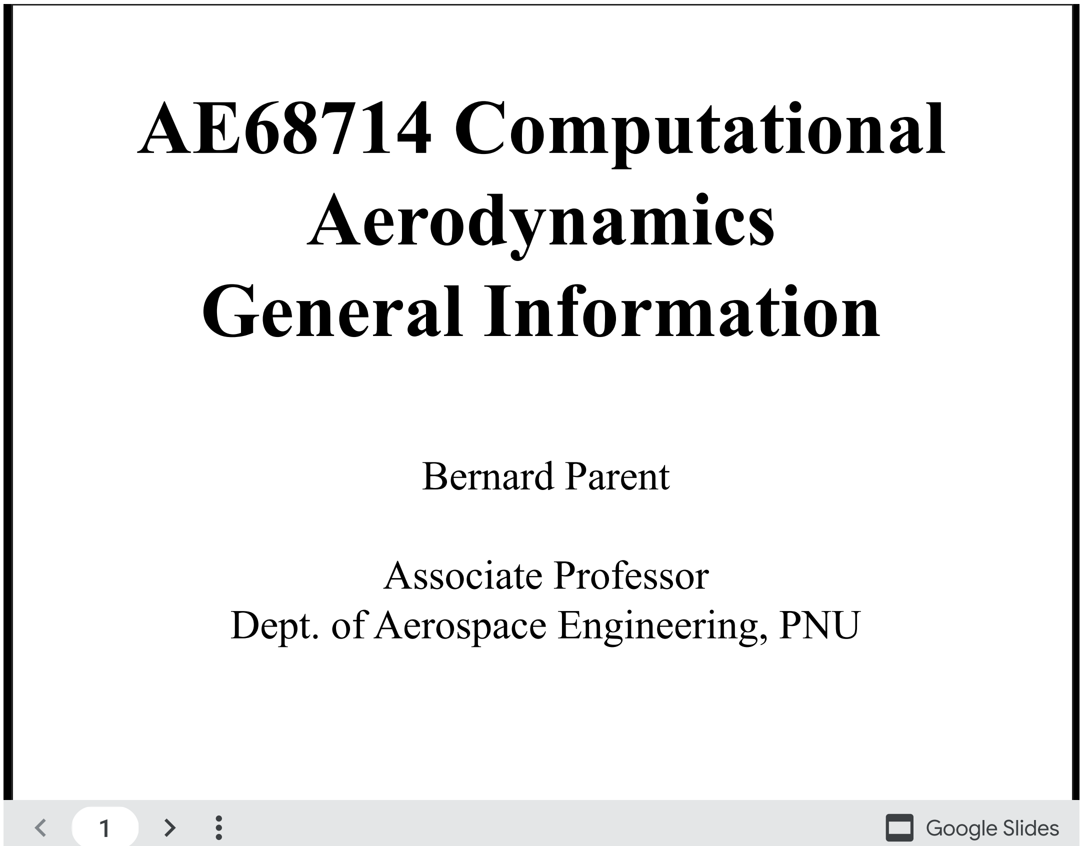
Computational Aerodynamics Syllabus

Course Objectives, Policies, and Grading



Course Calendar — Weekly Schedule

1. Outline of the course objectives. Derivation of the Euler equations (mass and momentum conservation equations).
2. Derivation of the total energy conservation equation. Recast of the Euler equations in strong conservative form and in vector form. Discrete form vs differential form. Discretization through Taylor series.
3. Generalized curvilinear coordinates. Euler equations in generalized coordinates.
4. Creating structured grids using CFDWARP: examples of the various segment types and various commands.
5. Scalar advection/wave equation. Flux Jacobian and eigenvalues of the Euler equations.
6. Wave speeds of the Euler equations. How to impose boundary conditions using wave speed theory. Subsonic inflow boundary condition.
7. Midterm Break

8. Subsonic outflow boundary condition. Supersonic outflow boundary condition.
9. Challenges involved when discretizing first-order derivative. Upwind scheme. Flux vector splitting (FVS). Flux difference splitting (FDS).
10. Advantage of FDS when resolving boundary layers. Second-order slope-limited schemes: positive coefficients and 1st-order at extrema. Total Variation Diminishing (TVD) schemes
11. Reconstruction-evolution procedure. Second-order slope-limited FDS. Weighted Essentially Non-Oscillatory schemes (WENO). Entropy correction through eigenvalue conditioning.
12. Numerical error vs physical error. How to assess solution convergence error. Determination of discretization error using solutions on two grid levels. Grid Convergence Index (GCI).
13. Estimate of order of accuracy using 3 mesh levels. Asymptotic range of convergence.
14. Example problems to prepare for final exam.
15. Final exam.