GPU COMPUTING

| II Semester: CSE | | | | | | | | |
|---------------------|---------------|--------------|------------------------------|---------|-------------------|-----|-----|-------|
| Course Code | Category | Hours / Week | | Credits | Maximum Marks | | | |
| | | L | Т | Р | С | CIA | SEE | Total |
| BCSB17 | Elective | 3 | 0 | 0 | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Total Tutoria | ls: Nil | Total Practical Classes: Nil | | Total Classes: 45 | | | |

I. COURSE OVERVIEW:

This course provides students with comprehensive knowledge of GPUs, covering various aspects including memory hierarchy, synchronization across CPU and GPU, and debugging GPU programs. Students will gain a deep understanding of the inner workings of GPUs and how to effectively utilize their capabilities.

II. OBJECTIVES:

The students will try to learn:

The parallel programming with Graphics Processing Units (GPUs).

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

| CO 1 | Make use of GPU programming for running Highly Parallel general purpose competitions in 2-Dimensional and 3-Dimensional thread mapping. | Understand |
|------|--|------------|
| CO 2 | Identify different types of memories used in GPUs for performance evaluation for a specific application. | Apply |
| CO 3 | Develop a GPU program for usage of concurrent data structures applied in different types of functions. | Evaluate |
| CO 4 | Make use of stream processing techniques used in GPUs in applications of weather modeling & medical applications. | |
| CO 5 | Develop a GPU program in application of image processing, graph algorithms & deep learning. | Understand |

IV. SYLLABUS

| UNIT-I | INTRODUCTION | Classes: 13 | | |
|--|--------------|-------------|--|--|
| listory, Graphics Processors, Graphics Processing Units, GPGPUs. Clock speeds, CPU / GPU comparisons, leterogeneity, Accelerators, Parallel programming, CUDA Open CL / Open ACC, lello World Computation Kernels, Launch parameters, Thread hierarchy, Warps / Wave fronts, Thread locks / Workgroups, Streaming multiprocessors, 1D / 2D / 3D thread mapping, Device properties, Simple | | | | |
| UNIT-II | MEMORY | Classes: 08 | | |

Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories

| UNIT-III | SYNCHRONIZATION |
|-----------------|-----------------|
|-----------------|-----------------|

Classes: 08

Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Work lists, Linked-lists. Synchronization across CPU and GPU **Functions**: Device functions, Host functions, Kernels functions, Using libraries (such as Thrust), and developing libraries.

| UNIT-IV | SUPPORT AND STREAMS | Classes: 09 |
|------------------|---|-------------|
| Debugging GPU F | Programs. Profiling, Profile tools, Performance aspects | |
| Asynchronous pro | cessing, tasks, Task-dependence, Overlapped data transfers, Default Stream, | |
| | | 11 1 |

Synchronization with streams. Events, Event-based- Synchronization - Overlapping data transfer and kernel execution, pitfalls.

UNIT-V CASE STUDIES

Classes: 5

Image Processing, Graph algorithms, Simulations, Deep Learning

Text Books:

- 1. David Kirk, Wen-meiHwu, Morgan Kaufman, "Programming Massively Parallel Processors: A Hands- on Approach", 2010 (ISBN: 978-0123814722)
- 2. Shane Cook, Morgan Kaufman "CUDA Programming: A Developer's Guide to Parallel Computing with GPUs", 2012 (ISBN: 978-0124159334)

Web References:

- 1. http://www.sctie.iitkgp.ernet.in/
- 2. http://www.rkala.in/softcomputingvideos.php
- 3. http://www.sharbani.org/home2/soft-computing-1
- $4.\ http://www.myreaders.info/html/soft_computing.html$

E-Text Books:

- 1. https://www.books.google.co.in/books?id=bVbj9nhvHd4C
- 2. https://www.books.google.co.in/books?id=GrZHPgAACAAJ&dq=1.+J.S.R.Jang,+C.T.Sun+and+E .Mizutani,+Neuro,+Fuzzy+and+Soft+Computing,+PHI,+2004,Pearson+Education.