Q1:

1- What is the distinction between computer structure and computer function?

Structure is how devices are interrelated, while function is the individual characteristics of each one.

- Structure: The way in which the components are interrelated.
- Function: The operation of each individual component as part of the structure

2- What are the four main functions and components of a general purpose computer?

1- Data processing
2- Data movement
3- Data storage
4- Control

A general purpose computer has four main components: the arithmetic and logic unit (ALU), the control unit, the memory, and the input and output devices (collectively termed I/O).

3- List and define the main structural components of a computer.

- CPU (Central processing unit): known as processor as well, it's the main computer component, responsible for the main functions of the computer.
- I/O: responsible for the communication between the computer and the external world.
- Data storage: device responsible for data saving.
- System bus: responsible for the interconnection between data storage, CPU and I/O.

4- List and define the main structural components of a processor.

- Control unit: Controls the operation of the CPU and hence the computer itself.
- ALU: make logical and arithmetic operations.
- Registers: temporally storage for data while processor operations.
- Internal bus: interconnect control unit, ALU and registers inside processor.

5- Explain Moore's law.

The number of transistors that could be put on a single chip would double each year.

6- Explain the key characteristics of a computer family.

- A computer family share the same architecture, allowing older programs versions to be run in newer hardware machines.
- Along versions, you can see a faster processor speed, a larger memory capacity and an increase of the number of capacitors in a processor chip.
- Similar or identical instruction set, Similar or identical operating system, Increasing speed, Increasing number of I/O ports, Increasing memory size, Increasing cost.

7- Choose a computer or a computer family, state its features, its technology principal, then compare between it with the previous and next computer or computer family?

1974 – 8080

Intel's first general purpose microprocessor

Its technology principal:

Designed to be the CPU of a general-purpose microcomputer.

8 bit microprocessor.

Features:

1. faster

2. has a richer instruction set

3. has a large addressing capability

Used in first personal computer – Altair

Previous computer:

1972 – Intel 8008

1. 8-bit microprocessor

2. designed for specific application

3. twice as complex as the 4004

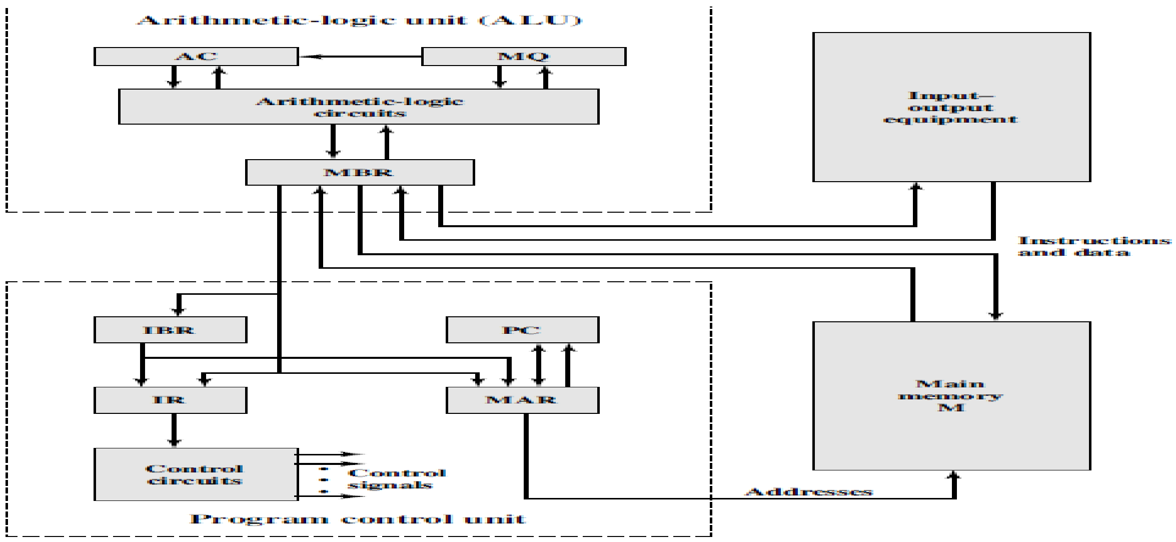
Next computer:

At the end of 1970s – 8086

1. 8086 – 5MHz – 29000 transistors.
2. Much more powerful
3. Use 16 bit
4. Instruction cache, prefetch few instructions
5. 8088 (8 bit external bus) used in first IBM PC

Q2:

For the following IAS computer architecture, indicate the width in bits of each of the data paths.



- Overall data paths to/from MBR is 40 bits
- Overall data paths to/from MAR is12 bits.
- All Paths to/from AC is 40 bits, IR is 8 and IBR 20 because it holds temporarily the right hand instruction from a word in memory.
- All Paths to/from MQ is 40 bits.

Q3 1-

A benchmark program is run on a 40 MHz processor. The executed program consists of 100,000 instruction executions, with the following instruction mix and clock cycle count:

Instruction Type	Instruction Count	Cycles per Instruction
Integer arithmetic	45000	1
Data transfer	32000	2
Floating point	15000	2
Control transfer	8000	2

Determine the effective CPI, MIPS rate, and execution time for this program.

CPI = $\frac{\sum_{i=1}^{n}(\text{CPIi}*Ii)}{Ic}$

CPI = $(\mathbf{1}\ x\ \mathbf{45000}) + (\mathbf{2}\ x\ \mathbf{32000}) + (\mathbf{2}\ x\ \mathbf{15000}) + (\mathbf{2}\ x\ \mathbf{8000})\ /\mathbf{100,000}$= 1.55

MIPS rate = f / CPI * 10^6 = 40 * 10^6 / 1.55* 10^6 = 25.80

T = Ic * CPI * t = 100,000 * 1.55 * (1/40*10₆) = 3.87 * 10-3

2-

Consider two different machines, with two different instruction sets, both of which have a clock rate of 200 MHz. The following measurements are recorded on the two machines running a given set of benchmark programs:

Instruction Type	Instruction Count (millions)	Cycles per Instruction
Machine A		
Arithmetic and logic	8	1
Load and store	4	3
Branch	2	4
Others	4	3
Machine A		
Arithmetic and logic	10	1
Load and store	8	2
Branch	2	4
Others	4	3

Answer:

$$CPI_A = \frac{\sum CPI_i \times I_i}{I_c} = \frac{(8\times1+4\times3+2\times4+4\times3)\times10^6}{(8+4+2+4)\times10^6} \approx 2.22$$

$$MIPS_A = \frac{f}{CPI_A \times 10^6} = \frac{200\times10^6}{2.22\times10^6} = 90$$

$$CPU_A = \frac{I_c \times CPI_A}{f} = \frac{18\times10^6\times2.2}{200\times10^6} = 0.2 \text{ s}$$

$$CPI_B = \frac{\sum CPI_i \times I_i}{I_c} = \frac{(10\times1+8\times2+2\times4+4\times3)\times10^6}{(10+8+2+4)\times10^6} \approx 1.92$$

$$MIPS_B = \frac{f}{CPI_B \times 10^6} = \frac{200\times10^6}{1.92\times10^6} = 104$$

$$CPU_B = \frac{I_c \times CPI_B}{f} = \frac{24\times10^6\times1.92}{200\times10^6} = 0.23 \text{ s}$$

b) Machine **B** has a **higher MIPS** than machine A, but it requires **a longer CPU time** to execute the same amount of benchmark programs.

3-

The following table, based on data reported in the literature [HEAT84], shows the execution times, in seconds, for five different benchmark programs on three machines.

Benchmark	Processor		
	R	M	Z
E	417	244	134
F	83	70	70
H	66	153	135
I	39,449	35,527	66,000
K	772	368	369

a. Compute the speed metric for each processor for each benchmark, normalized to machine R. That is, the ratio values for R are all 1.0. Other ratios are calculated using Equation (2.5) with R treated as the reference system. Then compute the arithmetic mean value for each system using Equation (2.3). This is the approach taken in [HEAT84].

b. Repeat part (a) using M as the reference machine. This calculation was not tried in [HEAT84].

c. Which machine is the slowest based on each of the preceding two calculations?

d. Repeat the calculations of parts (a) and (b) using the geometric mean, defined in Equation (2.6). Which machine is the slowest based on the two calculations?

a- Normalize to R :

Benchmark	Processor		
	R	M	Z
E	1	1.71	3.11
F	1	1.19	1.19
H	1	0.43	0.49
I	1	1.11	0.60
K	1	2.10	2.09
Arithmetic mean	1	1.31	1.50

b- Normalize to M

Benchmark	Processor		
	R	**M**	**Z**
E	0.59	1	1.82
F	0.84	1	1
H	2.32	1	1.13
I	0.90	1	0.54
K	0.48	1	1
Arithmetic mean	1.01	1	1.10

c- On (a) **R** is the slowest machine on (b), **M** is the slowest Machine.

d- Normalize to R:

Benchmark	Processor		
	R	**M**	**Z**
E	1	1.71	3.11
F	1	1.19	1.19
H	1	0.43	0.49
I	1	1.11	0.60
K	1	2.10	2.09
Geometric mean	1	1.15	1.18

- Normalize to M :

Benchmark	Processor		
	R	**M**	**Z**
E	0.59	1	1.82
F	0.84	1	1
H	2.32	1	1.13
I	0.90	1	0.54
K	0.48	1	1
Geometric mean	0.87	1	1.02

R is the slowest!