

EEE3002 Microprocessors Tutorial 3 (2014 Sem 1)

- 1) The factorial program is given as follows:

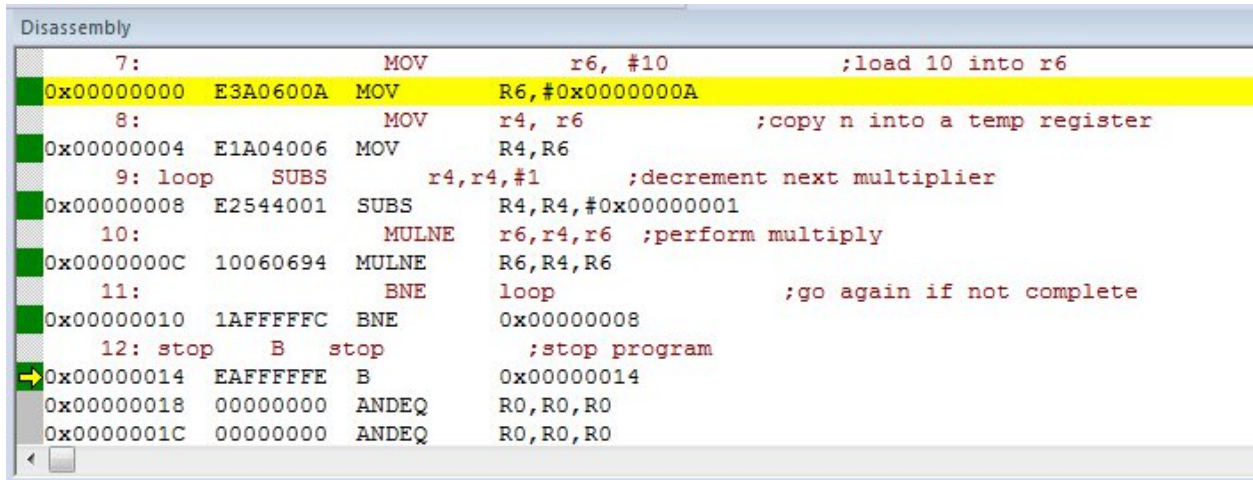
```
AREA Prog2, CODE, READONLY
ENTRY
MOV      r6, #10      ; load 10 into r6
MOV      r4, r6        ; copy n into a temp register
loop     SUBS      r4, r4, #1    ; decrement next multiplier
        MULNE     r6, r4, r6    ; perform multiply
        BNE       loop        ; go again if not complete
stop     B         stop
END
```

- a) Using the Disassembly window (Keil μ Vision4), write out the first six machine codes (32-bit instructions) for the above program in hex format.
 - b) Change the value in register r6 at the start of the program to 12. What value is in the register r6 when the code terminates? Verify that this hex number is correct.
- 2) Show three different ways to clear all the bits in register r12 to zero. You may not use any registers other than r12.
- 3) What is another way of writing the following line of code?
- ```
MOV PC, LR
```
- 4) Use an assembler directive to assign register r6 to the name `bouncer`.
- 5) Create a mask (bit pattern) in memory using the DCD directive and the SHL and OR operators for the following cases.
- a) The upper two bytes of the word are 0xFFEE and the least significant bit is set.
  - b) Bits 17 and 16 are set, and the least significant byte of the word is 0x8F.
  - c) Bits 15 and 13 are set.
  - d) Bits 31 and 23 are set.
- 6) What instruction puts the ASCII representation of the character "R" in register r11?
- 7) Give the directive to reserve a block of zeroed memory, holding 40 words and labeled `coeffs`.

## EE3002 Microprocessors Tutorial 3 Solutions

1) Attempt this question using Keil IDE.

a) The disassembly window is as follows:



```
Disassembly
7: MOV r6, #10 ;load 10 into r6
0x00000000 E3A0600A MOV R6, #0x0000000A
8: MOV r4, r6 ;copy n into a temp register
0x00000004 E1A04006 MOV R4, R6
9: loop SUBS r4, r4, #1 ;decrement next multiplier
0x00000008 E2544001 SUBS R4, R4, #0x00000001
10: MULNE r6, r4, r6 ;perform multiply
0x0000000C 10060694 MULNE R6, R4, R6
11: BNE loop ;go again if not complete
0x00000010 1AFFFFFFC BNE 0x00000008
12: stop B stop ;stop program
0x00000014 EAffffffE B 0x00000014
0x00000018 00000000 ANDEQ R0, R0, R0
0x0000001C 00000000 ANDEQ R0, R0, R0
```

The first six machine codes are as follows:

0xE3A0600A

0xE1A04006

0xE2544001

0x10060694

0x1AFFFFFFC

0xEAffffffE

Although it is possible to translate by hand, it is normally not attempted as the process is very tedious and error-prone.

(b) When the value is changed into 12, the program calculates 12 factorial. The value in r6 will be  $0x1C8CFC00 = 479001600 = 12!$

- 2) AND      r12, r12, #0  
MOV      r12, #0  
EOR      r12, r12, r12  
SUB      r12, r12, r12

3) The instruction MOV PC, LR can also be written as MOV r15, r14

4) bouncer    RN      6

- 5) a) MaskA DCD (0xFFEE:SHL:16):OR:1  
b) MaskB DCD 0x8F:OR:(3:SHL:16)  
c) MaskC DCD (1:SHL:13):OR:(1:SHL:15)  
d) MaskD DCD (1:SHL:31):OR:(1:SHL:23)
- 6) MOV r11, #'R'  
or  
MOV r11, #0x52 ; same but less easily understood
- 7) The SPACE directive reserves a zeroed block of memory.
- coeffs      SPACE 160 ; 40 words is 160 bytes!