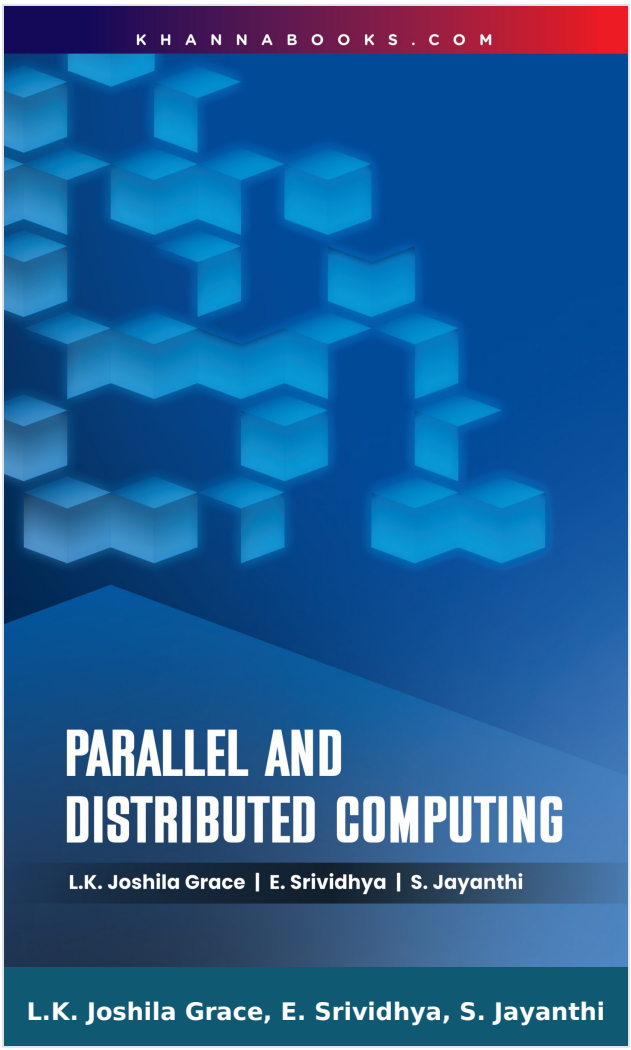

Parallel and Distributed Computing

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Product Description

The rapid growth in data processing and the increasing complexity of computational problems have made Parallel and Distributed Computing (PDC) an essential field in modern technology. This book serves as a comprehensive and authoritative guide, providing both the theoretical foundations and practical insights required to master this evolving domain. It systematically explores how systems can execute multiple tasks simultaneously, fundamentally improving speed, efficiency, and resource utilization. The core theme is the detailed exposition of PDC principles, architectures, and applications, starting with the motivations for parallelism and modifications to the traditional von Neumann model. It offers a deep dive into parallel hardware like SIMD and MIMD systems, advanced architectures such as CMPs and GPUs, and crucial concepts like cache coherence and OpenCL programming. The book then transitions to distributed computing, covering critical areas like communication models, synchronization, deadlock handling, and distributed file systems and shared memory. With its structured five-unit approach, real-world applications, and problem-solving exercises, this resource is designed to equip a broad target audience—including students, researchers, and professionals—with the necessary knowledge to design and implement efficient, scalable systems. Mastering the concepts presented herein will be instrumental in shaping the future of high-performance computing.

Salient Features:

• Fundamental Architectures: Provides comprehensive coverage of parallel hardware, including Flynn’s taxonomy (SIMD/MIMD), cache coherence, and the evolution of modern architectures like CMPs and GPUs.

• Advanced Programming Models: Detailed exploration of key models of parallelism such as the PRAM and CTA models, alongside an essential introduction to OpenCL for heterogeneous parallel computing.

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• Interconnection Networks: Focuses on the crucial role of interconnection networks in parallel and distributed systems. It discusses both static and dynamic approaches to ensure high-speed and efficient communication among all processors.

• Distributed Communication: Covers essential goals, design issues, and models like the Client-Server Model. Includes in-depth topics such as Remote Procedure Calls (RPC) and Group Communication mechanisms.

• Synchronization & Control: Offers an in-depth analysis of synchronization algorithms, deadlock handling, and distributed scheduling techniques for effective resource and process management in multi-node systems.

• Memory Management Systems: Dedicated units on Distributed File Systems (DFS) design, implementation, and an introduction to shared memory consistency models, including a MACH system case study.

• Performance Optimization: Addresses practical considerations for performance, including floating-point precision, parallel reduction techniques, and managing common caveats like overhead and over-parallelization.

• Real-World Applications: Explores the wide scope of PDC, with applications in scientific simulations, AI, big data analytics, bioinformatics, and commercial systems like web and database services.

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