Advanced Atmospheric Dynamics I

(METR 5113)

Fall 2008 Syllabus

General information

Essential mathematical and physical concepts underlying theory of atmospheric flows will be presented in depth. Applications of this theory to a broad variety of atmospheric flow types will be demonstrated. Basic equations of atmospheric dynamics will be thoroughly derived and analyzed. Calculus, differential equations (both ordinary and partial), linear algebra, and vector/tensor analysis will be extensively used throughout the course. Focus will be made on the understanding of fundamental principles of atmospheric dynamics and application of these principles in atmospheric modeling. Goal of the course is to develop quantitative and problem solving skills in atmospheric dynamics. It is not a survey course.

Time and place. Mon, Wed, Fri: 1:00 - 1:50 p.m.; Room NWC 5600.

Instructor. Dr. Evgeni Fedorovich (weather.ou.edu/~fedorovi/fedorovich.html)
NWC, School of Meteorology, Room 5419, Phone: 405 325 1197.
E-mail: fedorovich@ou.edu

Office hours. Mon, Wed, Fri: 2:00 - 3:00 p.m. or by appointment through E-mail.

Prerequisites: METR 3113 (Atmospheric Dynamics II) and MATH 4163 (Partial Differential Equations), or equivalent coursework, or permission of instructor.

Textbook: Kundu, P. K., and I. M. Cohen, 2008: *Fluid Mechanics*, fourth edition, Academic Press − Elsevier, 872 pp, or the third edition of this book published in 2004.

Recommended additional texts. See Appendix.

Class notes and supplementary materials will be posted on learn.ou.edu

Grading. Two in-class exams (September/October and November): 30% each. Final exam (December): 40%. Grading scheme: A - ≥85%, B - ≥70%, C - ≥50. Grades will be posted on learn.ou.edu.

List of topics (tentative):

Introduction. Fundamentals of Cartesian vector and tensor analysis. Kinematics. Lagrangian versus Eulerian viewpoints. Streamlines and trajectories. Strain rates, vorticity, and circulation. Conservation laws. Mass conservation. Forces and stresses. Conservation of momentum. Navier-Stokes equations. Mechanical energy equation. Thermal energy equation. Bernoulli's equation and its applications. Boussinesq approximation. Vorticity dynamics. Kelvin's circulation theorem. Vorticity equation. Wave theory. Surface and internal gravity waves. Dynamic similarity. Geophysical fluid dynamics. Equations of motion and their approximate forms. Ekman layer. Waves with rotation. Rossby waves.

Note: *Any student in this course who has a disability that may prevent him or her from fully demonstrating his or her abilities should contact Dr. Evgeni Fedorovich personally to discuss accommodations necessary to ensure full participation and facilitation of educational opportunities.*

Appendix to the METR 5113 Syllabus. Fall 2008.

Useful Additional Reading

for

Advanced Atmospheric Dynamics I

Dynamical Meteorology

Dutton, J. A., 1986: *Dynamics of Atmospheric Motion*. Dover.

Haltiner, G. J., and R. T. Williams, 1980: *Numerical Prediction and Dynamic Meteorology*, John Wiley.

Holton, J. R., 1992: *An Introduction to Dynamic Meteorology*. Academic Press.

Geophysical Fluid Dynamics

Cushman-Roisin, B., 1994: *Introduction to Geophysical Fluid Dynamics*. Prentice Hall.

Pedlosky, J., 1979: *Geophysical Fluid Dynamics.* Springer-Verlag.

Gill, A. E., 1982: *Atmosphere-Ocean Dynamics*. Academic Press.

McWilliams, J. C., 2006: *Fundamentals of Geophysical Fluid Dynamics*. Cambridge University Press.

Fluid Mechanics

Batchelor, G. K., 1967: *An Introduction to Fluid Mechanics*. Cambridge University Press.

Paterson, A. R., 1983: *A First Course in Fluid Dynamics*. Cambridge University Press.

Schlichting, H., 1968: *Boundary Layer Theory*. McGraw-Hill.

Yih, C.-S., 1979: *Fluid Mechanics*. West River Press.

Applied Mathematics

Arfken, G. 1970: *Mathematical Methods for Physicists*. Academic Press.

Braun, M. 1991: *Differential Equations and Their Applications*. Springer-Verlag.

Hildebrand, F. B., 1976: *Advanced Calculus for Applications*. Prentice-Hall.

Kreyszig, E. K., 1999: *Advanced Engineering Mathematics*, John Wiley & Sons.