

AMATH 732

Asymptotic Analysis and Perturbation Theory

Course Outline: Fall 2016

Instructor: Kevin Lamb (kglamb@uwaterloo.ca): MC6328, ext 36246.

Times: Monday & Wednesday 16:00-17:20 in MC 6460.

Intended Audience: Graduate students interested in approximation methods, particularly those from Applied Mathematics, Physics and Engineering. No formal pre-requisite. Mathematical background assumed. Undergraduates require instructor consent.

Topics

1. Introduction: simple linear systems, roots of polynomials
2. Nondimensionalizing: the projectile problem, scaling and orthodoxy
3. The nonlinear pendulum and method of multiple scales.
4. Asymptotics: small and large terms
5. Asymptotic expansions of integrals
6. Asymptotic Analysis of ODEs, the Airy equation, the turning point problem
7. Singular Perturbation Theory: introduction, the linear damped oscillator, methods.
8. Method of Stationary Phase
9. Asymptotics to derive model equations.

References

- Course notes which will be made available on the course website.
- Bender, C. M., and Orzag, S. A. *Advanced Mathematical Methods for Scientist and Engineers*, McGraw-Hill (1978). QA371.B43 1978
The book I was originally taught from by one of the authors. An important source for this course. A wealth of topics – far more than we will cover in this course. Lots and lots of problems. Some very difficult.
- Lin, C. C., and L. A. Segel, L. A. *Mathematics Applied to Deterministic Problems in the Natural Sciences*, MacMillan (1974). QA37.2.L55 1974
This is one of the best applied mathematics texts available. It was reprinted by SIAM in 1988. Parts of it can be read on google books. Strongly recommended.
- Murdock, J. A. *Perturbations: Theory and Methods*. QA871.M87 1999
- Nayfeh, A. H. *Introduction to Perturbation Techniques*. QA371.N32 1981
- Bleistein, N., and Handelsman, R. A. *Asymptotic Expansions of Integrals*, Holt, Rinehart and Winston, New York (1975). QA311.B58 1975
Title says it all. Dover republished an unabridged corrected version in 1986.

- Ablowitz, M. J., and Fokas, A. S. *Complex Variables: Introduction and Applications*, Cambridge University Press (2003). QA331.7.A25

Useful treatment of asymptotic evaluation of integrals (e.g., method of steepest descent).

Grading Scheme

- 20%: Assignments
- 10%: Oral quiz
- 20%: Group project
- 20%: Midterm
- 30%: Final Exam

Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check www.uwaterloo.ca/academicintegrity/ for more information.]

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, <http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm>. When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing academic offenses and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, academic advisor, or the undergraduate associate dean. For information on categories of offenses and types of penalties, students should refer to Policy 71, Student Discipline, <http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm>.

For typical penalties check Guidelines for the Assessment of Penalties, <http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm>.

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72, Student Appeals, <http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm>.

Note for students with disabilities: The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.