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

Course Syllabus: Contemporary Topics in Applied Math - AMCS 394C

Offering Department	Applied Mathematics and Computational Sc
Course Number	AMCS 394C
Course Title	Contemporary Topics in Applied Math
Academic Semester	Spring 2022/2023
Semester Start Date	01/22/2023
Semester End Date	05/17/2023
Class Schedule (Days & Time)	Contemporary Topics in Applied Math Lecture AMCS 394C Mon,Thu 09:30 - 10:55

Instructor(s)				
Name	**Email**	**Phone**	**Office Location**	**Office Hours**
Jinchao Xu	JINCHAO.XU@KAUST.EDU.SA			Mon, Thu 11am-12pm

Teaching Assistant(s)	
Name	**Email**
Dr. Juncai He	juncai.he@kaust.edu.sa
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Course Information	
Course Description	This is a course on the introduction of basic mathematical, numerical and practical aspects of deep learning techniques. It will provide students with mathematical background and also practical tools needed to understand, to analyze and to further develop numerical methods for deep learning and applications. The course is simultaneously geared towards math students who want to learn about the emerging technology of deep learning and also towards students from other fields who are interested in deep learning application but would like to strengthen their theoretical foundation and mathematical understanding.
Learning Outcomes	1. Understand basic ideas of machine learning and why deep learning works. 2. Learn to implement deep learning algorithms using Python and PyTorch. 3. Application of deep learning for image classifications.

Textbook/Materials	1. Goodfellow I., Bengio Y. and Courville A. Deep learning. MIT press, 2016. 2. Xu J. Deep Learning and Analysis, Lecture Notes (to be published by Springer).
Method of Assessments	40.00% - Homework /Assignments 20.00% - Course Project(s) 20.00% - Midterm exam 20.00% - Final exam
Nature of the Assignments	Homework consist of written homework for conceptual questions and programing assignments for practical exercises. The final homework score will be the average taking on all assigned homework. The final project will be closely related to topics in this course.
Course Policies	Please pay attention to the due date of the assignments. No late homework will be accepted. Attendance is mandatory. Students should notify the instructor in advance of missing any class or as soon as possible thereafter.
Additional Information	*Required Knowledge Linear algebra; multi-variable calculus; some programming experiences with Python are helpful.

Tentative Course Schedule
(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Mon 01/23/2023 Thu 01/26/2023	Introduction; logistic regression
2	Mon 01/30/2023 Thu 02/02/2023	Multivariable calculus, convexity, gradient descent method
3	Mon 02/06/2023 Thu 02/09/2023	Elements of probability; stochastic gradient descent
4	Mon 02/13/2023 Thu 02/16/2023	Elements of machine learning theory

Week	Lectures	Topic
5	Mon 02/20/2023	Python, implementation and MNIST
6	Mon 02/27/2023 Thu 03/02/2023	Introduction to linear finite element space
7	Mon 03/06/2023 Thu 03/09/2023	Shallow neural network (NN) functions and approximation theory
8	Mon 03/13/2023 Thu 03/16/2023	Implementation: shallow NN for MNIST
9	Mon 03/20/2023 Thu 03/23/2023	Spring Break
10	Mon 03/27/2023 Thu 03/30/2023	Deep neural networks; convolutional neural networks
11	Mon 04/03/2023 Thu 04/06/2023	Initialization; batch normalization; implementation: CNN for MNIST
12	Mon 04/10/2023 Thu 04/13/2023	The Poisson equation and linear finite element method

Week	Lectures	Topic
13	Mon 04/17/2023 Thu 04/20/2023	Gradient descent and smoothing properties; multigrid method
14	No schedule	MgNet: from multigrid to a special CNN
15	Mon 05/01/2023 Thu 05/04/2023	MgNet: Applications
16	Mon 05/08/2023 Thu 05/11/2023	Transformers and other neural networks; Review

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