THE UNIVERSITY OF COLORADO BOULDER

ASEN 6519: Isogeometric Methods
Fall 2020

SYLLABUS

Instructor:	Assistant Professor John Evans Office: AERO 361 E-Mail Address: john.a.evans@colorado.edu Office Hours: Monday/Wednesday/Thursday, 12:00 pm – 1:00 pm
Time:	Monday/Wednesday, 1:00 pm – 2:15 pm
Location:	AERO 232
Web Page:	Canvas (canvas.colorado.edu)

Course Objective:

To establish a fundamental understanding of the mathematical underpinnings of isogeometric analysis and to introduce isogeometric simulation methods for heat conduction, linear elastostatics, linear elastodynamics, and incompressible fluid flow.

Prerequisites:

Students should ideally have a background in finite element methods. Students who have taken ASEN 5007 (Introduction to Finite Elements) will be well-prepared. Familiarity with MATLAB or Python is also required.

Required Textbook:

There is no required textbook, but the official course notes are publicly available at the hyperlink https://github.com/cmglab/iga-notes.

Recommended Textbook:

Isogeometric Analysis: Toward Integration of CAD and FEA, Cottrell, Hughes, and Bazilevs, Wiley, 2009.

Reference and Supplemental Textbooks:

The Finite Element Method: Linear Static and Dynamic Finite Element Analysis, Hughes, Wiley, Dover, 2000.

The NURBS Book, Piegl and Tiller, Springer, 2013.

Bezier and B-spline Techniques, Prautzsch, Boehm, and Paluszny, Springer, 2002.

Topics:

1. **Fundamentals: Geometric Design and Mesh Generation**
    a. Bernstein Polynomials and Bézier Curves
    b. B-splines and NURBS (Non-Uniform Rational B-Splines)
    c. NURBS Curves, Surfaces, and Volumes
    d. Refinement
    e. Multiple Patches
    f. Bézier Extraction and Mesh Generation
2. **Fundamentals: Linear Elliptic, Parabolic, and Hyperbolic PDEs**
    a. The Isoparametric Concept
    b. Boundary Value Problems and Galerkin's Method
    c. Time-Dependent Problems and Semi-Discrete Methods
3. **Applications**
    a. Heat Conduction
    b. Linear Elastostatics and Elastodynamics
    c. Incompressible Fluids and Stabilized Methods

Class Format:

The class meets twice a week for an hour and fifteen minutes of formal lecture and discussion.

Grading:

> 60% Homework Assignments
> 15% Literature Review Project
> 25% Final Project

Grades will be posted to the class website on Canvas.

Homework Policy:

Six homework assignments will be assigned throughout the class. These assignments will include both analytical and computational components. Students should make an effort to turn in assignments that are organized, professional looking, and legible. It is recommended that students use LaTeX to type up their assignments. Students will submit each assignment, including code, to a Canvas Dropbox. ***Homework is due at 11:59 PM on the due date.*** Late assignments will not be accepted, though there will be a five-minute grace period.

Collaboration is permitted on homework. This means students may discuss the means and methods for solving problems and even compare answers, but students are not free to copy someone's assignment. The work that a student turns in must be his or her own – copying is not allowed for any assignment and will not be tolerated. Students who are caught copying (or providing his or her assignment to another) will receive an "F" for the course and reported to the Dean's office for further punitive action.

Literature Review Project:

A literature review project will be assigned during the first few weeks of class. Students will review a select topic in the field of isogeometric analysis. The literature review project will consist of a 5-page summary and synthesis and a 5-minute in-class presentation on the topic. A list of possible topics will be given out, but students may also elect to propose their own topic.

Final Project:

A final project will be assigned during the middle of the semester. Students will simulate a challenging application of engineering interest using isogeometric analysis. The final project will consist of a 8-10-page paper and a 10-minute in-class presentation. A list of possible applications will be given out, but students may also elect to propose their own application.

Accommodation for Disabilities:

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition or injury, see Temporary Medical Conditions under the Students tab on the Disability Services website.

Classroom Behavior:

Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on classroom behavior and the Student Code of Conduct.

Preferred Student Names and Pronouns:

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Honor Code:

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for

violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the [Honor Code Office website](#).

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation:

The University of Colorado Boulder (CU Boulder) is committed to fostering a positive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct, intimate partner abuse (including dating or domestic violence), stalking, or protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, [anonymous reporting](#), and the campus resources can be found on the [OIEC website](#).

Please know that faculty and instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

Religious Holidays:

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, you must let the instructors know of any such conflicts within the first two weeks of the semester so that we can work with you to make arrangements. See the [campus policy regarding religious observances](#) for full details.

Prepared by: John Evans   Date: January 13, 2020