GLASGOW COLLEGE UESTC

Exam paper

Embedded Processor (UESTC 2004)

Date: June 25th 2021
Time: 1430-1630

Attempt all PARTS. Total 100 marks

Use one answer sheet for each of the questions in this exam.
Show all work on the answer sheet.

Make sure that your University of Glasgow and UESTC Student Identification Numbers are on all answer sheets.

An electronic calculator may be used provided that it does not allow text storage or display, or graphical display.

All graphs should be clearly labelled and sufficiently large so that all elements are easy to read.

The numbers in square brackets in the right-hand margin indicate the marks allotted to the part of the question against which the mark is shown. These marks are for guidance only.

Q1 (a) Name five key terms (names) of registers widely used and their function. [10]

(b) How are the bytes ordered in computer memory [5]? Provide examples of different Endianness [5].

(c) Use adders to execute subtraction (X-Y) by two's complement. Here X = 0110; Y = 1100. Use this as an example to explain the difference between two's complement and one's complement [5]

Q2 (a) What are the basic data types associated with C? [2.5]

(b) In C programing language:

(i) What is the general description for while statements (illustrate drawing a flowchart) [5.5]

(ii) What are the 3 types of available loop types? [1.5]

(c) Write down a C expression corresponding to each of the following mathematical expressions.

(i) $\frac{t}{k} - \frac{\frac{t}{k}+2}{3S^2}$ [1]

(ii) $2a\frac{2c}{a+b}$ [1]

(iii) $\frac{-b+(b^2-4ac)}{2a}$ [1]

(d) Compute the values of the following C expressions assuming that a, b and c are integer variables and d is a float variable as declared below.

int a=2, b=3, c=4; float d=5.0;

(i) (b+2)/b+2 [0.5]

(ii) b*c/d [0.5]

(iii) a/(b/c-1) [0.5]

(iv) b%c*(a/d) [0.5]

(v) ++a+b-- [0.5]

(e) The formula for the volume of a spheroid is $\frac{4}{3}\pi a^2 b$ where a and b are the half-lengths of the major and minor axes respectively. The following C program reads values for a and b and then calculates and displays the volume. Complete the missing parts in the program. Use appropriate variable declarations in the program (do not use any additional variables) and write only 1 statement on each blank line with the question marks.

```
#include <stdio.h>

/*declare the constant value of π _as 3.141593

_____ [2]

int main()

{

/* declare variables */

_____ [2]

/*read the values of a and b from the keyboard*/

_____ [2]

/*compute the volume of the sphere */

_____ [2]

/*display the result onto the screen*/

_____ [2]

return 0;
 }
```

Q3 (a) For the decimal numbers $(758)_{10}$ and $(879)_{10}$, perform the following:

(i) Present the two numbers as BCD codes. [2]

(ii) Perform the BCD addition of the codes obtained in part (i). Present the final answer in a decimal format. Show a step-by-step work on how you performed the addition and reached the final answer. [4]

(iii) Describe one advantage of the BCD code when compared to the ASCII code. [1]

(iv) Describe one advantage of the ASCII code when compared to the BCD code. [1]

(b) Embedded systems need to engage in multitasking. Consider four independent tasks P1, P2, P3, and P4 with completion times and priorities given in Table Q3 (0 is highest priority, 3 is lowest priority).

Task	Completion time (ms)	Priority
P1	6	0
P2	8	3
P3	12	1
P4	5	2

Table Q3

If the tasks enter together the ready queue of a *non-preemptive priority-based scheduler*. Assuming there is no I/O waiting for the processes in this scheduling algorithm:

(i) Calculate average waiting time of all processes. [3]

(ii) Calculate the average Turn Around Time (TAT) of all processes. [3]

(iii) Determine if this scheduling algorithm is suitable for an online concert ticketing system? Justify your answer. [2]

(c) A Real Time Operating System (RTOS) is an approach to design embedded firmware. Based on the degree of tolerance in the timing constraints, RTOSs are classified into three types.

(i) List two of these types and describe each of them in detail. [6]

(ii) A vehicle airbag embedded system is a protection system that provides safety against a passenger's head crash. Out of the three types of RTOSs, which one resembles this system? Justify your answer. [3]

Q4 (a) There are two communication schemes for bus in embedded system, namely Parallel communications vs. Serial communications.

(i) Briefly describe the definition of the two schemes. [4]

(ii) Which one is more widely used in embedded system, and briefly explain why? [4]

(b) Three typical protocols UART, I2C and SPI are introduced in embedded system.

(i) Indicate each of the three protocols are used for synchronous communication or asynchronous communication respectively. [3]

(ii) Draw a timing diagram of an I2C bus START and STOP condition. [4]

(c) The Serial Peripheral Interface (SPI) is widely applied to short-distance communication by using a master-slave architecture with a single master.

(i) There are four logical signals in the SPI bus including SCLK and MOSI, please give the other two logical signals. [2]

(ii) For an SPI protocol, how many modes can be under different clocking configurations? [2]

(iii) Given Figure Q4, the timing diagram of an SPI protocol, explain the meaning of CPOL=0 and CPHA=1. [2]

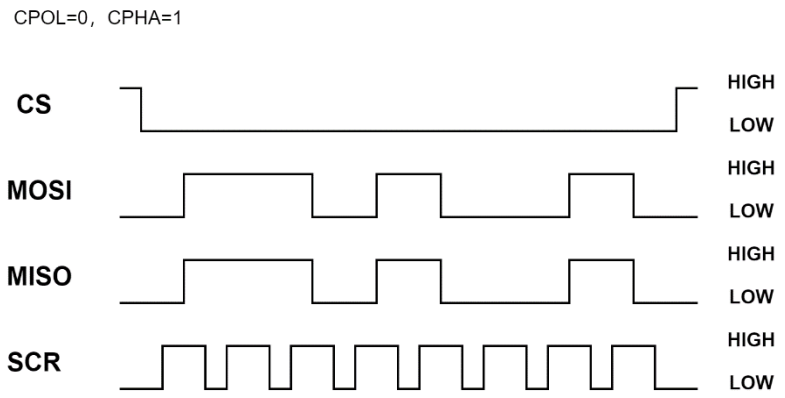

Figure Q4

(iv) Given Figure Q4, draw the sample time at this figure, and provide the received binary bits. [4]