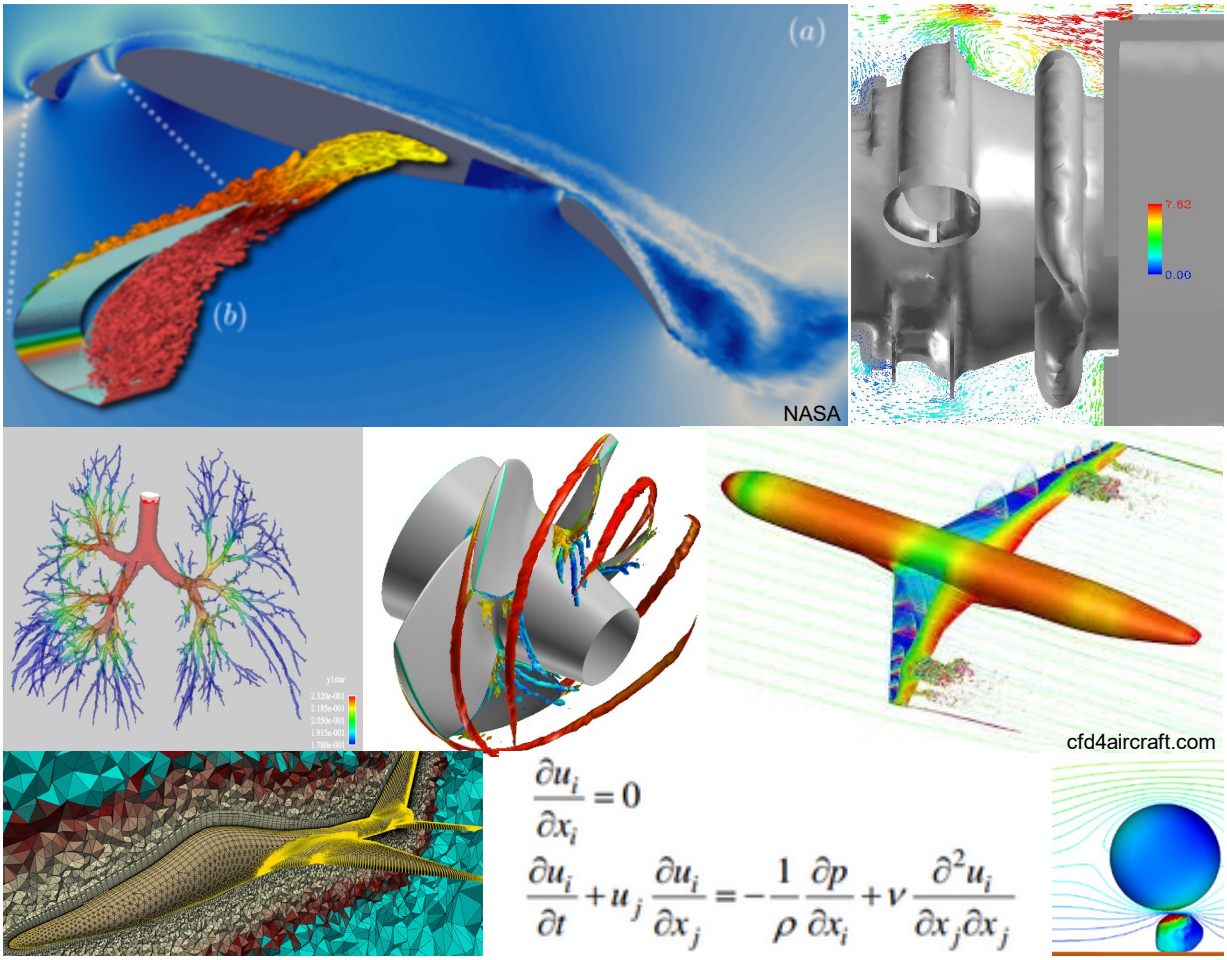
ME 423 SUMMER 2020
Introduction to Numerical Methods in Fluid Dynamics
On-line course delivery



Instructor: Dr. Robert F. Kunz, Professor of Mechanical Engineering, 814-865-2144, rfk102@psu.edu, online office hours:TBD

This course provides an introduction to the important and growing field of Computational Fluid Dynamics (CFD). The student will become familiar with the basic differential models, discretization practices and solution strategies of CFD. Fundamentals of algorithm classification, error and stability analysis will be covered. Also, several advanced topics of relevance to modern CFD analysis will be covered.

Required Text: None

Module Sequence
Module 1: Overview, History and Status of CFD
Module 2: Governing Equations of Fluid Dynamics
Module 3: Partial Differential Equation Classification
Module 4: Important PDEs in Fluid Dynamics
Module 5: Discretization
Module 6: Explicit Schemes, Implicit Schemes and Linearization
Module 7: Matrix Solution Schemes
Module 8: Introduction to Stability and Error Analysis
Module 9: Extending Error and Stability Analysis - I
Module 10: Extending Error and Stability Analysis - II
Module 11: Solution and Analysis of Hyperbolic Systems
Module 12: Solution and Analysis of Parabolic Systems
Module 13: Solution and Analysis of Elliptic Systems
Module 14: Stability and Convergence of Iterative Schemes, Matrix Stability Analysis
Module 15: Boundary Conditions
Module 16: Mesh Generation
Module 17: Pre- and Post-Processing and Visualization
Module 18: Finite Volume and Element Methods
Module 19: Turbulence Modeling
Module 20: Advanced Topics – to potentially include a) Unstructured and Overset Methods, b) Pressure Correction Methods, c) Multigrid and Other Acceleration Techniques, d) Machine Learning in CFD, e) Computer Architecture and Parallelization

Student requirements and grading:

- **Three take-home examinations each covering 1/3 course 50%**
- **One computer programming / term project 20%**
- **8 homework assignments 30%**

S	M	T	W	Th	F	S	
17 Week 1 lectures posted	18 FIRST DAY OF SUMMER CLASSES	19	20	21	22	23 HW 1 assigned Term Project Assigned	MAY
24 Week 2 lectures posted	25	26	27	28	29	30 HW 2 assigned	
31 Week 3 lectures posted	1	2	3	4	5 HW 1 due	6 HW 3 assigned	
7 Week 4 lectures posted	8	9	10	11	12 HW 2 due	13 Midterm 1 assigned	JUNE
14 Week 5 lectures posted	15	16	17	18	19 Midterm1 due	20 HW 4 assigned	
21 Week 6 lectures posted	22	23	24	25	26 HW 3 due	27 HW 5 assigned	
28 Week 7 lectures posted	29	30 Term Project Part 1 due	1	2	3 HW 4 due	4 HW 6 assigned	
5 Week 8 lectures posted	6	7	8	9	10 HW 5 due	11 Midterm 2 assigned	JULY
12 Week 9 lectures posted	13	14	15	16	17 Midterm 2 due	18 HW 7 assigned	
19 Week 10 lectures posted	20	21	22	23	24 HW 6 due	25 HW 8 assigned	
26 Week 11 lectures posted	27	28	29	30	31 HW 7 due	1 Midterm 3 assigned	
2 Week 12 lectures posted	3	4	5	6	7 HW 8 due	8	AUGUST
9 Week 13 lectures posted	10	11	12 LAST DAY OF SUMMER CLASSES	13	14 Midterm 3 Due Term Project Part 2 due	15	