



BLG 212E – Microprocessor Systems 2023-2024 Homework 2

Due Date: 24.12.2023, **Sunday**, 23:59.

Question 1 (20 Points):

You are expected to set up a timer interrupt using the System Tick Timer. Information regarding the microcontroller frequency and the timer interrupt period for each student is provided in the "PeriodFrequency.xlsx" file. Which specific value should be loaded into the SysTick Reload Value Register? To determine this, please calculate it step by step and provide the formula used in the calculation.

Question 2 (60 Points):

Your task involves writing a program in Arm Cortex M0+ assembly language to evaluate the performance of the Bubble Sort algorithm concerning array size. To start, create a timer interrupt using the parameters specified in Question 1. By employing this timer interrupt alongside the SysTick Timer parameters, you can extract the microcontroller's running time (in microseconds).

The provided pseudo code outlines the main function's structure. Your task involves implementing a program that sorts an array using the Bubble Sort algorithm and records execution times according to the element count. The numbers (unsigned) to be sorted are available in "array.txt," and they need to be integrated into your program in the specified sequence. Upon completion, the memory address of the sorted array should be stored in the R0 register, while the memory address of the execution times array should be stored in the R1 register. The program should also save the sorted array and execution times to the memory.

```
void main() {  
    //Initialize System Tick Timer to generate interrupt  
    Init_SysTick_Timer();  
    for(int i=2; i<=ARRAY_SIZE; i++){  
        //Record the current running time on the microcontroller as the start time.  
        Save_Start_Time();  
        //Run Bubble sort algorithm for the first i elements of array.  
        BubbleSort(i);  
        //Calculate execution time of BubbleSort function using start time.  
        Save_Execution_Time();  
    }  
    //Stop to System Tick Timer and clear interrupt configuration.  
    Stop_SysTick_Timer();  
    while (1);  
}
```

Hint: In the BubbleSort function, make sure to copy only the first 'i' elements of the array into memory. Avoid moving beyond the specified parameter to ensure the function operates within the designated range.

Constraints:

- Your main function name or label must be “__main”.
- Your code should include a comment for each line. Otherwise, points will be deducted.
- If you need to calculate any value, please write your formula and explain it step by step as a comment in the code.
- The program must be implemented with Arm Cortex M0+ assembly language.
- Your assembly source file is expected to work with Keil µVision IDE v5.
- Default configuration must be sufficient to run your programs. If your program expects any different configuration parameter, please write this at the top of the code in comment lines.
- If your program does not run with Keil µVision IDE you will get zero point from this question.

Question 3 (20 Points):

Using a computer program, create a chart illustrating the relationship between array size and execution time based on the saved execution time information, and subsequently, discuss your findings in relation to existing literature.

Submission: Please submit 1) an assembly file for the implementation of Question 2, 2) startup file for Question 2, and a pdf file for Question 1 and Question 3. Type your name and student ID at the top of files as comments. You are expected to submit your term project through the Ninova system before the due date. Late submissions will not be accepted.

Any solution must be your own work. If any plagiarism is detected, disciplinary regulations of the university will be followed.

Note: If you have any questions regarding the exam, you may contact to teaching assistant of the course. (Kadir Özlem (kadir.ozlem@itu.edu.tr)).