LAB 1
Using Visual Emulator

Download the emulator
https://salmanarif.bitbucket.io/visual/downloads.html

Answer to questions (Q)
Load the following Program in Visual Emulator

; The purpose of this program is to add: aa+bb=cc
;
; First we define the variables; The variables are stored in locations 0x100-0x108 in the MEMMORY

aa DCD 0x00112233 ;load (32 bit) value 0x00000001 into memory location 0x100 (by default) call it aa

bb DCD 2 ;load (32 bit) value 0x00000002 into memory location 0x104 (by default)

cc DCD 0 ;load (32 bit) value 0x00000000 into memory location 0x108 (by default)

main
LDR r1, =aa ;load memory address of aa into r1 After execution: PC = 0xC+4
LDR r2, [r1] ;load content of memory address in r1 into r2 (that is 0x0001)
LDR r3, =bb
LDR r4, [r3]
ADDS r5, r2, r4 ;r2+r4 -> r5 and update flags
LDR r6, =cc ;load memory address of cc into r6
STR r5, [r6] ;store the sum into variable cc
; this section shows that the sum is infact loaded into cc
LDR r7, =cc
LDR r8, [r7]
; cc+1--> r9
ADDS r9, r8, #1
END
Execute the Program:

Click on Step Forward
See what happens as you step through

Note how registers R1-R9 change

Note that the memory address for aa is 0x100, for bb is 0x104 and so far....

Click on HEX BIN and DEC and see the values.

**Question:**

Q1. What is the largest value of aa variable in HEX and DECIMAL? How many bits are required to represent this value?

Q2. What is the memory address of cc?
See what happens as you step through

Note that every time an instruction is executed, the PC value is increased.

Note that as ADDS is executed, the color of CSPR changes indicating it is being updated.

**Question:**

Q3. By the time the program is completed, what is the value of PC?
See what happens as you step through

Note that every time an instruction is executed the INTRUCTION clock cycle is increased.

**Question:**

Q4. How many instruction cycles are required to execute ADDS instruction?

Q5. How many instruction cycles are required to execute STR instruction?

Q6. How many instruction cycles are required to complete this code?
As you execute ....Click on MEMORY when LDR is executed. Note that you can see the Memory address for variable aa this is where it is saved.

Q7. How many bytes variable aa has?

```
2 ; First we define the variables; The variables are stored in
3 aa DCD 0x00112233 ;load (32 bit) value 0x00000001 into mem
4 bb DCD 2 ;load (32 bit) value 0x00000002 into mem
5 cc DCD 0 ;load (32 bit) value 0x00000000 into mem

7 main
8 LDR r1, =aa ;load memory address of variable aa into r1
9 LDR r2, [r1] ;load content of Memory into r2

10 LDR r3, =bb
11 LDR r4, [r3]
12 ADDS r5, r2, r4 ;r2+r4 -> r5 and union
13 LDR r6, =cc
14 STR r5, [r6] ;store the sum into variable cc
15 ; this section shows that the sum is in fact located
16 LDR r7, =cc
17 LDR r8, [r7]
18 ; let's check cc+1---> r9
19 ADDS r9, r8, #1
20 END
```
There are two separate memory structures for DATA and INSTRUCTIONS. The DATA MEMORY in this EMUALTOR starts from 0x100. However, the Instruction MEMORY starts from 0x0. We know that based on the value of the PC.

Note that in this case as PC increases, it points to a new instruction.

Q8. What is the PC value AFTER `ADDS r9, r8, #1` is executed?

Q9. What Does PC stand for?
ADD the following code to the end of your program. Step through the program and see how R1 changes.

Q10. Clearly explain what is happening to R1. What does RRX instruction do?

Q11. Mathematically every time RRX is performed what happens?

Q12. What does B instruction do?