

(Accredited by NAAC Approved by A.I.C.T.E. New Delhi, Recognized by Govt. of Karnataka & Affiliated to V.T U., Belagavi)
#57, Chimney Hills, Hesaraghatta Main Road, Chikkabanavara Post, Bengaluru- 560090

# **Department of Computer Science & Engineering**

Academic Year	:	2025-26	Course Name	:	Parallel computing
Semester	:	7A	Course Code	:	BCS702
Scheme	:	22	L: T: P: C	:	3:0:2:4
Total Contact hours	:	40 hours Theory + 8-10 Lab slots	CIE Marks	:	50
Course Plan Author	:	Latha A	SEE Marks	:	50
Date	:	1/8/25	Total Marks	:	100

## **Course Prerequisites:**

 Familiarity with programming languages like C, C++, or Python is typically required, along with an understanding of how computers work at a hardware level.

## **Learning Objectives:**

To demonstrate how to apply OpenMP pragma and directives to parallelize the suitable programs

### **Course Outcomes:**

СО	A	Blooms' Level	
CO1	•	Understand the need for parallel programming	L2
CO2		Demonstrate parallelism in MIMD system.	L2
СОЗ	•	Apply MPI library to parallelize the code to solve the given problem.	L3
CO4	• •	Apply OpenMP pragma and directives to parallelize the code to solve the given problem.	L3
CO5		Design a CUDA program for the given problem.	L3

### **Blooms' Taxonomy:**

L1	L2	L3	L4	L5	L6
Remembering	Understanding	Applying	Analyzing	Evaluating	Creating

## **Program Outcomes:**

PO1	:	Engineering knowledge	PO7	:	Environment and sustainability
PO2		Problem analysis	PO8	:	Ethics
PO3	:	Design/development of solutions	PO9	:	Individual and team work



(Accredited by NAAC Approved by A.I.C.T.E. New Delhi, Recognized by Govt. of Karnataka & Affiliated to V.T U., Belagavi)
#57, Chimney Hills, Hesaraghatta Main Road, Chikkabanavara Post, Bengaluru- 560090

PO4	:	Conduct investigations of problems	f complex	PO10	•	Communication
PO5	••	Modern tool usage		PO11		Project management and finance
PO6	:	The engineer and society		PO12	:	Life-long learning

# **Program Specific Outcomes:**

PSO1:	Model computational problems by applying mathematical concepts and design solutions using suitable data structures & amp; algorithmic techniques.
PSO2:	Demonstrate basic knowledge of computer science in efficient design of problem solutions of varying complexity.
PSO3:	Create career path to become a successful computer science professional, entrepreneur and relish for higher studies

# **CO-PO-PSO Mapping:**

		Program Outcomes													
СО	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	<b>PO</b> 7	PO 8	PO 9	PO 10	PO 11	PO 1 2	PSO 1	PSO 2	PSO 3
CO1	2					1						2	2		
CO2	2	2							2			2	2	2	
CO3	3	2	2	2	2				2	2	2	2	3	2	2
CO4	3	2	2	2	2				2	2	2	2	3	2	2
CO5	3	2	3	2	2				2	2	2	2	3	3	3
Target	2.6	2	2.3	2.0	2.0	1.0			2.0	2.0	2.0	2.0	2.8	2.3	2.3

# **Course Content (Syllabus)**

Module-1	08
Introduction to parallel programming, Parallel hardware and parallel software – Classifications of parallel computers, SIMD systems, MIMD systems, Interconnection network Cache coherence, Shared-memory vs. distributed-memory, Coordinating the processes/threads, Shared-memory, Distributed-memory.	
Module-2	08



(Accredited by NAAC Approved by A.I.C.T.E. New Delhi, Recognized by Govt. of Karnataka & Affiliated to V.T U., Belagavi)
#57, Chimney Hills, Hesaraghatta Main Road, Chikkabanavara Post, Bengaluru- 560090

**GPU programming, Programming hybrid systems, MIMD systems, GPUs, Performance** – Speedup and efficiency in MIMD systems, Amdahl's law, Scalability in MIMD systems, Taking timings of MIMD programs, GPU performance.

Module-3 08

**Distributed memory programming with MPI** – MPI functions, The trapezoidal rule in MPI, Dealing with I/O, Collective communication, MPI-derived datatypes, Performance evaluation of MPI programs, A parallel sorting algorithm.

Module-4 08

**Shared-memory programming with OpenMP** – openmp pragmas and directives, The trapezoidal rule, Scope of variables, The reduction clause, loop carried dependency, scheduling, producers and consumers, Caches, cache coherence and false sharing in openmp, tasking, thread safety.

Module-5 08

**GPU programming with CUDA** - GPUs and GPGPU, GPU architectures, Heterogeneous computing, Threads, blocks, and grids Nvidia compute capabilities and device architectures, Vector addition, Returning results from CUDA kernels, CUDA trapezoidal rule II: improving performance, CUDA trapezoidal rule III: blocks with more than one warp.

#### **Schedule of Instruction:**

Class No	Торіс	Date	RBT	со	Mode								
Modul	Module-1												
Introd	uction to parallel programming												
1.	Introduction to CO, Subject, Subject Prerquisites	11-08-25	L2	CO1	С&В								
2.	Introduction and classifications of Parallel computers	12-08-25	L2	CO1	C&B								
3.	SIMD systems	18-08-25	L2	CO2	C&B								
4.	MIMD systems	19-08-25	L2	CO2	C&B								
5.	Cache coherence	22-08-25	L2	CO1	C&B								
6.	Shared-memory	25-08-25	L2	CO1	C&B								
7.	distributed-memory	29-08-25	L2	CO1	C&B								
8.	Coordinating the processes/threads	1-09-25	L2	CO1	C&B								



(Accredited by NAAC Approved by A.I.C.T.E. New Delhi, Recognized by Govt. of Karnataka & Affiliated to V.T U., Belagavi) #57, Chimney Hills, Hesaraghatta Main Road, Chikkabanavara Post, Bengaluru- 560090

9.	Shared-memory	2-09-25	L2	CO2	C&B							
10.	Distributed-memory	8-09-25	L2	CO2	C&B							
Modu		0 07 28	LZ	CO2	Сав							
	GPU programming, MIMD systems											
11.	Speedup	9-09-25		CO2	C&B							
	Efficiency in MIMD systems	10-09-25		<u> </u>								
12.	Amdahl's law	12-09-25	L2	CO2	C&B							
13.			L2	CO2	C&B							
14.	Scalability in MIMD systems	15-09-25	L2	CO2	C&B							
15.	Scalability in MIMD systems	16-09-25	L2	CO2	C&B							
16.	Taking timings of MIMD programs	19-09-25	L2	CO2	C&B							
17.	GPU performance	22-09-25	L2	CO1	C&B							
18.	GPU performance	23-09-25	L2	CO1	Video							
Modu	le-3											
Distril	outed memory programming with MPI											
19.	MPI functions	29-09-25	L3	CO3	C&B							
20.	The trapezoidal rule in MPI	30-09-25	L3	CO3	C&B							
21.	The trapezoidal rule in MPI	03-10-25	L3	CO3	PPT							
22.	Dealing with I/O	06-10-25	L3	CO3	PPT							
23.	Collective communication	07-10-25	L3	CO3	PPT							
24.	Collective communication	08-10-25	L3	CO3	PPT							
25.	MPI-derived datatypes	07-10-25	L3	CO3	PPT							
26.	Performance evaluation of MPI programs	08-10-25	L3	CO3	PPT							
27.	A parallel sorting algorithm	13-10-25	L2	CO3	PPT							
Modu												
28.	openmp pragmas and directives	14-10-25	L2	CO4	PPT							
29.	The trapezoidal rule	15-10-25	L3	CO4	C&B							
30.	Scope of variables	17-10-25	L3	CO4	C&B							
31.	The reduction clause	23-10-25	L3	CO4	C&B							
32.	The reduction clause	27-10-25	L3	CO4	C&B							
33.	loop carried dependency	28-10-25	L2	CO4	PPT							
34.	scheduling, producers and consumers	29-10-25	L2	CO4	PPT							
35.	Caches, cache coherence and false sharing in openmp	3-11-25	L2	CO5	PPT							
Modu	le-5											



(Accredited by NAAC Approved by A.I.C.T.E. New Delhi, Recognized by Govt. of Karnataka & Affiliated to V.T U., Belagavi)
#57, Chimney Hills, Hesaraghatta Main Road, Chikkabanavara Post, Bengaluru- 560090

GPU p	orogramming with CUDA				
36.	GPUs and GPGPU	4-11-25	L3	CO5	PPT
37.	GPU architectures	5-11-25	L3	CO5	PPT
38.	Heterogeneous computing	6-11-25	L3	CO5	PPT
39.	Threads, blocks, and grids	10-11-25	L3	CO5	PPT
40.	Threads, blocks, and grids	11-11-25	L2	CO5	PPT
41.	Nvidia compute capabilities and device architectures	12-11-25	L2	CO5	PPT
42.	Vector addition	13-11-25	L2	CO5	PPT
43.	Returning results from CUDA kernels, CUDA trapezoidal rule	17-11-25	L2	CO5	PPT



(Accredited by NAAC Approved by A.I.C.T.E. New Delhi, Recognized by Govt. of Karnataka & Affiliated to V.T U., Belagavi)
#57, Chimney Hills, Hesaraghatta Main Road, Chikkabanavara Post, Bengaluru- 560090

## PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments	Date	RBT	CO	Mode
1	Write a OpenMP program to sort an array on n elements using both sequential and parallel mergesort(using Section). Record the difference in execution time.	18-08-25	L3	CO4	EBL
2	Write an OpenMP program that divides the Iterations into chunks containing 2 iterations,respectively(OMP_SCHEDULE =static,2). Its input should be the number of iterations, and its output should be which iterations of a parallelized for loop are executed by which thread.	25-08-25	L3	CO4	EBL
	For example, if there are two threads and four iterations, the output might be the following:				
	a. Thread 0: Iterations 0 — 1				
	b. Thread 1 : Iterations 2 – 3				
3	Write a OpenMP program to calculate n Fibonacci numbers using tasks.	01-08-25	L3	CO4	EBL
4	Write a OpenMP program to find the prime numbers from 1 to n employing parallel for directive. Record both serial and parallel execution times.	08-09-25	L3	CO4	EBL
5	Write a MPI Program to demonstrate MPI_Send and MPI_Recv.	15-09-25	L3	CO3	EBL
6	Write a MPI program to demonstration of deadlock using point to point communication and avoidance of deadlock by altering the call sequence	22-09-25	L3	CO3	EBL
7	Write a MPI Program to demonstrate Broadcast operation.	29-09-25	L3	CO3	EBL
8	Write a MPI Program demonstration of MPI_Scatter and MPI_Gather	06-09-25	L3	CO3	EBL
9	Write a MPI Program to demonstration of MPI_Reduce and MPI_Allreduce (MPI_MAX, MPI_MIN, MPI_SUM, MPI_PROD)	13-10-25	L3	CO3	EBL



(Accredited by NAAC Approved by A.I.C.T.E. New Delhi, Recognized by Govt. of Karnataka & Affiliated to V.T U., Belagavi)
#57, Chimney Hills, Hesaraghatta Main Road, Chikkabanavara Post, Bengaluru- 560090

#### **Textbooks:**

T1	Peter S Pacheco, Matthew Malensek – An Introduction to Parallel Programming, second edition, Morgan Kauffman.
T2	Michael J Quinn – Parallel Programming in C with MPI and OpenMp, McGrawHill.

#### **Reference books:**

R1	Calvin Lin, Lawrence Snyder – Principles of Parallel Programming, Pearson				
R2	Barbara Chapman – Using OpenMP: Portable Shared Memory Parallel				
	Programming Scientific and Engineering Computation				

### Web links and Video Lectures (e-Resources):

1.	https://sites.google.com/view/sumaisecoursewebsite
2.	Introduction to parallel programming: <a href="https://nptel.ac.in/courses/106102163">https://nptel.ac.in/courses/106102163</a>

### **Assessment Schedule:**

S.N.	Assessment Type	Content	СО	Duration	Marks	Date
1.	CIE 1 (Theory)	M1,M2,M3	CO1,CO2,CO3	1:00	1.5	
2.	CIE 2 (Theory)	M3,M4,M5	CO3,CO4,CO5	1:00	15	
3.	CIE (Lab) - Record	M1,M2,M3 M4,M5	001,002,000	8-9 labs of each 2 hrs	15	
4.	CIE (Lab) - Test	M1,M2,M3 M4,M5	CO1,CO2,CO3 CO4,CO5	2:00	10	
5.	Quiz	M1,M2,M3 M4,M5	CO1-C05		10	
7.	Semester End Examination	M1,M2,M3 M4,M5	CO1,CO2,CO3 CO4,CO5	3:00	50	

RB – Text Book/Reference Book, \*L – Lecture, V- Videos or any other mode, \*RBT – Revised Blooms' Taxonomy, L: T: P: C – Theory/Lecture: Tutorial: Practical/Drawing: Credits, SEE: Semester End Examination, CIE: Continuous Internal Evaluation, Seminar: Group of 6-8 students, Module 1,2,3,4 & 5,\*\*The sum of total marks of three tests, two assignments, and seminar will be out of 100 marks and will be scaled down to 50 marks. (As per the scheme), CIE + SEE = 50 + 50 = 100 marks

Faculty In charge Course Coordinator