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

Course Syllabus: Contemp. Topics in Computational Science - AMCS 394E

Division	Computer, Electrical and Mathematical Sciences & Engineering
Course Number	AMCS 394E
Course Title	Contemp. Topics in Computational Science
Academic Semester	Fall
Academic Year	2019/2020
Semester Start Date	08/25/2019
Semester End Date	12/10/2019
Class Schedule (Days & Time)	10:30 AM - 12:00 PM | Mon Thu

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
David Isaac Ketcheson	david.ketcheson@kaust.edu.sa	+966128080306		

Teaching Assistant(s)

Name	Email
N/A	N/A

Course Information

Comprehensive Course Description	The course will cover a variety of PDE models for waves, from both a theoretical and a numerical perspective. Topics to be covered include: 1. First-order hyperbolic PDEs Analysis: characteristics, shock waves, weak solutions, entropy solutions, the Riemann problem Numerical methods: finite volume methods, limiters, and approximate Riemann solvers Applications: traffic models, shallow water waves, compressible fluid dynamics 2. Higher-order wave equations Analysis: dispersion relations, invariants, solitary waves, integrability Numerical methods: spectral and pseudospectral methods Applications: Korteweg-de Vries, incompressible fluid dynamics This represents more topics than we can probably cover in a semester, so the focus will be determined partly by the interests of enrolled students.
Course Description from Program Guide	
Goals and Objectives	Become familiar with PDE-based models for a wide variety of wave behavior. Understand the dynamics of solutions to these models. Understand and implement numerical methods for their solution.
Required Knowledge	PDEs and numerical methods at the level of AMCS 231 and 252.

Reference Texts	LeVeque: Numerical methods for conservation laws LeVeque: Finite volume methods for hyperbolic problems Whitham: Linear and nonlinear waves Boyd: Chebyshev and Fourier spectral methods Trefethen: Spectral methods in Matlab
Method of evaluation	**100.00**% - Homework /Assignments
Nature of the assignments	Assignments will involve theoretical exercises (including some proofs) and implementation of numerical methods.
Course Policies	No late work will be accepted.
Additional Information	

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Mon 08/26/2019 Thu 08/29/2019	Linear wave equations: dispersion relations, hyperbolicity, examples
2	Mon 09/02/2019 Thu 09/05/2019	Hyperbolic conservation laws. Characteristics and shocks.
3	Mon 09/09/2019 Thu 09/12/2019	Basic numerical methods.
4	Mon 09/16/2019 Thu 09/19/2019	Scalar nonlinear hyperbolic PDEs. The Riemann problem. Rankine-Hugoniot jump conditions. Weak solutions and entropy solutions.
5	Mon 09/23/2019 Thu 09/26/2019	Saudi National Day
6	Mon 09/30/2019 Thu 10/03/2019	Advanced numerical methods: limiters, approximate Riemann solvers.
7	Mon 10/07/2019 Thu 10/10/2019	High-order numerical methods: WENO, DG, time stepping.
8	Mon 10/14/2019 Thu 10/17/2019	In-depth analysis and numerics for the shallow water equations.
9	Mon 10/21/2019 Thu 10/24/2019	Spring Break
10	Mon 10/28/2019 Thu 10/31/2019	Mid-semester break
11	Mon 11/04/2019 Thu 11/07/2019	Mid-semester break
12	Mon 11/11/2019 Thu 11/14/2019	Mid-semester break
13	Mon 11/18/2019 Thu 11/21/2019	Mid-semester break
14	Mon 11/25/2019 Thu 11/28/2019	Mid-semester break
15	Mon 12/02/2019 Thu 12/05/2019	Mid-semester break
16	Mon 12/09/2019	Exams

Note

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