MICROPROCESSOR LAB EXPERIMENT 6

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Introduction :

- In this experiment, we will observe various aspects relating to the ARM assembly language.
- We will also write a few programs in ARM assembly. We will use Keil μVision software to run the ARM assembly language programs
- ARM stands for **Advanced RISC Machine** which is bit more advanced than AVR.

ARM and Keil μvison :

- ARM architectures are the most common electronic design in the world.
- It is known for its speed.
- Using an ARM architecture gives hardware designers more control over their designs and performance, as well as more control over their supply chains.
- In this experiment , we use **LPC2378** microcontroller for operations.
- The tasks that we are going to perform here will help us know the basic operations in ARM.
- By using these we will analyse the various instructions available in ARM and get familiar with those.

Instructions used :

Instruction	Usage
LDR Rx,Rd	Load the value at the memory **Rd** in the register **Rx**
ADD Rx,Rm,k	Add the values in the registers **Rm** and **K** i.e this can be a value and store it in the register **Rx**.
MUL Rx,Rm,K	Multiply the values in the registers **Rm** and **K** i.e this can be a value and store it in the register
STR Rm,Rx	Store the address of the register **Rx** in the pointer **Rm**
MOV Rm1,Rm2	Copy the value stored in the register **Rm1** to the register **Rm2**
SUB Rm1,Rm2,k	Subtract the values in the registers **Rm** and **K** i.e this can be a value and store it in the register **Rx**.
CMP Rm1,Rm2	Compare the values of the registers **Rm1** and **Rm2** and raise the following flags in the status registers - Sign flag - Negative flag - Carry flag if the first value is smaller than the second value.
DEC Rm	Decrease the value in the register **Rm** by an unit.
BEQ	It is a conditional statement to check if the zero flag is raised and move to the given pointer.
SWI &11	It is used to break the program counter and end the program.

Introductory tasks

Introduction :

- This task involves knowing the basic instructions given in the table.
- First two tasks are solved below.

Code - Task-1

```
        AREA Program, CODE, READONLY
        ENTRY
                MOV r0,#11
stop
        B stop
        END
```

Explanation

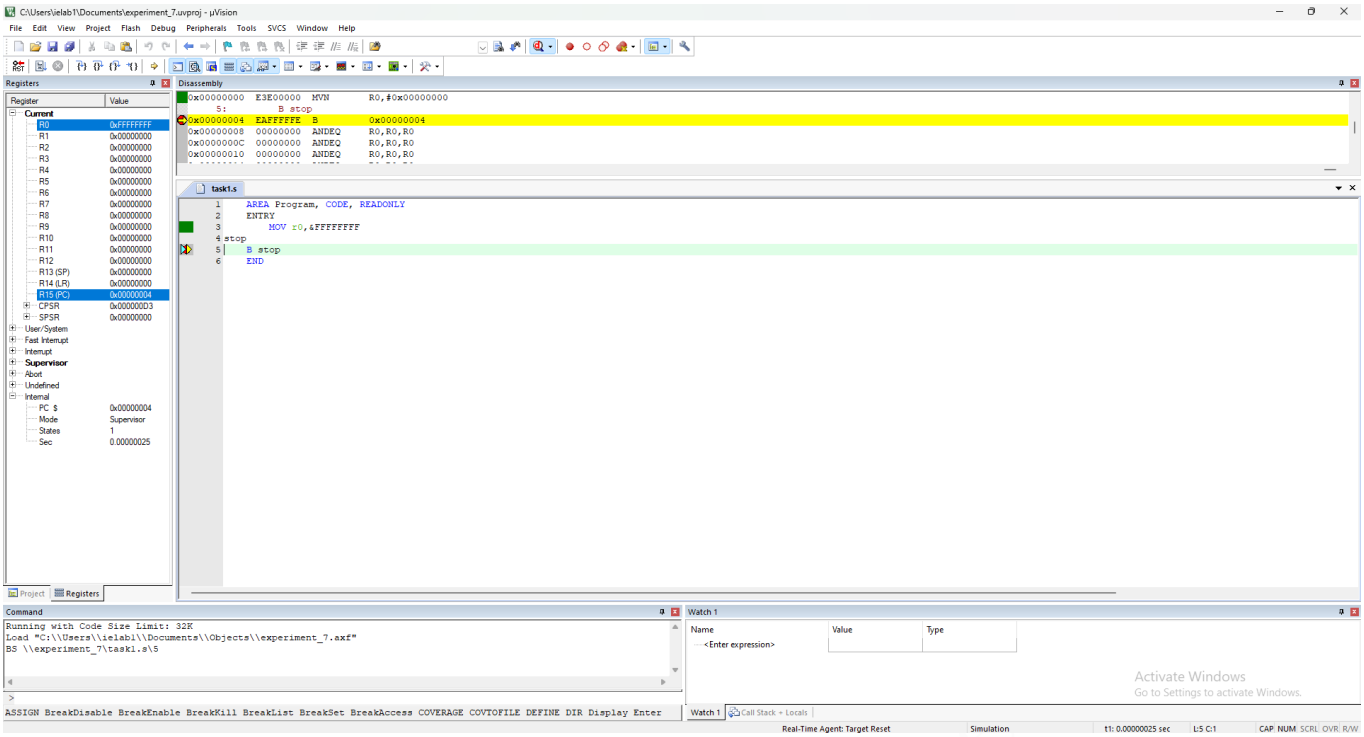
- AREA , CODE , READONLY are assembler directives that direct the code to begin the program and run throgh it.
- **MOV** copies the value to the register.
- # means decimal format.

Code - Task-2

```
        AREA Program, CODE, READONLY
        ENTRY
                MOV r0,&FFFFFFFF
stop
        B stop
        END
```

Explanation

- This code is supposed to create an error but suprisingly it does not.
- $ means it is in hexadecimal format.
- The error is because the value given at the second argument should be of 8 bits , but it exceeds.
- This is because ARM compiler 5 recognises the error and adds the necessary instructions on its own.



Task-3

Introduction :

- In this task , we will execute the given assembly code and check the value at each registers.

Code

```
        AREA Reset, CODE, READONLY
        ENTRY
                LDR r0,  = 7
                MUL r1, r0, r0
                LDR r2,  = 4
                MUL r1, r2, r1
                LDR r3,  = 3
                MUL r3, r0, r3
     ADD r1, r1, r3
stop
                B stop

       END
```

Explanation :

- Let us analyse it line by line.

Line-1:

```
        LDR r0,  = 7
```

This creates a label to number 7 and assigns the value 7 to register **R0**

R0 = 0x00000007

Line-2:

```
        MUL r1, r0, r0
```

This multiplies the value stored in **R0** with that of **R0** and stores it in the register **R1**.

R0 = 0x00000007

R1 = 0x00000031

Line-3:

```
        LDR r2,  = 4
```

This creates a label to number 7 and assigns the value 4 to register **R2**

R0 = 0x00000007

R1 = 0x00000031

R2 = 0x00000004

Line-4:

```
        MUL r1, r2, r1
```

This multiplies the value stored in **R2** with that of **R1** and stores it in the register **R1**.

R0 = 0x00000007
R1 = 0x000000C4
R2 = 0x00000004

Line-5:

```
1       LDR r3, = 3
```

This creates a label to number 3 and assigns the value 4 to register **R3**

R0 = 0x00000007
R1 = 0x000000C4
R2 = 0x00000004
R3 = 0x00000003

Line-6:

```
1       MUL r3, r0, r3
```

This multiplies the value stored in **R0** with that of **R3** and stores it in the register **R3**.

R0 = 0x00000007
R1 = 0x000000C4
R2 = 0x00000004
R3 = 0x00000015

Line-7:

```
1       ADD r1, r1, r3
```

This adds the value stored in **R1** with that of **R3** and stores it in the register **R1**.

R0 = 0x00000007
R1 = 0x000000D9
R2 = 0x00000004
R3 = 0x00000015

Task-4

Introduction :

- In this task , we will obtain the tenth number in a Fibonacci sequence.

Code

```
AREA Reset, CODE, READONLY
        ENTRY
                LDR r0, =8 ;counter
                LDR r1,=0 ;second last term
                LDR r2,=1 ;last term
LOOP
                MOV r3,r1 ;copying content to temporary register
                MOV r1,r2 ;updating second last term
                ADD r2,r3 ;calculating last term
                SUBS r0,r0,#1 ;decrement counter
                BNE LOOP
stop
                B stop
       END
```

Explanation :

- r0 is the counter. The program stops when r0 becomes zero.
- r1 stores the second last term of the sequence.
- r2 stores the last calculated term of the sequence.

Task-5

Introduction :

- In this task , we will divide a 32-bit binary number by a 16-bit binary number and store the quotient as well as the remainder.

Code

```
        AREA Program, CODE, READONLY
        ENTRY
                LDR r0,Num1
                LDR r1,Num2
                MOV r2,#0
Loop
                CMP r1,#0 ;test division by 0
                BEQ Error1
                CMP r0,r1 ;is the dividend less than the divisor ?
                BMI Result ;if yes, then we are done
                ADD r2,#1 ;add one to quotient
                SUB r0,r1
                B Loop
Error1
                MOV R3, #0xFFFFFFFF ;error flag (-1)
Result
                LDR R4, = Remainder ;store the remainder and quotient
                STR R0,[R4]
                LDR R5, = Quotient
                STR R2,[R5]
                SWI &11
Num1 DCD &00000009
Num2 DCD &00000005
        ALIGN
        AREA Data2, DATA, Readwrite
Quotient DCD 0
Remainder DCD 0
        END
```