



CS/EE-3xx, 5xx Parallel-processing with CUDA

Fall 2023

Course Catalog Description	
<p>Graphics processors (GPUs) have found new applications in AI, Data Science and computation intensive fields in last decade or so. Building fast and efficient applications to process large amount of data requires programming competencies using GPUs. Currently NVIDIA has the largest share of GPUs. NVIDIA's parallel computing platform and API, CUDA, allows General Purpose GPU programming (GPGPU). Major Components of this course include Memory Hierarchy, working with the CUDA compiler driver (nvcc), efficient programming using blocks, grid concepts used in parallel processing and CUDA Applications in Linear Algebra and AI etc.</p>	

Course Details	
Credit Hours	3
Core	None
Major Elective	EE, CS
Open for Student Category	Juniors, Seniors, Graduate
Closed for Student Category	

Course Prerequisite(s)/Co-Requisite(s)	
<p>Pre-requisites: Good Programming Experience in C, C++ (Junior level standing. Must have experience with OOP).</p>	

Course Offering Details						
Lecture(s)	No. of Lec(s) Per Week	2	Duration	75 min	Timings and Venue	
Recitation (per week)	No. of Rec (s) Per Week	0	Duration			
Lab (if any) per week	NO. of Session(s) Per Week	0	Duration			
Tutorial (per week)	NO. of Tut(s) Per Week	X	Duration			

Instructor	Dr. Jahangir Ikram
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Secretary/TA	TBA
TA Office Hours	TBA
Course URL (if any)	LMS will be used



Course Learning Outcomes	
	The students should be able to:
CLO1	Develop and Apply Basic Knowledge in CUDA Memory Models
CLO2	Develop and Apply Basic Knowledge in CUDA programming environment
CLO3	Design Algorithms using Threading
CLO4	Analyze Graphics Programming Algorithms
CLO5	Design Graphics Programming Algorithms

Relation to EE Program Outcomes				
EE-220	Related PLOs	Level of Learning	Teaching Methods	CLO Attainment checked in
CLO1	PLO1	?	Instruction, Assignments	Midterm, Final
CLO2	PLO2	?	Instruction, Assignments	Midterm, Final
CLO3	PLO3	?	Instruction, Assignments	Midterm, Final
CLO4	PLO2	?	Instruction, Assignments	Midterm, Final
CLO5	PLO3	?	Instruction, Assignments	Midterm, Final

Grading Breakup and Policy	
Quizzes (8):	20%
Assignments (3):	40%
Midterm Exam:	15%
Final Examination:	25%

Course Overview			
Lecture	Topics	Recommended Readings	CLO Covered
1.	<ul style="list-style-type: none"> Introduction to GPU Programming, Applications of CUDA CUDA Programming Model and the CUDA C API 	Chapter 1 (JS ¹)	
2.	<ul style="list-style-type: none"> CUDA Memory Models, Parallel Thread Execution and Basic Interesting applications in Fractals Introduction to the CUDA Computing Tools 	Chapter 2,3,4(JS ¹)	CLO 1
3.			
4.	<ul style="list-style-type: none"> Shared Memory Optimization, Threading and Thread Cooperation Vector Sum optimization Dot-Product optimization 	Chapter 5(JS ¹)	
5.			
6.			
7.			
8.	<p>Quiz 01:</p> <p>Quiz 02: Assignment 01 Assigned</p>		
9.	<ul style="list-style-type: none"> How-To examples covering topics such as: <ul style="list-style-type: none"> Using support of GPU-accelerated libraries Applications to Zero-Copy Memory, Asynchronous Data Transfers, Unified Virtual Addressing, Peer-to-Peer Communication, Concurrent Kernels, 		
10.			
11.			
12.			
13.	<ul style="list-style-type: none"> Basic linear algebra operations: <ul style="list-style-type: none"> Matrix transpose Matrix-matrix multiplication Parallel sum of large arrays 		CLO 4
14.			
<p>Viva: 25th 26th and 27th February 2022</p>			
Midterm Exam			



15.	<ul style="list-style-type: none"> • Performance measurement and optimization 		CLO 5
16.	<ul style="list-style-type: none"> • Bandwidth tests 		
17.	<ul style="list-style-type: none"> • Application profiling using timers 		
Quiz 04: Assignment 3			
18.	<ul style="list-style-type: none"> • CUDA Threading and Memory Models In-depth • Memory Bank and Shared Memory Conflicts • Parallel Patterns • High level CUDA wrappers (Introduction to Thrust) • Sparse Matrix Vector Multiplication • Optimization Tips 		CLO2 - CLO5
19.			
20.			
21.			
Quiz 05: Assignment 4			
22.	<p>Assignment 05</p> <p>Quiz 06:</p> <p>Assignment 03 Viva: 25th 26th 27th March 2022</p>		
23.	CUDA Application		
24.			
25.	Quiz 07:		
26.	Quiz 08: 11th April 2021		
27.			
28.			
Final Exam			

Textbook(s)/Supplementary Readings
<p>[1] Textbook 1: "CUDA by Example – An Introduction to General Purpose GPU Programming" by Jason Sanders and Edward Kandrot, NVIDIA Corporation.</p> <p>[2] Test Book 2: The CUDA Handbook: A Comprehensive Guide to GPU Programming by Nicholas Wilt, Addison- Wesley Professional, 2013.</p> <p>[3]</p>

Examination Detail	
Midterm Exam	Yes/No: Yes
Final Exam	Yes/No: Yes Duration: 3:00 hrs Exam Specifications: Closed Book, Closed Notes, Calculator Allowed

Prepared by:	Dr. Jahangir Ikram
Date:	June 15, 2023 (draft)