| Course Type | Course Code | Name of Course | L | T | P | Credit |
|---|---|---|---|---|---|---|
| DP3 | **MCC302** | **GPU Computing Lab** | 0 | 0 | 2 | 2 |

**Course Objective**

**Objective**: To learn GPU computing with CUDA C/C++ , PyCUDA and OpenACC

**Learning Outcomes**

Upon successful completion of this course, students will be able:

- to write programs for High Performance Computing (HPC)
- to optimize CUDA Programs in terms of speed
- to apply GPU computing in various Parallel patterns and Convolution Neural Networks

| Unit No. | Topics to be Covered | Lecture Hours | Learning Outcome |
|---|---|---|---|
| 1 | Programs -Hello world, a Kernel Call and Passing Parameters, Check Device Information | 2 | To learn basic CUDA program structure |
| 2 | Display grid and block structure, Vector Addition on GPU | 2 | To learn tread organization |
| 3 | Matrix-Matrix Multiplication on GPU | 2 | To learn Matrix-Matrix multiplication in CUDA |
| 4 | Distance Kernel and Header Kernel, Tiled Matrix-Matrix Multiplication | | To understand tiled algorithm |
| 5 | Implementation of warp divergence and reduction algorithm | 2 | To understand warp divergence and reduction kernel |
| 6 | Numerical accuracy of fusing a multiply-add, Floating-point's inability | 2 | To know single and double precision computation |
| 7 | Single and multi streams CUDA program with the use of paged-locked memory and asynchronous data transfer | 2 | To know basics of CUDA streams |

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|---|---|---|---|
| 8 | CUDA programme for 1D/2D Parallel and Tiled Convolutions | 2 | To understand implementation of Convolution Operation |
| 9 | CUDA Implementation of Convolution Neural Networks | 2 | To learn CNN implementation |
| 10 | Reduction of Convolution Layer to Matrix Multiplication, Parallel histogram computation, merge sort | 2 | To learn other parallel patterns |
| 11 | Simple PyCUDA program , Device Information,<br>Matrix-Matrix Multiplication in PyCUDA, | 2 | To learn basics of PyCUDA program structure |
| 12 | Kernel Invocation with GPUArray, Evaluating elementwise expressions with PyCUDA with NumbaPro | 2 | To understand GPUArray and Elements-wise expressions |
| 13 | Jacobi iterative method to solve Laplace equation for heat transfer with OpenACC kernels and parallel directives. Program for OpenACC routine directive with CUDA device kernel and calling CUDA device kernel from OpenACC | 2 | To learn OpenACC program structure, OpenACC kernel and parallel directives |
| 14 | LAB Exam | 2 | |
| | Total | 28 | |

**Text Books**


1. David B. Kirk:Programming Massively Parallel Processors: A Hands-on Approach, Wen-mei W. Hwu, Elsevier, 2016
2. Dr. Brian Tuomanen:Hands-On GPU Programming with Python and CUDA: Explore high-performance parallel computing with CUDA, Packt Publishing Ltd, 2018


**Reference Books**


1. John Cheng, Max Grossman, Ty McKercher: Professional CUDA C Programming,John Wiley & Sons, 2014
2. Jason Sanders:CUDA by Example: An Introduction to General-Purpose GPU Programming, Edward Kandrot, publisher Addison-Wesley Professional, 2010