Activity 1

1.

Concurrent Programming

Concurrent programming is a form of computing where multiple processes are executed in overlapping time periods. These processes can start, run, and complete in overlapping time intervals.

Example: A web server handling multiple requests from users. Each request can be handled by a separate thread, allowing the server to manage several requests concurrently without waiting for one to complete before starting another.

Parallel Programming

Parallel programming is a type of computation in which many calculations or processes are carried out simultaneously. Large problems are divided into smaller ones, which are then solved at the same time using multiple processors.

Example: In scientific computations, such as matrix multiplication, the workload can be divided into smaller tasks that run concurrently on multiple processors

Distributed Computing

Distributed computing involves multiple computers working together on a common task. These computers communicate and coordinate their actions by passing messages to one another over a network.

Example: In a distributed database system, data is stored on multiple machines. Queries are processed by distributing the workload across these machines.

2.

Amdahl's law is a formula that gives the theoretical speedup in latency of the execution of a task at a fixed workload that can be expected of a system whose resources are improved. Used to find the maximum improvement possible by just improving a particular part of a system.

$$S_{\text{latency}}(s) = \frac{1}{(1-p) + \frac{p}{s}}$$

Slatency is the theoretical speedup of the execution of the whole task;
s is the speedup of the part of the task that benefits from improved system resources;
p is the proportion of execution time that the part benefiting from improved resources originally occupied.

3.

A:

P = 20% = 0.2

S = 10

$S_{latency}$ = 1/((1 - 0.2) + (0.2 / 10) = 1/(0.8 + 0.02) = 1.22

B:

P = 50% = 0.5

S = 2

$S_{latency}$ = 1/((1 - 0.5) + (0.5 / 2) = 1/(0.5 + 0.25) = 1.33

Speeding up all floating-point operations by 2 times results in a better overall speedup (1.33) compared to speeding up FPSQR by 10 times (1.22).

Activity 2

1.

SISD

In SISD, a single processor executes a single instruction stream to operate on data stored in a single memory.

Example: A single-core CPU found in personal computers before the advent of multi-core processors.

MISD

In MISD, multiple processors execute different instruction streams on the same data stream.

Example: Fault-tolerant systems where multiple redundant processors check the same data to ensure consistency and reliability.

SIMD

In SIMD, a single instruction stream controls multiple processing elements, where each processing element executes the same instruction on different pieces of data.

Example: Modern graphics processing units (GPUs) use SIMD architecture to perform parallel processing of pixels in image rendering tasks.

MIMD

In MIMD, multiple autonomous processors simultaneously execute different instruction streams on different data streams.

Example: Multi-core processors in modern computers

2.

Array Processor

A processor that performs computations on large arrays of data. It applies the same instruction to multiple data points simultaneously.

Example: Modern GPUs (Graphics Processing Units), processing large arrays of pixels in parallel to render images quickly.

3.

Single Program, Multiple Data (SPMD)

In SPMD, multiple autonomous processors run the same program but on different data sets. Each processor executes the same code but operates on different pieces of data independently.

Example: In a weather simulation, each processor might simulate different geographic regions using the same set of instructions.

Multiple Program, Multiple Data (MPMD)

In MPMD, multiple autonomous processors run different programs on different data sets. Each processor can execute a different code on different pieces of data

Example: A multimedia server system. One processor might handle video encoding, another might handle audio encoding, and yet another might manage data storage. Each of these processors runs a different program tailored to its specific task.