COE718: Embedded Systems Design

Midterm Exam- Sample 2015

Name and Student ID: _____

Total Time Allowed: 120 Minutes Maximum Marks: 60

i. The examination has 5 pages and 5 questions. Answer all the questions.
ii. To earn maximum credit, your answer must be concise, to the point and in the given space
iii. All questions are not of the same difficulty and value. Consider this when allocating time for their solutions.

1. (a) Von Neumann and Harvard architectures are employed in various embedded processor designs. Briefly explain the main differences between the architectures. Which of these architecture is more suitable for high performance CPUs? Which are more suitable for low-power embedded devices? Justify your answer by also providing examples of CPUs based on each of the architectures.

MARKS: 6

1. (b) The ARM Cortex-M3 CPU has a much faster response time when addressing multiple interrupts in comparison to other CPUs. Briefly explain how this faster response time is achieved in a Cortex-M3 CPU.

MARKS: 6

1. (c) ARM CPUs are widely used in handheld devices. Identify at least two specific features of the ARM microarchitecture and/or architecture that facilitate smaller code size. Justify your answer in detail.

MARKS: 4

1. (d) ARM CPUs are most used for embedded computing systems for a large number of real world applications. List and explain at least two applications that would use an ARM CPU.

MARKS: 4

2. Consider the peripheral address 0x40090067. Assuming the ARM Cortex-M3 system architecture, calculate the Bit Band address needed to directly access bit 8 of the specified peripheral address. Show all your calculations.

MARKS: 5

3. Consider the following .c code snippet:

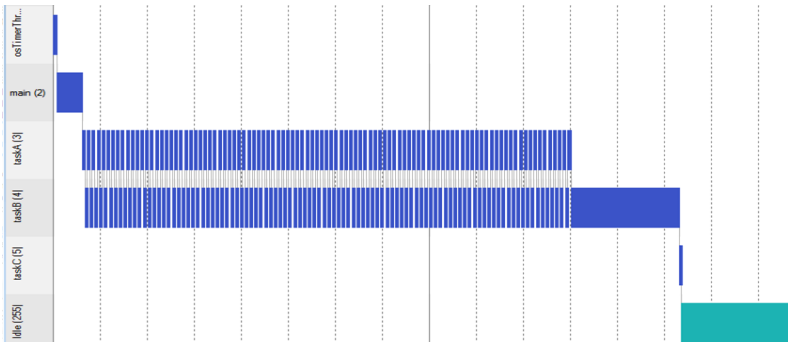
```
void subroutine1(){
    int x, y = 2;
    x = y + 1;
}
int main(void){
    int a;
    ....

    subroutine1();
    ....
}
```

Convert the code above to ARMv7 assembly. Assume that the variable ***a*** is stored to register ***R1*** which must be pushed onto the stack, where the CPU must save state, execute the subroutine, and return to main() to continue executing the program.

MARKS: 10

4. Consider the pre-emptive multitask scheduling execution timeline below, taken from the uVision Event Viewer:



Write the multitasking application (in C code) needed to create and execute the above timeline. Assume that TaskA increments the variable countA 100x, while TaskB increments the variable countB 200x. Once both tasks are complete, taskC accumulates the sums of countA and countB 50x. Assign task priorities as required, and specify any parameters that must be present (or not present) in the RTX kernel (i.e. RTX_Conf_CM).

MARKS: 13

```
#include <stdio.h>
#include "LPC17xx.h"
#include <RTL.h>

int main(void){
    SystemInit();

}
```

5. Indicate (in the space provided) whether the following statements are TRUE or FALSE. To obtain full marks for each question, include SHORT comments in support of your answer.

MARKS: 12 (2 each)

a) The ARM Cortex-M3 is based on the Harvard architecture.
TRUE ___ or FALSE ____?

_____

_____

b) Conditional execution is a useless feature in ARM CPUs for compact application code.
TRUE ___ or FALSE ____?

_____

_____

c) The ARM Cortex-M3 is a 16-bit processor with 16 registers.
TRUE ___ or FALSE ____?

_____

_____

d) The ARM Cortex-M3 CPU employs an efficient technique to access bitwise status and/or data information from peripheral devices.
TRUE ___ or FALSE ____?

_____

_____

e) A Hard Real Time system is a soft-real time system that may occasionally miss its deadlines, but does not benefit from the constant late delivery of service.
TRUE ___ or FALSE ____?

_____

_____

f) ARM's H-Series line consist of CPUs dedicated to High-Performance applications.
TRUE ___ or FALSE ____?

_____

_____