memory unit.