Indian Institute of Information Technology Sri City, Chittoor

Mid Term 1 Examination– Feb 2024

Computer Architecture

Maximum Marks: 30 Time Duration: 90 mins
Date: 6th Feb 2024 Course Code: CS0200

Roll Number _____ Section _____

Instructions

1. **All questions are compulsory. All sub-parts of a question should be written together.**
2. **Attach the question paper with the answer sheet.**

Multiple Objective Questions

1. Which of the following statements is correct in terms of Moore's law?
   - **a) Moore's law is the observation that the number of transistors in an integrated circuit (IC) doubles about every two years.**
   - b) Moore's law is the observation that the number of registers in an integrated circuit (IC) doubles about every two years.
   - c) Moore's law is the observation that the number of registers in an integrated circuit (IC) doubles about every five years.
   - d) None of the above

2. Why DRAM is slower in comparison to SRAM.
   - **a) As DRAM has a capacitor, it continuously leaks current.**
   - b) As DRAM has a capacitor, it continuously increases current.
   - c) As DRAM has a capacitor, it continuously produces current.
   - d) All of the above

3. For any x and y declared as 'int', what is the result of the following statement?

x > 0 && y > 0 => x + y > 0

   - a) Always true
   - b) Always false
   - **c) Sometimes false, sometimes true**
   - d) None of the above

4. UMax is equivalent to _____.
   - a) UMin+1
   - b) TMax+1
   - c) 2*TMax-1
   - **d) 2 *TMax+1**

5. The value of **data** after the following code is executed **_30_____**.

```
unsigned int data = 15; //
data = data << 1;
```

6. If the serial fraction in Amdahl's Law is 0.2, what is the maximum speedup achievable with infinite processors?
   - a. 2x
   - **b. 5x**
   - c. 10x

d. 20x

$$\lim_{N\to\infty} \frac{1}{(1-P)+\frac{P}{N}} = \frac{1}{(1-0.8)} = \frac{1}{0.2} = 5x$$

7. What is the hexadecimal representation of the value 2048

a) 0x400 b) 0x600 **c) 0x800** d) 0x 900

8. When a program prog.c is compiled with the directive " linux> gcc -m32 prog.c" then

a) The program will run correctly on a 32 bit compiler
b) The program will run correctly on a 32 bit or 64 bit compiler
c) The program will run correctly on a 64 bit compiler
d) The program generates an error

9. For which of the following data types in C byte ordering is not an issue

a) Short **b) Char** c) Int d) float

10. Consider three different processors, P1 P2 and P3, executing the same instruction set. P1 has a 3 GHz clock rate and a CPI of 1.5. P2 has a 2.5 GHz clock rate and a CPI of 1.0. P3 has a 4.0 GHz clock rate and a CPI of 2.2. Which processor has the highest performance expressed in instructions per second?

a) P1 has the highest performance among the three.
b) P2 has the highest performance among the three.
c) P2 and P3 have highest performance among the three.
a) P3 has the highest performance among the three.

P1: 3GHz / 1.5 = 2 * 10^9 instructions per second
P2: 2.5GHz / 1.0 = 2.5 * 10^9 instructions per second
P3: 4GHz / 2.2 = 1.82 * 10^9 instructions per second

Descriptive Questions

1. Explain each component of hardware organization with an appropriate diagram. [5 Marks]

1. Central Processing Unit (CPU): The CPU is the brain of the computer. It executes instructions and performs calculations. Modern CPUs often contain multiple cores, allowing them to handle multiple tasks simultaneously.

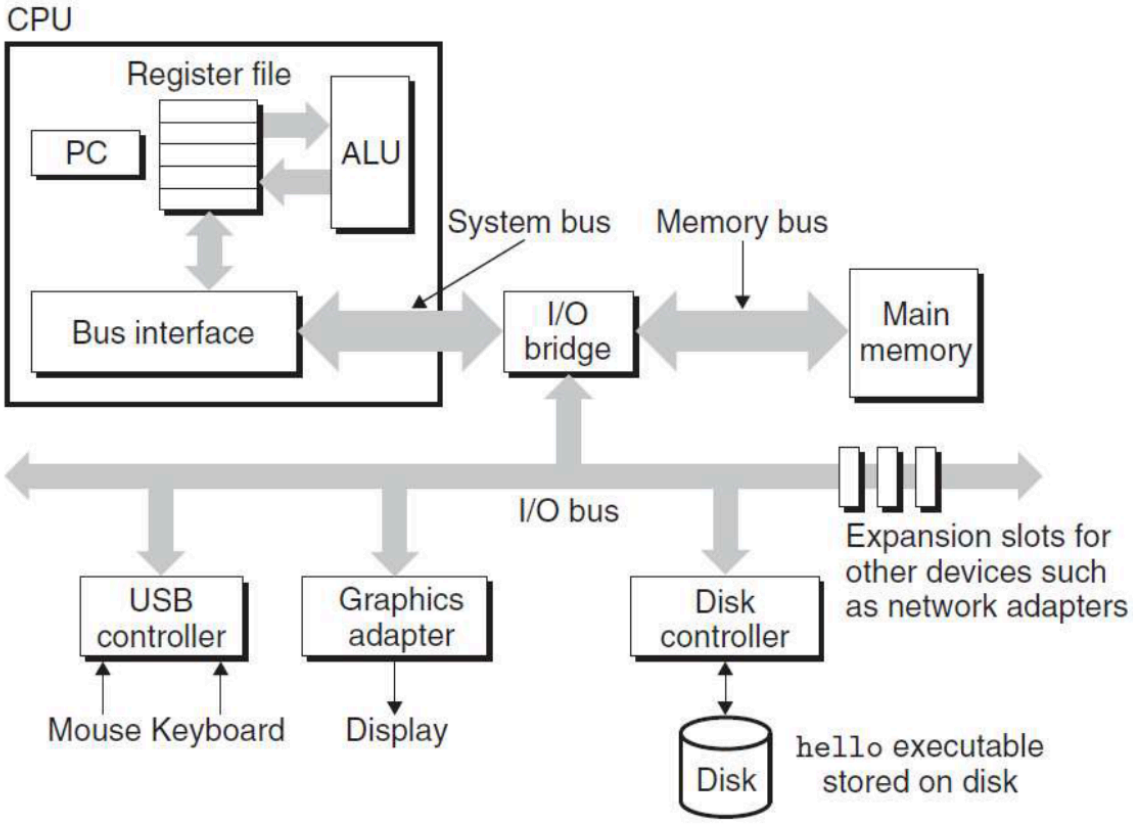
2. Memory (RAM): Random Access Memory (RAM) is temporary storage that the CPU uses to store data and instructions that it needs to access quickly. RAM is volatile, meaning it loses its contents when the computer is turned off.

3. Storage Devices: Storage devices such as hard disk drives (HDDs) and solid-state drives (SSDs) are used to store data and programs permanently. They retain data even when the computer is turned off. SSDs are much faster than HDDs but are often more expensive.

4. Input Devices: Input devices such as keyboards, mice, and touchscreens allow users to

interact with the computer and provide input.

5. Output Devices: Output devices such as monitors, printers, and speakers display or output information from the computer.



Hardware Organization of a System

2.

a. Suppose a program (or a program task) takes 1 billion instructions to execute on a processor running at 2 GHz. Suppose also that 50% of the instructions execute in 3 clock cycles, 30% execute in 4 clock cycles, and 20% execute in 5 clock cycles. What is the execution time for the program or task? **[1.5M]**

Instruction count: **10^9 instructions.** clock rate to be **0.5×10^{-9} seconds.**	**0.5M**
Value Frequency Product 3 0.5 1.5 4 0.3 1.2 5 0.2 1.0 CPI = 3.7	**0.5M**
Execution time = $1.0\times10^9 \times 3.7 \times 0.5\times10^{-9}$ sec = 1.85 sec.	**0.5M**

b. Suppose the processor in above question**(a)** is redesigned so that all instructions that

were initially executed in 5 cycles now execute in 3 cycles. Due to changes in the circuitry, the clock rate has to be decreased from 2.0 GHz to 1.9 GHz. No changes are made to the instruction set. What is the overall percentage improvement? **[2.5M]**

1. clocks per instruction, we had a value of 3.7 before the change. We compute clocks per instruction after the change as an effective value: **Value Frequency Product** **3 0.5 1.5** **4 0.3 1.2** **3 0.2 0.6** **CPI = 3.3**	**0.5M**
2. The performance ratio **=(3.7/3.3)*(1.9/2.0)** **=7.03/6.6=1.0651** **6.515%improvement**	**1 M**

c. What are the Unit of measure of CPU execution time for a program and clock cycle time **[1M]**

1. CPU execution time: clock ticks or seconds	[0.5M]
2. lock cycle time : cycle per second,	[0.5M]

3. For each expression, write the answer in True or False with proper explanation. Write the answer in tabular format similar to the one given below. [5 Marks]

S. No.	Expression	Answer (True or False)	Explanation
1	0==0U [1 Mark]	True	Zero representation is same in both signed and unsigned
2	(unsigned) -1 > -2 [2 Marks]	True	-1 is UMax in signed
4	-1 > -2 [1 Mark]	True	No type casting, both are signed
5	-1 < 0 [1 Mark]	True	No type casting, both are signed

4. Answer the following questions **[1+ 2+2 M]**

a. Using only bit-level and logical operations, write a C expression that is equivalent to x == y. In other words, it will return 1 when x and y are equal and 0 otherwise.

The expression is !(x ^ y).

That is, x^y will be zero if and only if every bit of x matches the corresponding bit of y .We then exploit the ability of ! to determine whether a word contains any nonzero bit.

b. What is the difference between little and big endian representations? Give an example.

Big Endian

- Least significant byte has highest address

Little Endian

Least significant byte has lowest address

Example

- Variable x has 4-byte representation 0x01234567
- Address given by &x is 0x100

Big Endian

0x100 0x101 0x102 0x103

01	23	45	67

Little Endian

0x100 0x101 0x102 0x103

67	45	23	01

c. Suppose that a and b have byte values **0x55** and **0x46**, respectively. Fill in the following table indicating the byte values of the different C expressions in hexadecimal.

Expression	Value
~a | ~b	0xBB
!a || !b	0x00
a && ~b	0x01
a & !b	0x00

********** ALL THE BEST **********