جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: GPU and GPGPU Programming - CS 380

Division	Computer, Electrical and Mathematical Sciences & Engineering
Course Number	CS 380
Course Title	GPU and GPGPU Programming
Academic Semester	Fall
Academic Year	2018/2019
Semester Start Date	08/26/2018
Semester End Date	12/11/2018
Class Schedule (Days & Time)	01:00 PM - 02:30 PM | Sun Wed

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Markus Hadwiger	markus.hadwiger@kaust.edu.sa	+966128080260		Come by my office (Bldg 1, Room 2119) or send me an email to make an appointment.

Teaching Assistant(s)

Name	Email
Peter Rautek	peter.rautek@kaust.edu.sa

Course Information

Comprehensive Course Description	This course covers the architecture and programming of GPUs (Graphics Processing Units). It covers both the traditional use for rendering graphics, as well as the use of GPUs for general purpose computations (GPGPU), or GPU Computing. We will cover the basic architecture and the programming model of GPUs. We will cover both the traditional use of GPUs for graphics and visualization, as well as their use for general purpose computations (GPGPU). We will cover GPU many-core hardware architectures, shading and compute programming languages and APIs, programming vertex, geometry, and fragment shaders, programming with CUDA, Brook, OpenCL, stream computing, approaches to massively parallel computations, memory subsystems and caches, rasterization, texture mapping, linear algebra computations, alternative and future architectures. A very important part of the course are the programming exercises, where you will use OpenGL/GLSL and CUDA for a variety of assignments and a semester project.
Course Description from Program Guide	The course covers the architecture and programming of GPUs (GraphicsProcessing Units). It covers both the traditional use of GPUs forgraphics and visualization, as well as their use for general purpose computations (GPGPU, GPU Computing). The main contents are: GPUmany-core hardware architecture, shading and GPU programming languages and APIs, programming vertex, geometry, and fragment shaders, programming with CUDA, Brook, OpenCL, stream computing, approaches to massively parallel computations, memory subsystems and caches,rasterization, texture mapping, linear algebra computations, alternative and future architectures.
Goals and Objectives	The goal is to convey a deep understanding of GPU architecture and APIs (OpenGL, GLSL, CUDA) with important practical applications. The goal is an understanding of both the traditional use of GPUs for rendering graphics, as well as the use of GPUs for general purpose computations (GPGPU), or GPU Computing. By the end of the course you should be able to implement non-trivial GPU programs for graphics as well as for computation.
Required Knowledge	Most important are programming skills, preferentially low-level programming knowledge in C/C++. An understanding of basic computer architecture (processors, memory hierarchies, virtual memory, etc.) is also important.

Reference Texts	www.amazon.com/OpenGL-Shading-Language-Cookbook-Second/dp/1782167021/ www.amazon.com/Programming-Massively-Parallel-Processors-Hands/dp/0128119861/
Method of evaluation	**30.00**% - Course Project(s) **30.00**% - Quiz(zes) **40.00**% - Homework /Assignments
Nature of the assignments	There will be 4 programming assignments spread out over the semester, which are pre-specified. In addition, you can define your own semester programming project for a GPU programming topic that you like. There will be weekly reading assignments, and we will do several quizzes (written; closed-book).
Course Policies	Attendance is mandatory. Every day past the deadline of an assignment reduces the points by 10%.
Additional Information	The course webpage is located here: faculty.kaust.edu.sa/sites/markushadwiger/pages/cs380.aspx This includes the slides from previous years, which should give a good in-depth overview of the contents of the course.

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Sun 08/26/2018 Wed 08/29/2018	Introduction
2	Sun 09/02/2018 Wed 09/05/2018	GPU Architecture 1 & 2
3	Sun 09/09/2018 Wed 09/12/2018	GPU Architecture 3 & 4
4	Sun 09/16/2018 Wed 09/19/2018	GPU Architecture 5 & 6
5	Sun 09/23/2018 Wed 09/26/2018	Shading and Compute APIs 1
6	Sun 09/30/2018 Wed 10/03/2018	Shading and Compute APIs 2 & 3
7	Sun 10/07/2018 Wed 10/10/2018	GPU Texturing 1 & 2
8	Sun 10/14/2018 Wed 10/17/2018	GPU Texturing 3 & 4 Virtual Texturing
9	Sun 10/21/2018 Wed 10/24/2018	Stream Computing and GPGPU
10	Sun 10/28/2018 Wed 10/31/2018	CUDA Memory Access 1 & 2
11	Sun 11/04/2018 Wed 11/07/2018	CUDA Memory Access 3 & 4
12	Sun 11/11/2018 Wed 11/14/2018	GPU Parallel Reduction GPU Parallel Scan / Prefix Sum
13	Sun 11/18/2018 Wed 11/21/2018	Shuffles, Atomics, Instruction Level Parallelism Cooperative Thread Groups
14	Sun 11/25/2018 Wed 11/28/2018	Linear Algebra Operators Sparse Matrix-Vector Ops (SpMV)
15	Sun 12/02/2018 Wed 12/05/2018	The Latest GPU Architectures Tensor Cores
16	Sun 12/09/2018	Semester Project Presentations
17		
18		

Note

The instructor reserves the right to make changes to this syllabus as necessary.