LAB-03

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Aim:-

To (a) learn the architecture of ARM processor (b) learn basics of ARM instruction set, in particular the ARM instructions pertaining to computations (c) go through example programs and (d) write assembly language programs for the given set of (computational) problems

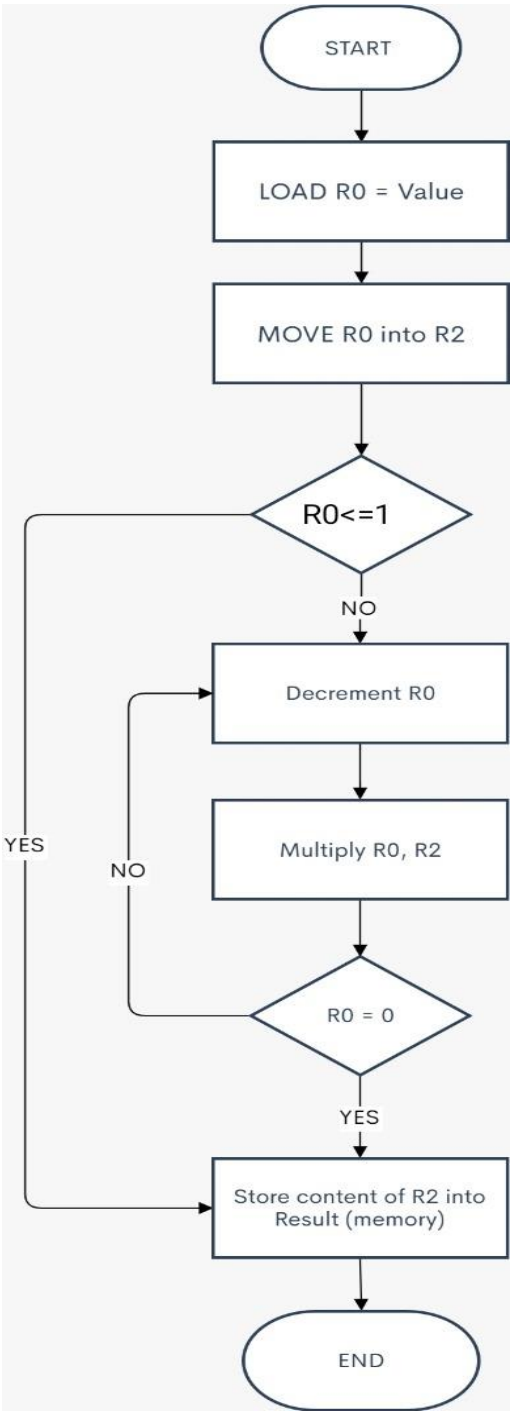
Tasks:

Engineering Problem Solve the following engineering problems using ARM through assembly programs

1. Compute the factorial of a given number using ARM processor through assembly programming
2. Combine the low four bits of each of the four consecutive bytes beginning at LIST into one 16-bit halfword. The value at LIST goes into the most signicant nibble of the result. Store the result in the 32-bit variable RESULT.
3. Given a 32 bit number, identify whether it is an even or odd. (You implementation should not involve division).

SOLUTIONS:-

1) FLOW CHART

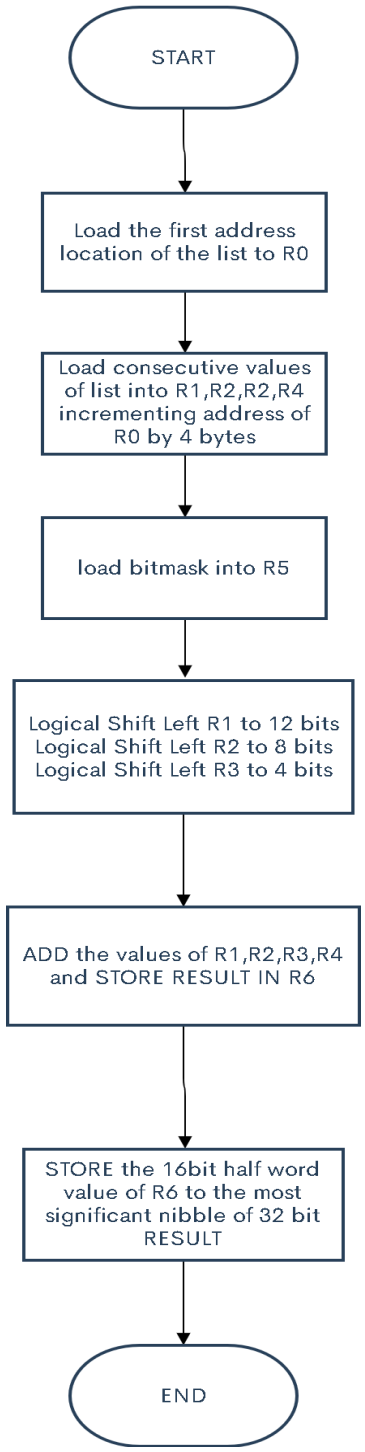


CODE:

```
*       FACTORIAL OF A NUMBER
        TTL    factorial
        AREA Program, CODE, READONLY
        ENTRY

Main            LDR    R0, Value
                MOV  R2, R0

                CMP  R0, #1          ; CHECK R0 WITH DECIMAL VALUE 1
                BGT  FACT            ; IF VALUE >1 THEN JMP TO FACT

                MOV  R2, #1
                STR  R2, RESULT      ; For VALUE== 1 OR 0 we are storing
                                     ; RESULT=1(ie.,0!=1!=1)
                SWI &11

FACT    SUB  R0, #1                   ; USING R0 AS A COUNTER

REPEAT          MUL  R2, R0,R2           ; R2=R0*R2
                SUBS R0, R0, #1           ; R0=R0-1 SET THE FLAG RESGISTER VALUES
                BNE  REPEAT
                STR  R2, RESULT

HERE    B       HERE
Value   DCD      &4
RESULT DCD  0
                END
```

2)

FLOW CHART:

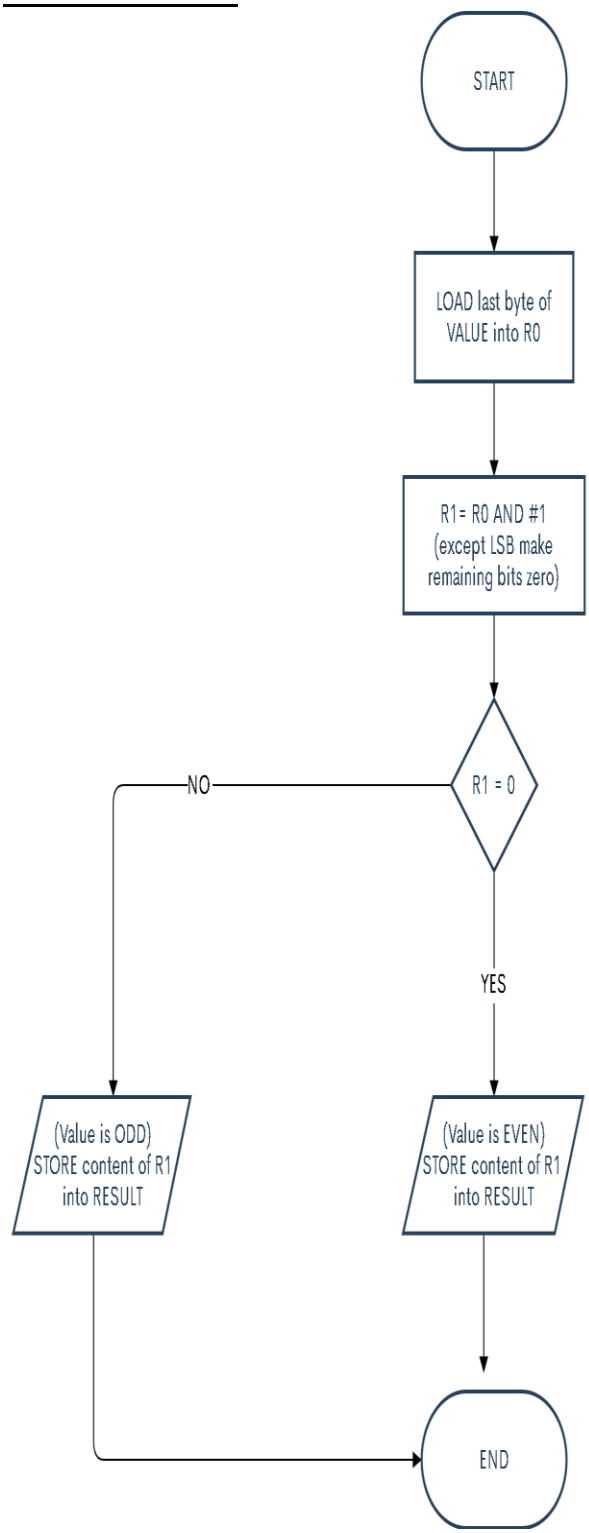

START
Load the first address location of the list to R0
Load consecutive values of list into R1,R2,R2,R4 incrementing address of R0 by 4 bytes
load bitmask into R5
Logical Shift Left R1 to 12 bits
Logical Shift Left R2 to 8 bits
Logical Shift Left R3 to 4 bits
ADD the values of R1,R2,R3,R4 and STORE RESULT IN R6
STORE the 16bit half word value of R6 to the most significant nibble of 32 bit RESULT
END

CODE:

```
AREA PROGRAM, CODE, READONLY
    ENTRY

MAIN
       LDR R5, Mask
    LDR R0, =Value      ; pointing to first address  location of value
       LDRB R1, [R0]       ; loading last byte of hex 3B
       LDRB R2, [R0, #4]!   ; loading last byte of hex 4C by incrementing address of R0 by
4 bytes
       LDRB R3, [R0, #4]!
       LDRB R4, [R0, #4]!
       AND R1, R1, R5      ;obtaining last four bits of R1 using bitmask register R5 and
storing result back to R1
       AND R2, R2, R5       ;obtaining last four bits of R2 using bitmask register R5 and
storing result back to R2
       AND R3, R3, R5
       AND R4, R4, R5
       MOV R1, R1, LSL #12  ; first four bits of 16 bit halfword
       MOV R2, R2, LSL #8   ; second four bits of 16bit halfword
       MOV R3, R3, LSL #4   ; next four bits of 16 bit halfword
       ADD R6, R1, R2       ; adding all values in four registers to obtain 16bit halfword
       ADD R6, R6, R3
       ADD R6, R6, R4
       STR R6, Result       ; storing the contents of R6 into the most significant nibble
RESULT(32bit)
HERE   B      HERE

Mask   DCW &000F
              ALIGN
Value  DCD &3B, &4C, &1D, &46
              ALIGN
Result        DCD 0
                     END
```

3)

FLOW CHART:-


START
LOAD last byte of VALUE into R0
R1= R0 AND #1 (except LSB make remaining bits zero)
R1 = 0
NO
YES
(Value is ODD) STORE content of R1 into RESULT
(Value is EVEN) STORE content of R1 into RESULT
END

CODE:-

```
*       to find a number is even or odd
        TTL EVEN_ODD
        AREA PROGRAM, CODE, READONLY
        ENTRY
MAIN
        LDRB R0, VALUE              ; loading last byte of R0
        ANDS R1, R0, #1             ; performing AND operetion for R1 and R0, also updating
status resgister
        STR R1,       RESULT        ;storing the final value of R1 back to the
                                     ; RESULT(result=0 says EVEN)
                                    ; result=1 says the value is ODD
HERE    B HERE
VALUE DCD &10
        ALIGN
RESULT DCD &0

        END
```

CONCLUSIONS-

1. We learnt about the basics of the ARM architecture.

2. We learnt about the code format we have to use in the assembler.

3. We learnt how to write loops using branch instruction and register indirect addressing.

4. We learnt about how to use various logical shifts, arithmetic instructions.