**CSCI 540 Homework Assignment 1**

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1. **In computer languages, what is translation? (5%)**

**Answer:**

The translator converts computer programs from one language to another using a programming language processor. Source code for an application is used to create machine code. The translator's main job is to translate machine language programs written in high-level languages into CPU-friendly forms. It also detects and reports errors in translation.

**Types of Translators:**

There are three different kinds of translators, and they are as follows:

**Compiler:**

Programs written in high-level programming languages are translated into low-level programming languages using a compiler, which is a translator. The entire program is translated in a single session, and any mistakes found after the conversion are reported. A compiler depends on the platform and the processor.

**Interpreter:**

The interpreter is a translator that transforms high-level computer languages into low-level programming languages, much like the compiler. The distinction is that it logs errors as they are found and modifies the program one line of code at a time. Because an interpreter is processor agnostic, it is also more portable than a compiler.

Eg: Compliable languages include C, C++, Java, etc.

**Assembler:**

Code written in assembly language is translated into machine language using a tool called an assembler. It functions more like an interpreter than an assembly language compiler, but it does the same goal.

Eg: Some examples of assemblers are GNU and GAS.

1. **In computer languages, what is interpretation? (5%)**

**Answer:**

An "interpreted language" is a type of computer language that is often interpreted rather than converted into machine instructions. It is one in which a different program rather than the target computer reads and executes the instructions. The interpreter translates the code one statement at a time rather than scanning the entire program and turning it into machine code like a compiler does.

Translations halt when the first error is made. As a result, debugging is easy. Python, JavaScript, and Ruby are programming languages that use interpreters; Java, C++, and C are programming languages that use compilers.

1. **What is a virtual machine? (5%)**

**Answer:**

Removing resources from a real system creates a virtual machine, an isolated computing environment. A virtual machine (VM) is a computational resource that uses software to run apps and programs instead of a real computer. One or more virtual "Guest" machines are hosted by a real "Host" machine. Each virtual machine has its own operating system and functions independently of the others even though they are all running on the same host.

**Virtual machine types:**

VMs come in two varieties:

**Process VMs**, which completely isolate the operating system and programs from the actual computer. Process VMs, which isolate a single process.

E.g.: The .Net framework, the Parrot Virtual Machine, and the Java Virtual Machine are a few examples.

**System Virtual Machines** use hypervisors as a middleman to allow software access to hardware resources.

E.g.: VMware, the Intel/Linux Foundation (Xen), Oracle and Microsoft (Hyper-V) are well-known players in the hypervisor market.

1. **What is a data path? (5%)**

**Answer:**

Data processing processes are carried out by functional units called arithmetic logic units and multipliers, as well as registers and buses, in a data channel. It makes up the central processing unit, together with the control unit. By utilizing multipliers to combine many data pathways together, a bigger data path can be created.

The ALU, the collection of registers, and the internal buses of the CPU are the components that make up the data pipeline.

1. **Distinguish bit, Byte, and word. (5%)**

**Answer:**

**Bit:** The smallest piece of data that can be stored in a computer is a bit. Its value might range between 0 and 1. Bit sizes range from 4, 8, 12, 16, 32, and so on up to 64, therefore a word may be as long as 64 bits or as short as 8 bits.

**Byte:** Eight bits make up a byte. A single character, such as a letter, number, or symbol, can be represented by it. In general Byte making it shorter than a word.

**Word:** A collection of bytes is a word. Word sizes on computers vary, but they are typically 16, 32, or 64 bits. The number of bits or characters that make up a word determines the word length.

1. **What are the registers in CPU? (5%)**

**Answer:**

Registers for temporary storage are present in CPUs. In order to prevent access from outside the CPU, registers are employed internally, whereas certain registers are open to users. In the majority of modern CPU designs, both types of registers are present. Registers come in a wide variety, some of which are often used.

Below are the some of the most common CPU registers:

* Stack Control Register (SCR)
* Instruction Register (IR)
* Flag Register
* Memory Buffer Register (MBR)
* Index Register (IR)

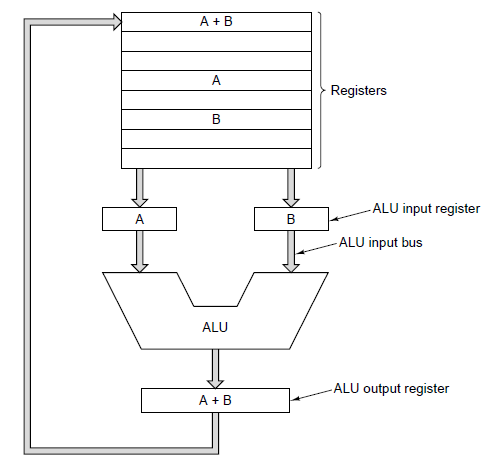
1. **What are the design principles for modern computers? (5%)**

**Answer:**

People who developed general-purpose CPUs make every effort to abide by a set of design guidelines, frequently referred to as the RISC design guidelines:

* Increase the rate at which instructions are issued.
* MIPS is an acronym for millions of instructions per second and it is connected to the number of instructions that are issued each second.
* Parallelism can affect MIPS speed.
* Make sure that instructions have a defined length and a limited number of fields. This will help to reduce the rate at which new instructions are issued.
* The fewer formats there are for instructions.
* Memory References Should Only Be Made During Loads and Stores.
* The majority of instructions should use registers as their operands and return to them.
* It can take a while to access memory.
* Only LOAD and STORE instructions should therefore make references to memory.
* Provide a large number of registers – Due to the somewhat sluggish access time to memory, a large number of registers (at least 32) must be provided. allowing words to be retrieved and stored in registers until they are no longer required.

1. **Consider the operation of a machine with the data path of the figure below. Suppose that loading the ALU input registers takes 5 nsec, running the ALU takes 10 nsec, storing the result back in the register scratchpad takes 5 nsec, and there is no pipeline. What is the maximum number of MIPS (Million Instructions Per Second) this machine is capable of? (5%)**



**Answer:**

According to the given data:

It takes five nanoseconds to load data into the ALU input registers, ten nanoseconds to operate the ALU, and five to load the result back into the scratch pad registers. It has a data cycle of 20 nsec. The total times is 20nsec for one cycle to calculate the MIPS divide one sec with 20nsecs.

Millions of instructions per second (MIPS) = (1x10^9)/20

= 5 X 10^7

= 50000000 nsec

As a result, 50 MIPS is the maximum MIPS this machine can generate without pipelining.

1. **In a single-core CPU that has a five-stage pipeline, it takes 1 CPU clock cycle to fetch the instruction, 1 CPU clock cycle to decode the instruction, 1 CPU clock cycle to fetch the operands from the registers, 2 CPU clock cycles to execute the instruction, and 1 CPU clock cycles to write the result back to the register. How many CPU clock cycle does it need to execute approximately 60,000 instructions? You do not need to consider any storage other than the registers, and you should assume the instructions are executed in their original order. (10%)**

**Answer:**

The given data as follows:

Number of instructions(N) = 60000

Five Stage Pipeline(K) = 5

Number of Clock Cycles(T) = 2

|  |
| --- |
| Total Clock Cycles = (N+K-1)\*T |

= (60000+5-1)\*2

= 12,0008

1. **In a 16-bit little endian machine, how is the text “YA” stored in a word? How is the integer number 910 stored in a word? Write down the binary bits. (10%) (Hint: You need to use the ASCII table on Page 139.)**

**Answer:**

As per the given information:

|  |  |
| --- | --- |
| Y | 01011001 |
| A | 01000001 |

The Binary Format as follows.

YA - 0101100101000001

Address stored in Lower part and Upper part i.e.

|  |  |
| --- | --- |
| Lower M has | 01000001 (A) |
| Higher M+1 has | 01011001 (Y) |

The given number 910 is stored in a word.

Converts the given number into hexadecimal which is 038E

The Equivalent binary number as follows

0000 0011 1000 1110

Split the given binary number into two bytes i.e.

|  |  |
| --- | --- |
| Most Significant Byte | 10001110 |
| Lowest Significant Byte | 00000011 |

The Little-endian format for given Address.

|  |  |
| --- | --- |
| 8E at Lower Address M has | 10001110 |
| 03 at Higher Address M+1 has | 00000011 |

1. **Devise a 7-bit even-parity Hamming code for the numbers 0 to 4. (Hint: 0 is 0000 without parity bits.) (10%)**

**Answer:**

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**A close-up of a paper

Description automatically generated**

1. **A computer has a bus with 5-nsec cycle time, during which it can read or write a 32-bit word from memory. The computer has an Ultra4-SCSI disk that uses the bus and runs at 160 MBytes/sec. The CPU normally fetches and executes one 32-bit instruction every 1 nsec. How much does the disk slow down the CPU? Write down the percentage of CPU cycles that are spent on disk access. (10%)**

**Answer:**

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Description automatically generated**

1. **How long does it take to read a disk with 10,000 cylinders, each containing four tracks of 2048 sectors? First, all the sectors of Track 0 are to be read starting at Sector 0, then all the sectors of Track 1 starting at sector 0, and so on. The rotation time is 10 msec, and a seek takes 1 msec between adjacent cylinders and 20 msec for the worst case. Switching between tracks of a cylinder can be done instantaneously. (10%)**

**Answer:**

**A close-up of a paper

Description automatically generated**

1. **Let us assume we use RAID level 5 to store the following binary data:**

**01011111 00001010 11001101**

**10010001 00100001 11110011**

**Let us assume we have 4 disk drives, and the size of a strip is 8 bits. Illustrate how the data is stored on the 4 drives. Fill the table below. (10%)**

**(Note that in practice, a strip is much larger than 8 bits. A strip contains at least 1 sector, and a sector is typically 4096 bits.)**

**Answer:**

|  |  |  |  |
| --- | --- | --- | --- |
| RAID level 5 | | | |
| Disk drive #1 | Disk drive #2 | Disk drive #3 | Disk drive #4 |
| **01011111** | **00001010** | **11001101** | **10011000** |
| **10010001** | **00100001** | **01000011** | **11110011** |

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