

UNIVERSITY OF DELAWARE
Mathematical Sciences Department
Math 810 Asymptotic and Perturbation Methods Spring 2009

Instructor: Dr. Richard J. Braun, Ewing 509, (302) 831-1869, braun@math.udel.edu

Lecture times: MWF 2:30-3:20 in Willard 135.

Office Hours (may change): M 3:30-4:30, WF 11:15-12:00, or by appointment.

Required Texts: (1) "Multiple Scale and Singular Perturbation Methods," by Kevorkian and Cole, Springer, 1996. (2) "Perturbation Methods" by Hinch, Cambridge, 1991.

Topics: A tentative list of the topics is below; it's tentative because I may include some relatively new topics like connection to renormalization groups and network dynamics, and it varies how much we can get done in a semester. The order will resemble the list below. The parentheses group like section numbers in a compact form.

- Kevorkian and Cole: §1.1, 1.2.1-4, 1.3; 2.2.(1,2,4), 2.5; 4.1,4.2,4.3.(1,2), 4.4; 5.1, 5.2; 3.3; 3.3.(7,9,4), 6.1, 3.1.3.
- Hinch: §1.1-5; 2; 5.(1-3,6); 6.(1,2); 7.(1,2,5); 3; 5.(3,4); 7.(3,4).

The topics/problems I hope to cover are, roughly in order:

- Algebraic equations
- Boundary value ODE problems: boundary layer theory, matched asymptotic expansions, exponential asymptotics (if time allows), WKB theory
- Initial value ODE problems: linear and nonlinear oscillators, multiple scales, strained coordinates
- Asymptotic expansion of integrals
- Partial differential equations: some introductory problems
- If time allows: Connection with renormalization groups, network dynamics, etc

Grading: Homework (roughly weekly or less) 65%; 1 75-minute exam (expected on 3/23/09) 15%; brief report plus 15 minute presentation 20%. No make-up exams will be given unless mandated by University policy. You may discuss the homework with others, but it is individual and you should do the problems yourself.

I will occasionally mention how to use Maple and/or Mathematica and how it may be used to advantage for some aspects of these problems. I will not explicitly have any Maple or Mathematica component in the class assignments, though I may give extra credit for implementing problems using symbolic packages and sharing the files.

The presentation and report will be on a topic that the student and I mutually agree upon (could be an application area of interest to you or a recent development of perturbation methods or both. It will be individual with no two topics the same. I expect to have one or two sessions for the talks; attendance is required. The number of lectures will be reduced if necessary.

Some other texts and monographs on this subject are below. I will place as many of these as I can on 2 hour reserve in Morris Library.

- *Scaling, Self-similarity and Intermediate Asymptotics*, G.I. Barenblatt, (University Press, Cambridge, 1996).
- *Advanced Mathematical Methods for Scientists and Engineers*, C.M. Bender and S.A. Orszag, (McGraw-Hill, New York, 1978). The newer "edition" from Springer in 1999 appears to have identical content to the 1978 edition to me.
- *Asymptotic Expansion of Integrals*, N. Bleistein and R.A. Handelsman, (Dover, New York, 1986).
- *Introduction to Perturbation Methods*, M.H. Holmes, (Springer, New York, 1996).
- *Asymptotics and Special Functions*, F.W.J. Olver, (Academic, San Diego, 1974).
- *Perturbation Methods in Fluid Mechanics*, M. Van Dyke, (Parabolic, Stanford, 1975).