Exam Date & Time: 14-Jun-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

FOURTH SEMESTER B.TECH. DEGREE EXAMINATIONS - JUNE 2024
SUBJECT: CSE 2223/CSE_2223 - EMBEDDED SYSTEMS
(SPL: COMPUTER SCIENCE AND ENGINEERING - CYBER SECURITY/COMPUTER SCIENCE/ COMPUTER SCIENCE AND ENGINEERING - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

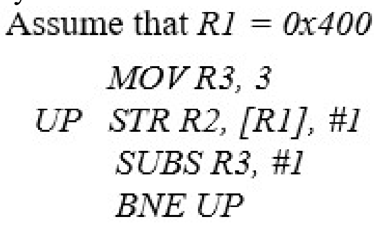
EMBEDDED SYSTEMS [CSE 2223]

Marks: 50 **Duration: 180 mins.**

A

Answer all the questions.

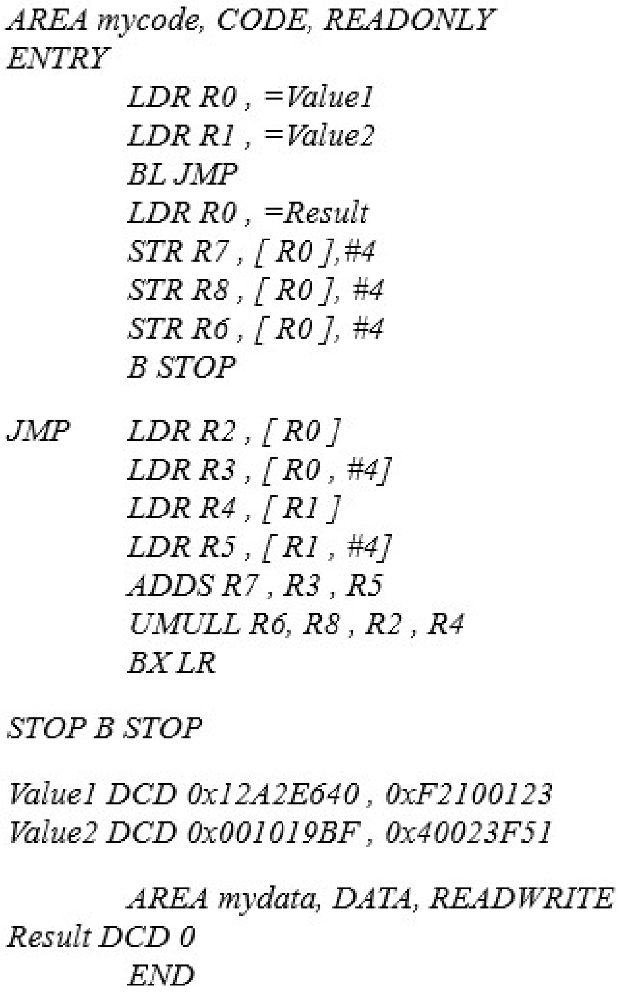
1A) Distinguish between aligned and non-aligned data in ARM memory space. Show the data transfer of the following cases with appropriate figures and indicate the number of memory cycle times it takes for data transfer. (4)



Assume that *R1* = *0x40000000* and *R2* = *0x4598F31E*.

```
        MOV R3, 3
   UP   STR R2, [R1], #1
         SUBS R3, #1
         BNE UP
```

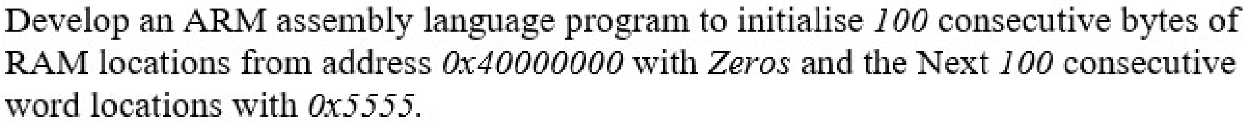
1B) Analyse the following program and write the contents of register *R6*, *R7* and *R8*. (3)



```
AREA mycode, CODE, READONLY
ENTRY
        LDR R0 , =Value1
        LDR R1 , =Value2
        BL JMP
        LDR R0 , =Result
        STR R7 , [ R0 ],#4
        STR R8 , [ R0 ], #4
        STR R6 , [ R0 ], #4
        B STOP

JMP     LDR R2 , [ R0 ]
        LDR R3 , [ R0 , #4]
        LDR R4 , [ R1 ]
        LDR R5 , [ R1 , #4]
        ADDS R7 , R3 , R5
        UMULL R6, R8 , R2 , R4
        BX LR

STOP B STOP

Value1 DCD 0x12A2E640 , 0xF2100123
Value2 DCD 0x001019BF , 0x40023F51

        AREA mydata, DATA, READWRITE
Result DCD 0
        END
```

1C) Use the following instructions to perform push and pop operations on a fully ascending stack. Explain the operation with a neat schematic diagram. (3)
i) *LDR* and *STR*
ii) *LDM* and *STM* with all possible suffixes

2A) i) Explain the syntax and workings of instruction RORS in ARM assembly language with a suitable diagram and example. (4)
ii) Explain How Rotate left can be implemented using *ROR* with a suitable example.

2B) 

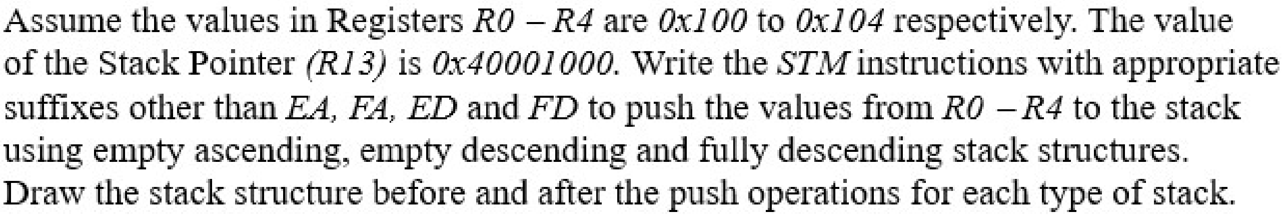
Develop an ARM assembly language program to initialise *100* consecutive bytes of RAM locations from address *0x40000000* with *Zeros* and the Next *100* consecutive word locations with *0x5555*. (3)

2C) Develop an ARM assembly language subroutine to compute the factorial of a byte stored in register *R1*. Use this subroutine to find the factorial of *N* numbers stored in consecutive byte locations from *DATA1* and store the results in word locations beginning from *DATA2*. [Design the solution with the help of neat FLOWCHART before coding] (3)

3A) Develop an Embedded C program to display "LIFE" in the seven-segment display (SSD) units interfaced with LPC 1768. Assume that the eight segments of all the SSD units are connected to the port pins *P0.4* to *P0.11* and the SSD units can be enabled one by one using the port pins *P1.23* to *P1.26*. (4)

3B) Write the appropriate Embedded C statements to do the following: (3)

i) Configure Port pins *P2.10* and *P2.11* to perform *function1* (first alternate function) and *P2.22* and *P2.23* to *function2* (second alternate function).
ii) Configure port pins *P1.14* to *P1.18* as input and *P1.22* to *P1.30* as output.
iii) Read the values at port pins *P0.10* to *P0.16* only after hiding those available at other pins.

3C) 
Assume the values in Registers *R0 – R4* are *0x100* to *0x104* respectively. The value of the Stack Pointer *(R13)* is *0x40001000*. Write the *STM* instructions with appropriate suffixes other than *EA, FA, ED* and *FD* to push the values from *R0 – R4* to the stack using empty ascending, empty descending and fully descending stack structures. Draw the stack structure before and after the push operations for each type of stack. (3)

4A) Write an algorithm/flowchart for setting UART dividers. Calculate the baud rate divisor for UART communication in LPC1768 having a main oscillator frequency of 14.7456 MHz and a desired baud rate of 9600. (4)

4B) Explain the working of RS232 in serial communication. (3)

4C) Write an embedded C program to utilize the pin P0.26 on the LPC1768 microcontroller as the DAC output pin to generate a triangular waveform with maximum possible peak-peak amplitude. (3)

5A) Write a program to modulate the brightness of an LED using LPC1768 PWM using P3.25. (4)

5B) Discuss match registers and capture registers of the LPC1768 timer. If the PCLK frequency is 6 MHz, what would be the prescaler value required to achieve a resolution of 2 microseconds? (3)

5C) Develop an embedded C program to enable external interrupt EINT3 using P2.13 and LED should be on using P2.12 GPIO to indicate the interrupt occurrence. (3)

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