ELECTIVE – VI

2CSE60E5: Parallel Programming [3 0 2 3 1]

Learning Outcomes:
After learning the course the students should be able to:

- Describe different types of parallelism, their principles and structures
- Comprehend the principles, techniques, and practices relevant to the design and implementation of parallel computing systems
- Construct parallel algorithms for distributed and shared memory parallel systems

SYLLABUS

Unit No.	Topics	Lectures (Hours)
1	**Introduction** Von Neumann architecture, Why do we need high speed computing? How do we increase the speed of computers?, Some interesting features of parallel computers	2
2	**Solving Problems in Parallel** Temporal parallelism, Data Parallelism, Combined temporal and data parallelism, Data parallelism with dynamic assignment, Data parallelism with quasi-dynamic assignment, Comparison of Temporal and Data Parallel Processing	3
3	**Instruction level Parallel Processing** Pipelining of Processing Elements, Delays in Pipeline Execution, Delay due to resource constraints, Delay due to data dependency, Pipeline delay due to branch instructions, Hardware modification to reduce delay due to branches, Software modification to reduce delay due to branches, Difficulties in Pipelining	4
4	**Parallel Algorithms** Models of Computation, Random access machine, parallel random access machine, Interconnection networks, combinational circuits, Analysis of Parallel Algorithms, Running time, Number of processors and cost	4
5	**Introduction to Parallel Processing** Architectural Classification schemes, Multiplicity of instruction – data stream, Serial versus parallel processing, Parallelism versus pipelining, Parallel Processing Applications	3
6	**Principles of Pipelining and Vector Processing** Principles of designing Pipeline Processors, Instruction prefetch and branch handling, Data buffering and busing structures, Internal forwarding and register tagging, Hazard detection and resolution	3

7	**Structures and Algorithms for Array Processors** SIMD Array Processors, SIMD computer organization, Masking and data routing mechanisms, Inter PE communications	**4**
8	**Processes, Shared Memory and Simple Parallel Programs** Introduction, Processes and processors, Shared memory–1, Forking-Creating Processes, Shared memory-2, Processes are randomly scheduled – Contention	**4**
9	**Basic Parallel Programming Techniques** Introduction, Loop splitting, ideal speedup, Spin-locks, Contention and Self-scheduling, Histogram	**4**
10	**Barriers And Race Conditions** Introduction, The Barrier Calls, Expression splitting	**3**
11	**Introduction To Scheduling – Nested loops** Introduction, Variations on loop splitting, Variation on self – scheduling, indirect scheduling	**4**
12	**Overcoming Data Dependencies** Introduction, Induction variable, Forward dependency, Block scheduling and forward dependency, Backward dependency, Split table loops, Special scheduling – Assign based on condition	**4**
13	**Scheduling Summary** Introduction, Loop splitting, Expression splitting, Self scheduling, Indirect scheduling, Block scheduling, Special scheduling	**3**

Reference Books:

1. Computer architecture and parallel processing by Kai Hwang
2. Parallel Computers – Architecture and Programming by V. Rajaraman and C. Siva Ram Murthy
3. Introduction to Parallel Programming by Steven Braver
4. Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP", Tata McGraw-Hill Publishing Company Ltd., 2003.