Office of the Registrar

Course Addition / Change Request

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

New Courses

Program:______________________________

COURSE NUMBER: COURSE TITLE: Mathematical Introduction to Deep Learning CREDITS:

Contemporary Topics Course:

*Course Description (Please attached syllabus) 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.

Pre-requisites: linear algebra, multivariable calculus Co-requisites:__________ Core Requirement: ☐ YES ☐ NO

*** Use additional pages if necessary**

Existing Courses

PROGRAM:____________________ COURSE NUMBER*:________________ COURSE TITLE Deep learning Algorithms and Analysis

Proposed Changes(use additional pages if necessary):____

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***Course number cannot be reassigned unless the course has been dormant for three years**

Signature of Program Chair:____ Date:_________________(mm/dd/year)

Signature of Division Dean:____Date:___________________(mm/dd/year)

Curriculum Committee Approval ☐ YES ☐ NO Date:_________________(mm/dd/year)

Program notified:_______________(mm/dd/yy) Added to Curriculum:_______________(mm/dd/yy)

Processed By:_______________________ Signature:______________ Date: __________________

*Required

Course addition - Syllabus: Course Title*	
Division*:	CEMSE
Course Number:	AMCS ****
Course Title (Limited to 40 characters)*:	Deep Learning and Analysis
Expected Starting Academic Semester*:	Spring 2023
Expected Starting Academic Year*:	2023
Course proposer(s)*:	
Name(s) *:	Jinchao Xu
Phone:	
Email*:	jinchao.xu@kaust.edu.sa
Instructor(s) information*:	
Name(s) *:	Jinchao Xu
Phone:	
Email*:	jinchao.xu@kaust.edu.sa
Prerequisite Course Number*:	Linear algebra; multivariable calculus
Comprehensive Course Description*:	This is a graduate course on the introduction of basic mathematical, numerical and practical aspects of deep learning techniques. It will provide students with the mathematical background and also practical tools needed to understand, analyze and further develop numerical methods for deep learning methods 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.
Course Description for Program Guide*:	Prerequisites: linear algebra and multivariable calculus. Familiarity with machine learning or artificial intelligence recommended. Topics: linear regression, SGD, learning theory, finite element, DNNs, approximation theory, CNNs, multigrid methods, and MgNet.
Goals and Objectives*:	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.
Required Knowledge*:	Linear algebra; multi-variable calculus; some programming experiences with Python are helpful.
Reference Texts*:	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 evaluation (Percentages & Graded content such as Assignments, Oral quizzes, Projects, Midterm exam, Final Exam, Attendance and participation, etc.)**:**	**40%** - Homework **20%** - Midterm exam **20%** - Final exam **20%** - Final project
Nature of the assignments (assigned reading, case study, paper presentation, group project, written assignment, etc.)**:**	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 (Absences, Assignments, late work policy, etc.):	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:	

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

Tentative Course Schedule: *(Time, topic/emphasis & resources)*	
Week/Lecture	**Topic**
1	Introduction; logistic regression
2	Multivariable calculus, convexity, gradient descent method
3	Elements of probability; stochastic gradient descent.
4	Elements of machine learning theory;
5	Python, implementation and MNIST
6	Introduction to linear finite element space
7	Shallow neural network (NN) functions and approximation theory
8	Implementation: shallow NN for MNIST
9	Deep neural networks; convolutional neural networks

10	Initialization; batch normalization; implementation: CNN for MNIST
11	The Poisson equation and linear finite element method
12	Gradient descent and smoothing properties; multigrid method
13	MgNet: from multigrid to a special CNN
14	MgNet: Applications
15	Transformers and other neural networks; Review