EXERCISE

Q.1   Select the best answer for the following MCQs.

i. Which part of computer performs Fetch, Decode and Execute cycle?
   A. ALU   B. Control Unit   C. Output Unit   D. Registers

ii. Where are the results of ALU operations transferred?
   A. Counter register   B. Base register
   C. Data register   D. Accumulator register

iii. Which of these buses selects a memory word for a read or write operation?
   A. Data bus   B. Control bus   C. Address bus   D. System bus

iv. Which of these registers controls the sequence in which instructions are fetched from memory for execution?
   A. Program counter   B. Memory buffer register
   C. Data register   D. Counter register

v. A memory word that is to be stored in or fetched from memory must first be transferred into which register?
   A. Accumulator   B. Data register
   C. Memory buffer register   D. Program counter

vi. Which instruction causes transfer of instruction execution to a specified address?
   A. Comparison instruction   B. Branch instruction
   C. Shift instruction   D. Data movement instruction

vii. Which of these instructions will perform addition of two numbers?
   A. Operation instruction   B. Shift instruction
   C. Comparison instruction   D. Data movement instruction

viii. Through which bus, instructions are transferred from main memory to instruction register?
   A. Control bus   B. Address bus   C. Instruction bus   D. Data bus

ix. How many distinct operations can be performed if op-code of a microprocessor consists of 4 bits?
   A. 4   B. 8   C. 16   D. 32

x. Which part of computer decodes instructions?
   A. ALU   B. Main memory
   C. Program counter   D. Control unit

Answers

i.	B	ii.	D	iii.	C	iv.	A	v.	C
vi.	B	vii.	A	viii.	D	ix.	C	x.	D

Q.2. Write short answers of the following questions.

i. What is a microprocessor?

Answer

Microprocessor

   Microprocessor is truly the "brain" of the computer system. It combines the circuitry that generates all the control signals needed to execute instructions.

ii. What is the function of ALU in the computer?

Answer

Function of ALU

   The ALU function is to perform operations such as addition, subtraction, multiplication, division, exponentials, data manipulations (for example, shifting), comparisons and logical operations such as AND, OR, NOT, etc. on the data contained in the registers.

iii. What is the function of control unit in the computer?

Answer

Function of CU

The function of control unit is to direct and coordinates the activities of the entire computer system. It controls the working of all the input/output devices, all the primary and secondary storage devices and the calculations performed by the ALU. Control unit controls the operations of computer system based on the instructions in the program by executing them in a proper order.

iv. Define bus.

Answer

Bus

A bus is an electrical pathway inside the computer system over which data/information transferred from one part to the other. It connects the CPU to the main memory on to motherboard.

Define register

Register

Register is small memory device whose function is to temporarily store data information and pass it on to the other parts of the processor or main memory during the processing.

v. Define cache memory.

Answer

Cache Memory

Cache memory is a very small amount of memory inside the microprocessor. It is faster than main memory but it is very expensive. It stores some active portion main memory, which is frequently required by the CPU.

vi. What is meant by instruction code?

Answer

Instruction Code

Instruction code is a group of bits that tells the computer to perform a specific operation. Instructions are stored in the main memory, waiting to be processed by the processor.

vii. What is operation code?

Answer

Operation Code

Operation code represents the action that the processor executes.

viii. What is the advantage of using address mode in an instruction?

Answer

Advantage

The advantage of using address mode in an instruction is that it indicates the way in which the operand is accessed.

ix. Differentiate between CISC and RISC architecture.

Answer

Differences between CISC and RISC architectures

The following are few differences between CISC and RISC architectures:

1. CISC instructions utilize more cycles than RISC.
2. CISC has way more complex instructions than RISC.
3. CISC typically has fewer instructions than RISC.
4. CISC implementations tend to be slower than RISC implementations.
5. Computers typically use CISC while tablets, smart phones and other devices use RISC.

Q3. Write long answers of the following questions.

i. Describe general purpose and special purpose registers.

Answer

General Purpose Registers

General-purpose registers are used to store data as well as addresses. These registers are used for

arithmetic data movement. Typically, these are 8 to 32 bit registers.

Commonly Used General Purpose Registers
Following are the commonly used general purpose registers:

1. Accumulator Register (AC) and Data Register (DR)
These two registers hold the operands (values) that the ALU operates on during the execution of an instruction. Operands are values on which operations such as addition or multiplication is to be performed. Operands are loaded into these registers from memory. After performing the operation, the results of ALU are transferred to the accumulator (AC). Both the accumulator and the data registers can receive data from memory over the data bus but only the accumulator can send data/information back to the memory.

2. Base Register (BR)
It is used to hold a number that can be added to (or, in some cases, subtracted from) the address portion of a computer instruction to form an effective address. It is also known as Index register.

3. Counter Register (CR)
It contains the address (location) of the instruction being executed at the current time. As each instruction gets fetched, the Counter register increases its stored value by 1. After each instruction is fetched, it points to the next instruction in the sequence. When the computer restarts or is reset, it normally reverts to 0.

Special Purpose Registers
These registers hold the state of a program. They include program counter, instruction register, memory address register and memory buffer registers. These are used by Control Unit control the operations of CPU and by the Operating System programs to control the execution of the programs.

Types of Special Purpose Registers:
Following are the types of special purpose registers:

(i) Instruction Register (IR)
Instruction register holds program instructions that are fetched from the memory for execution. It holds the instruction while the instruction decoder circuit decodes it. After decoding, the timing and control logic generates the proper sequence of control signals to complete the execution of the instruction.

(ii) Memory Address Register (MAR)
Memory address register hold the address of memory location from where a memory word is to be fetched or where data is to be stored.

(iii) Memory Buffer Register (MBR)
A memory word that is to be stored in or to be fetched from memory must first be transferred into MBR. MBR acts as a buffer (a small temporary memory) allowing to microprocessor and memory unit to act independently without being affected by minor differences in operation.

(iv) Program Counter (PC)
It controls the sequence in which instructions are fetched from memory. At any given instant, the contents of PC indicate the address in memory from which the next instruction is be fetched. Contents of PC are loaded into MAR to fetch an instruction from memory. After fetching an instruction from memory, the PC is incremented by one to point to the next instruction to be fetched.

ii. Explain the types of buses used in computers.

Answer

Types of Buses
Following are the three types of buses:

- ➢ Address Bus
- ➢ Data Bus
- ➢ Control Bus

1. Address Bus
The address bus is used by the CPU to select a memory word for a read or operation. It is unidirectional bus because information flows in only one direction. Address width is from 16 to 32 bits.

A system with a 32-bit address bus can address 2^{32} (4,294,967,296) memory locations.

2. Data Bus

The data bus is a bidirectional bus over which data can be sent from the microprocessor to memory (Write operation) or from the memory to the microprocessor (Read operation). Although, it is called data bus, the information carried on this will not always be data, it will often be instruction codes fetched by the microprocessor. Data bus width is from 32 to 64 bits

3. Control Bus

The control bus is a group of wires that sends timing and control signals to all the parts of computer needed to carry out the instructions. Some of the control lines are outputs from the microprocessor and others are inputs to the microprocessor from I/O devices. Control bus width is in the range of 8 to 16 bits.
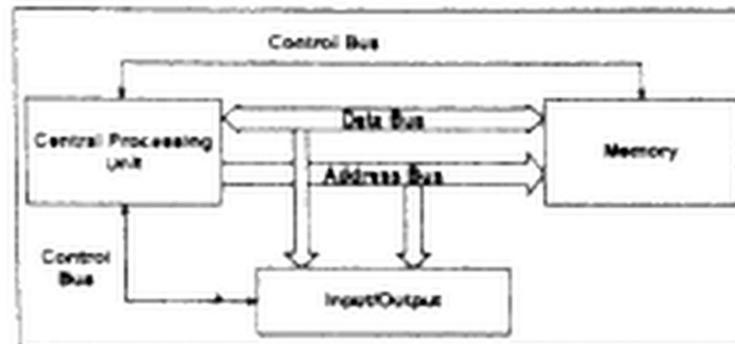

Fig. 3.5b System Buses

iii Describe the types of CPU instructions.

Answer

Types of CPU Instructions

Modern computers support many types of instructions. The following are some general types of instructions used in computers:

- ➤ Data Transfer Instructions
- ➤ Data Processing Instructions
- ➤ Program Control Instructions

1. Data Transfer Instructions

Data Transfer instructions transfer data from one location in the computer to another location without changing the data content. The most common transfers are between:

- ➤ Registers and memory
- ➤ Registers and I/O
- ➤ Registers to registers

Examples of data transfer instructions

Examples of some common data transfer instructions are:

- ➤ MOV
- ➤ LOAD
- ➤ STORE

1. MOV (MOVE) instruction

MOV (MOVE) instruction transfers data from a memory location to a register, register to memory and register to register. This instruction is also used to store the result of a computation.

Example

MOV A, B (Move the contents of register A to B)

(ii) LD (LOAD) instruction

LD (LOAD) instruction loads particular register contents from memory.

Example

LD A (Load the data to register A from memory)

(iii) STO (STORE) instruction

STO (STORE) instruction stores information from register to memory location.

2. Data Processing Instructions

These instructions are related to the arithmetic and logic operations. The arithmetic or logic operations are performed on the values of two registers and the result is also placed in a register.

Types of Data manipulation instructions

Data manipulation instructions can be divided into three basic types:

➢ Arithmetic Instructions
➢ Logical Instructions
➢ Shift Instructions

(i) Arithmetic Instructions

These instructions are used to perform arithmetic operations. The four basic arithmetic instructions are ADD (Addition), SUB (Subtraction), MUL (Multiplication) and DIV (Division).

(ii) Logical Instructions

These instructions are used to perform logical operations like AND, OR, NOT, etc. on binary data stored in registers.

(iii) Shift Instructions

Shift instruction is used for transfer of bits either to the left or to the right of an operand.

3. Program Control Instructions

Program control or transfer of control is a way of altering the order in which statements are executed. There are a number of instructions used for this purpose like JMP (Jump) and LOOP.

(i) JMP instruction

The JMP instruction jumps to begin the execution at another location.

(ii) LOOP instruction

The LOOP instruction is used when number of statements is to be repeated.

iv. Explain different types of instruction formats with examples.

Answer

Types of Instruction Formats

Some types of instruction formats are as follows:

➢ Zero-Address Instruction
➢ One-Address Instruction
➢ Two-Address Instruction

1. Zero Address Instruction

The Zero Address instruction format requires only op-code, having no operand to work with.

Example

Examples of the Zero Address instruction format are HALT and STOP, which do not have any address.

Op-Code	Operand

Example: STOP

2. One Address Instruction

One Address instruction format requires one op-code and one Operand.

Example

Example of the one address instruction format is LDA (Load Accumulator), JMP (Jump) etc.. These instructions require one address to do the operation. Like JMP requires one address in order to jump to that specific address location.
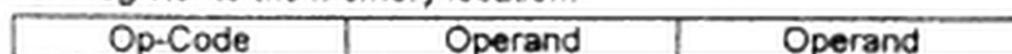
Example: JMPAX

3. Two Address Instruction

Two Address instruction format requires one op-code and two operands.

Example

Example of such instruction format is the MOV (Move), which moves data from the memory location to the register and from register to the memory location.

Op-Code	Operand	Operand

Example: ADD A, B

v. Explain CPU instruction cycle.

Answer

CPU Instruction cycle

Instruction cycle is the basic operation cycle of a computer to execute various instructions. A computer retrieves an instruction from its memory, determines what actions the instruction requires, and carries out those actions by the process.

Steps of Instruction Cycle

The following are the three instruction cycle steps:

> Fetch operations
> Decode operation
> Execute operation

Fig.3.7 Instruction Cycle

1. Fetch Operation

In this operation, the control unit fetches an instruction from main memory by sending an address through the address bus and a read command through the control bus. The fetch operation places the instruction into the instruction register (IR) inside the microprocessor.

2. Decode operation

In this step, the instruction decoder decodes the instruction to determine what the instruction is intended to do.

3. Execute Operation

Once the instruction has been decoded, it can be executed. In this operation, the timing and control logic circuitry in the control unit generates signals needed to execute the instruction. The instruction may perform arithmetic, make a decision, simply move data from one memo location to another, etc..
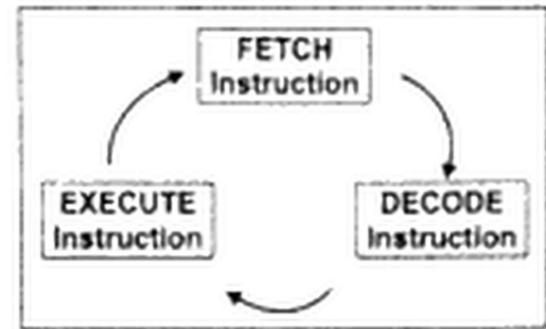
LAB ACTIVITIES

Following lab activities are to be carried out during the practical periods.

1) **Components on the motherboard including microprocessor, RAM and ROM should, be shown to the students.**

Answer
   Practical Work

2) **Installation of microprocessor on the motherboard along with the cooling fan) should be demonstrated.**

Answer
   Practical Work

3) **Students should be explained how data bus, control bus and address bus circuits are designed on the motherboard and they should have a clear understanding about their functions.**

Answer
   Practical Work

4) **Students should be explained how programs are loaded into the RAM memory and executed by the microprocessor.**

Answer
   Practical Work

5) **All the above activities should also be demonstrated through videos or animations.**

Answer
   Practical Work