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Subject :- HPC

HPC Assignment No. :- 1

* Title :- Application Case Study of HPC.

* Aim :- Demonstration of an application case study of High Performance Computing.

* Objective :- To demonstrate case study of High-Performance Computing and its importance in real world.

* Theory :-

* Technical Concepts of HPC in Smart city traffic management.

* The selected application utilizes HPC to predict and mitigate urban traffic congestion through high-speed, large-scale simulations. The technical framework involves :-

(1) Real-time data integration:-
HPC systems ingest massive stream of live data from GPS devices, road sensors, cameras & weather station to build a detailed digital twin of city mobility.

(2) Parallel Processing & Microscopic:-
Unlike standard PCs, HPC uses clusters of linked nodes & parallel CPU/GPU core to simulate the movement of millions of individual vehicles simultaneously.

(3) Dynamic Optimization:-
The system runs complex algorithms to generate congestion heatmaps and optimize signal timings in real-time, allowing for adaptive rerouting that can save billions of gallons of fuel compared to static systems.

(4) High-speed Decision Making:-
By processing data hundreds of times faster than a regular machine, HPC allows city planners to rerun simulations with fresh data instantly to respond to accidents or sudden weather changes.

★ FAQ's:-

① Write scope of High-Performance Computing in Medical Domain / or Agriculture Domain / or Weather forcasting.

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Agriculture Domain:-

HPC is used for "Agricultural Forcasts" to provide accurate warnings regarding monsoon timing, size & soil moisture content, helping farmers optimize planting & irrigation.

② List top 5 supercomputers of the world with their specification from www.top500.org.

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According to the 66th TOP500 list realised in Novembes 2025, the leading systems are:-

① **El Capitan**

Country:- USA

Specifications:- 1.809 Exaflop/s;
₹2,340,000 crores;
AMD 4th Gen EPYC processores &
AMD instinct MI300A accelerates

② **Frontier**

Country:- USA

Specifications:- 1.353 Exaflops/s;
9,066,176 crores.

HPE Cray Ex architecture with 3rd Gen AMD EPYC CPUs & AMD instinct 250X Accelerators.

③ Aurora

Country :- USA

Specifications :- 1,012 ExaflOP/S;
9,264,128 cores;
Intel Xeon CPU Max Series & Intel Data Centre GPU Max Series accelerators.

③ What is Quantum Computing & its relevance for HPC?

→ Quantum computing uses principles of quantum mechanics to perform computations in a fundamentally different way than classical computers, solving problems that are too complex or slow for current machines.

The future of HPC involves "accelerated R&D". where quantum processors act as specialized accelerators for classical supercomputers, handling specific tasks like complex chemical simulations or cryptography.