UNIT 1: COMPUTING PARADIGMS

1Q: Explain in detail about High Performance Computing?

1A:

- In high-performance computing systems, a pool of processors (processor machines or central processing units [CPUs]) connected (networked) with other resources like memory, storage, and input and output devices, and the deployed software is enabled to run in the entire system of connected components.
- The processor machines can be of homogeneous or heterogeneous type.
- The legacy meaning of high-performance computing (HPC) is the supercomputers; however, it is not true in present-day computing scenarios.
- Therefore, HPC can also be attributed to the other computing paradigms, as it is a common name for all computing systems.
- Thus, examples of HPC include a small cluster of desktop computers or personal computers (PCs) to the fastest supercomputers.
- HPC systems are normally found in those applications where it is required to use or solve scientific problems.
- Most of the time, the challenge in working with these kinds of problems is to perform suitable simulation study, and this can be accomplished by HPC without any difficulty.
- Scientific examples such as protein folding in molecular biology and studies on developing models and applications based on nuclear fusion are worth noting as potential applications for HPC.

2Q: Write short notes on Parallel computing?

2A:

- Parallel computing is also one of the facets of HPC.
- Here, a set of processors work cooperatively to solve a computational problem.
- These processor machines or CPUs are mostly of homogeneous type.
- Therefore, this definition is the same as that of HPC and is broad enough to include supercomputers that have hundreds or thousands of processors interconnected with other resources.
- One can distinguish between conventional (also known as serial or sequential or Von Neumann) computers and parallel computers in the way the applications are executed.
- In serial or sequential computers, the following apply:
- It runs on a single computer/processor machine having a single CPU.
- A problem is broken down into a discrete series of instructions.
- Instructions are executed one after another.
- In parallel computing, since there is simultaneous use of multiple processor machines, the following apply:
- It is run using multiple processors (multiple CPUs).
- A problem is broken down into discrete parts that can be solved concurrently.
- Each part is further broken down into a series of instructions.

- Instructions from each part are executed simultaneously on different processors.
- An overall control/coordination mechanism is employed.

3Q: Discuss in detail about Distributed computing?

3A:

- Distributed computing is also a computing system that consists of multiple computers or processor machines connected through a network, which can be homogeneous or heterogeneous, but run as a single system.
- The connectivity can be such that the CPUs in a distributed system can be physically close together and connected by a local network, or they can be geographically distant and connected by a wide area network.
- The heterogeneity in a distributed system supports any number of possible configurations in the processor machines, such as mainframes, PCs, workstations, and minicomputers.
- The goal of distributed computing is to make such a network work as a single computer.
- Distributed computing systems are advantageous over centralized systems, because there is a support for the following characteristic features:
- 1. Scalability: It is the ability of the system to be easily expanded by adding more machines as needed, and vice versa, without affecting the existing setup.
- 2. Redundancy or replication: Here, several machines can provide the same services, so that even if one is unavailable (or failed), work does not stop because other similar computing supports will be available.

4Q: What is Cluster computing,explain in detail ?

4A:

- A cluster computing system consists of a set of the same or similar type of processor machines connected using a dedicated network infrastructure.
- All processor machines share resources such as a common home directory and have software such as a message passing interface (MPI) implementation installed to allow programs to be run across all nodes simultaneously.
- This is also a kind of HPC category.
- The individual computers in a cluster can be referred to as nodes.
- The reason to realize a cluster as HPC is due to the fact that the individual nodes can work together to solve a problem larger than any computer can easily solve.
- And, the nodes need to communicate with one another in order to work cooperatively and meaningfully together to solve the problem in hand.
- If we have processor machines of heterogeneous types in a cluster, this kind of clusters become a subtype and still mostly are in the experimental or research stage.

5Q: Explain in detail about Grid computing?

5A:

- The computing resources in most of the organizations are underutilized but are necessary for certain operations.
- The idea of grid computing is to make use of such non utilized computing power by the needy organizations, and thereby the return on investment (ROI) on computing investments can be increased.
- Thus, grid computing is a network of computing or processor machines managed with a kind of software such as middleware, in order to access and use the resources remotely.
- The managing activity of grid resources through the middleware is called grid services.
- Grid services provide access control, security, access to data including digital libraries and databases, and access to large-scale interactive and long-term storage facilities.
- Grid computing is more popular due to the following reasons:
- Its ability to make use of unused computing power, and thus, it is a cost-effective solution (reducing investments, only recurring costs)
- As a way to solve problems in line with any HPC-based application
- Enables heterogeneous resources of computers to work cooperatively and collaboratively to solve a scientific problem Researchers associate the term grid to the way electricity is distributed in municipal areas for the common man.

6Q: Discuss in detail about Cloud computing?

6A:

- The computing trend moved toward the cloud from the concept of grid computing, particularly when large computing resources are required to solve a single problem, using the ideas of computing power as a utility and other allied concepts.
- However, the potential difference between grid and cloud is that grid computing supports leveraging several computers in parallel to solve a particular application, while cloud computing supports leveraging multiple resources, including computing resources, to deliver a unified service to the end user.
- In cloud computing, the IT and business resources, such as servers, storage, network, applications, and processes, can be dynamically provisioned to the user needs and workload.
- In addition, while a cloud can provision and support a grid, a cloud can also support non grid environments, such as a three-tier web architecture running on traditional or Web 2.0 applications.

7Q: Write short notes on Bio computing?

7A:

- Biocomputing systems use the concepts of biologically derived or simulated molecules (or models) that perform computational processes in order to solve a problem.

- The biologically derived models aid in structuring the computer programs that become part of the application.
- Biocomputing provides the theoretical background and practical tools for scientists to explore proteins and DNA.
- DNA and proteins are nature's building blocks, but these building blocks are not exactly used as bricks;
- The function of the final molecule rather strongly depends on the order of these blocks.
- Thus, the biocomputing scientist works on inventing the order suitable for various applications mimicking biology.
- Biocomputing shall, therefore, lead to a better understanding of life and the molecular causes of certain diseases.

8Q: What is Mobile computing,explain in detail?

8A:

- In mobile computing, the processing (or computing) elements are small (i.e., handheld devices) and the communication between various resources is taking place using wireless media.
- Mobile communication for voice applications (e.g., cellular phone) is widely established throughout the world and witnesses a very rapid growth in all its dimensions including the increase in the number of subscribers of various cellular networks.
- An extension of this technology is the ability to send and receive data across various cellular networks using small devices such as smartphones.
- There can be numerous applications based on this technology; for example, video call or conferencing is one of the important applications that people prefer to use in place of existing voice (only) communications on mobile phones.
- Mobile computing–based applications are becoming very important and rapidly evolving with various technological advancements as it allows users to transmit data from remote locations to other remote or fixed locations.

9Q: Explain in detail about Quantum computing?

9A:

- Manufacturers of computing systems say that there is a limit for cramming more and more transistors into smaller and smaller spaces of integrated circuits (ICs) and thereby doubling the processing power about every 18 months.
- This problem will have to be overcome by a new quantum computing–based solution, wherein the dependence is on quantum information, the rules that govern the subatomic world.
- Quantum computers are millions of times faster than even our most powerful supercomputers today.
- Since quantum computing works differently on the most fundamental level than the current technology, and although there are working prototypes, these systems have not so far proved to be alternatives to today's silicon-based machines.

10Q: Discuss in detail about Optical computing?

10A:

- Optical computing systems use the photons in visible light or infrared beams, rather than electric current, to perform digital computations.
- An electric current flows at only about 10% of the speed of light.
- This limits the rate at which data can be exchanged over long distances and is one of the factors that led to the evolution of optical fiber.
- By applying some of the advantages of visible and/or IR networks at the device and component scale, a computer can be developed that can perform operations 10 or more times faster than a conventional electronic computer.

11Q: What is Nano computing,explain briefly?

11A:

- Nanocomputing refers to computing systems that are constructed from nanoscale components.
- The silicon transistors in traditional computers may be replaced by transistors based on carbon nanotubes.
- The successful realization of nanocomputers relates to the scale and integration of these nanotubes or components.
- The issues of scale relate to the dimensions of the components; they are, at most, a few nanometers in at least two dimensions.
- The issues of integration of the components are two fold:
- first, the manufacture of complex arbitrary patterns may be economically infeasible, and
- Second, nanocomputers may include massive quantities of devices.
- Researchers are working on all these issues to bring nanocomputing a reality