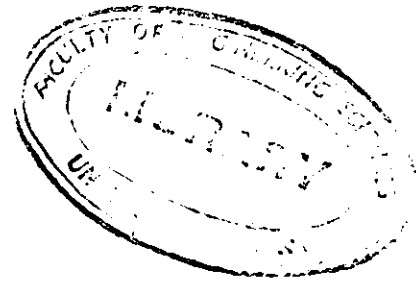




UNIVERSITY OF GHANA
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BACHELOR OF SCIENCE IN ENGINEERING
SECOND SEMESTER EXAMINATIONS, 2012/2013
CPEN 404 EMBEDDED SYSTEMS (3 Credits)

Answer All Questions; TIME : $2\frac{1}{2}$ Hours

1. (a) Explain the term "Embedded System" and state four(4) components of a typical embedded system. [4 marks]
(b) Explain any three(3) characteristics of an embedded system. [9 marks]
(c) i. State any four(4) application areas of embedded systems. [2 marks]
ii. Discuss the "MARS Pathfinder" as an embedded system application. [5 marks]
2. (a) Explain the difference between *I2C* and *SPI* transmission and give two (2) common devices capable of interfacing to *I2C*. Briefly explain the operation of the *I2C* communication protocol and give one advantage and one disadvantage of the *I2C*. [6 marks]
(b) i. A microcontroller-based billboard at the entrance of the University has to display information regarding graduation ceremony. If the embedded controller has 9600 bps baud rate and the data entered for the UART for display on LCD was "all graduands are required to be seated by 9:00am for the ceremony", compute how long it will take for the system to transmit the data to the LCD? [4 marks]
ii. If the processor operates at 200MHz, find the number of times it will take to write to the UART output register assuming the system uses 4 clock cycles per write. [4 marks]
(c) Assume the data 10011111 is read from port P_1 of the 8051 microcontroller in 2b above and written to port P_2 . Write a simple function to illustrate how the data is transferred from P_1 to P_2 . Assume the LCD is connected to port P_2 . If pin 2 is for reset and pin 4 is for load, write the command that would be used to implement this. Sketch a diagram to illustrate the LCD connection to the controller. [6 marks]
3. (a) i. Distinguish between EEPROM and Flash EEPROM. [2 marks]
ii. Briefly explain any two implementations of NVRAM. [2 marks]
(b) i. State any four(4) common memory problems. [2 marks]
ii. Explain either data bus test or address bus test [5 marks]
(c) A microcontroller has a memory capacity of 4kB. This memory space is implemented using 128 byte chip sets. If the starting address of this memory is 88_h , Calculate:
i. the number of wires needed to address this memory [2 marks]
ii. the number of chip sets required [2 marks]
iii. the end address of this memory [5 marks]

4. (a) Distinguish between a schematic diagram and a circuit diagram as used in reference to embedded system design. [2 marks]
- (b) You have been contracted by a poultry farmer to design an incubator regulated by a micro controller. In your view as the designer :
- mention any three system requirements [3 marks]
 - state any two system specifications for your design [2 marks]
 - draw a basic process flow diagram that best reflects the overview of the microcontroller based system [3 marks]
 - with a sketch of the system's circuitry, explain your thought process (including circuit principles used) in solving this problem [10 marks]
5. (a) Explain the following terms :
- Response time [2 marks]
 - Throughput [2 marks]
- (b) Derive an expression for the execution time in terms of clock rate, the instruction count and the CPI. [4 marks]
- (c) Consider the execution of a task on a 500 MHz processor. The program consists of 4 types of instructions as shown in Table 1. Calculate the average CPI and the corresponding MIPS rate. [4 marks]

Table 1: Instructions and CPI values

Instruction	Occurrence/%	CPI
Integer Arithmetic	60	1
Floating point Arithmetic	20	2
Load and Store	10	4
Memory Reference	10	6

- (d) Two programs P_1 and P_2 are run on two machines M_1 and M_2 and the following measurements were made.

Table 2: Measurements for P_1 and P_2 on

Program	Time on M_1	Time on M_2
P_1	10s	5s
P_2	3s	4s

The following additional measurements on P_1 were also made:

Table 3: Additional measurement on P_1

Program	IC on M_1	IC on M_2
P_1	200×10^6	160×10^6

The clock rates of machines M_1 and M_2 are 200 MHz and 300 MHz respectively.

- Find the CPI for program P_1 on each of the two machines. [4 marks]
- Assuming the CPI for P_2 on each machine is the same as CPI for P_1 calculated above, find the instruction count for program P_2 running on each machine. [4 marks]

