MATH 858G: Asymptotic Methods with Applications
Department of Mathematics, UMCP **Spring 2024**
Handout: COURSE SYLLABUS AND POLICIES **Date:** 01/25/2024

Lectures: MATH 0307 (Math Bldg- Kirwan Hall) **Time:** TuTh 9:30am–10:45am
Note: Lectures are **in person**. No recording is planned.

CONTACT INFO:
Instructor: Dio Margetis; e-mail: diom@umd.edu
Office: 2106 Kirwan Hall; phone: 5-5455.
Instructor's Homepage: https://www.math.umd.edu/∼diom/

Office hours: (i) In person: Tuesdays 11:00am-11:45am (after class); **(ii) on Zoom:** Wednesdays 5:00pm-5:45pm; or **(iii) by appointment**. Office hours *start on Tue 01/30/24*.
Zoom meetings for instructor's office hour are scheduled through ELMS/Canvas.
Students are encouraged (but not required) to wear KN95 face masks during in-person meetings. Students at instructor's office hours should have *specific and well-defined* questions.

Grader: TBA as soon as the info becomes available; e-mail: TBA
Grader's Office hour: Time: TBA

ELMS/Canvas: This platform will be used for part of the course. For example, the details of the Zoom meetings (ID and passcodes) for office hours should be found there. Only authenticated UMD users will be allowed to join Zoom meetings. **This syllabus along with lecture notes and Homeworks** will be posted there. To access ELMS, go to http://myelms.umd.edu; log in using your UMD username & password.

PREREQUISITES: The course is largely self-contained but also requires some self-study on the way. Knowledge of multivariable calculus is necessary. Some knowledge of differential equations and complex variables will be helpful. The UMD courses MATH 241, 246, 462, and 463, for example, would suffice, but they are not required. Some reviews will be given in class as needed. Ask for the instructor's advice if you are in doubt.

TEXT: No required text. A highly recommended text to be followed closely is:
"Introduction to Perturbation Methods", by Mark H. Holmes, Springer, 2nd (or 1st) Ed.

Course Web page: https://www.math.umd.edu/∼diom/courses/858G/
To access it, **go to my homepage (above) – click on Teaching & then find course.**
(However: All homeworks will be posted at ELMS/Canvas.)

SCOPE & TOPICS: Mathematical concepts and tools that permeate models in various areas of the physical sciences and engineering. **Emphasis is placed on analytical techniques for finding approximate solutions to ODEs, PDEs and – if time permits! – to difference equations**. A goal is to help students formulate and solve quantitative problems of science and engineering, from the atomic to the macroscopic scale. Applications include problems from fluid and solid mechanics, elasticity, electromagnetism, mathematical biology, quantum mechanics, condensed-matter and atomic physics.

PART I. Convergent, asymptotic and formal series expansions.

PART II. Matched asymptotic expansions & perturbation series for ODEs, PDEs, and difference eqs: Regular and singular perturbations. Boundary layer theory.

PART III. Multiple scales: Multiscale expansions. Forced motion near resonance. Weakly coupled oscillators. Linear and nonlinear wave propagation. Wave-wave interactions. Nonlinear diffusion. Weakly nonlinear difference equations.

PART IV. WKB and related methods: Expansions. Turning points. Uniform approximation. Wave propagation and energy methods. Slender-body approximation. Discrete WKB method.

PART V. Homogenization: Averaging procedure. Periodic microstructure. Porous flow.

PART VI. Bifurcation and stability: Bifurcation point. Lyapunov-Schmidt method. Linearized stability. Quasi-steady states and relaxation. Weakly coupled nonlinear oscillators.

Applications: Nonlinear waves in optics, fluid & gas dynamics; nonlinear diffusions in materials; scattering and bound states in quantum mechanics; porous media; homogenization of composites; cloaking in acoustics and optics; plasmonic crystals.

GRADING POLICY: NO exams or tests. Grades will be based exclusively on 4-6 problem sets (homeworks). Each set will be due (usually) 2 weeks after the date it is handed out.

You can take the course for 1-3 credits; or audit it. You are expected to write your *own* solutions if you take the course for credit. *The amount of homework expected from each student depends on the number of credits. The problems to be done will be indicated on each set.*

HOMEWORKS: Once assigned, the homeworks must be turned in by the date specified, **in class**. **Late homeworks will not be accepted**. Your solutions are required to be *legible and clear*. Illegible solutions will not be graded. Solutions won't be distributed by instructor.

Since the course aims to sharpen your ingenuity and analytical skills, there is no need for calculators for homeworks. Calculators are *prohibited unless stated otherwise in a homework.*

Submissions: Homeworks should be turned in **in person**, in class, in a TIMELY FASHION.

Word of Caution: Students who unjustifiably do not return homeworks take risks regarding their grades; and will be called upon to explain and might be advised to drop the course. **Any request for extension of deadline for homework is subject to university rules for: integrity of the course and close pursuit of its academic goals; and fairness for all students.** Thus, I may pose severe restrictions on or even refuse granting an extension, if I deem that accepting the initial request may compromise such rules. IF requests for excused absences affect assignments, documentation for justification will be asked strictly.

If you feel that you are entitled to more points on a homework, you may **resubmit your paper** with a note explaining why your grade should be changed. (Since each questioned problem will be very carefully reexamined, it is possible that you could end up losing points in the re-evaluation process.) Any request for re-evaluation is overdue if it is made later than 5 days after the return of the (graded) paper. The Instructor and grader reserve the right to **disregard your paper resubmission if they deem this is overdue or unsubstantiated**.

WORKING TOGETHER & ACADEMIC INTEGRITY. All work that you submit must be your own. You are welcomed to discuss homework material with each other in a general way, but you may not consult any one else's written work. Any marked similarity in

form between submissions with different authors might be regarded as evidence of academic dishonesty. You must cite any reference you use and clearly mark any quotation or close paraphrase that you include. Such citation will not lower your grade, although extensive quotation might. **Homeworks should be done individually.**

You are expected to read carefully and adhere to the following instruction.

The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit https://policies.umd.edu/student-affairs/university-of-maryland-code-of-student-conduct

To further exhibit your commitment to academic integrity, remember to sign the Honor Pledge on all examinations: *"I pledge on my honor that I have not given or received any unauthorized assistance on this examination (assignment)."*

Additional note for MATH 858G: You will not be asked to sign such a pledge on assignments, but you are expected to adhere to the principles of the pledge there.

DISABILITY (ADS) SUPPORT: Students with documented disabilities should notify the Instructor and discuss the corresponding accomodations according to policies of the Accessibility & Disability Service (ADS) **by the 2nd week of classes.**

UNIVERSITY POLICIES: In general, it is our shared responsibility to know and abide by the UMD's policies. General policies on Courses of the Graduate School are found here:

https://gradschool.umd.edu/course-related-policies

Topics include academic integrity, student and instructor conduct, accessibility and accommodations, attendance and excused absences, grades and appeals, intellectual property.

STUDENT RESOURCES & SERVICES. Taking personal responsibility for your own learning means acknowledging when your performance does not match your goals and doing something about it. I hope you will come talk to me so that I can help you find the right approach to success in the course; and I encourage you to visit https://tutoring.umd.edu to learn more about the wide range of campus resources available to you.

You should also know there is a wide range of resources on campus to support you in various ways (see for example UMD's Student Resources and Services website).

For confidential counseling, students are advised to visit or contact the UMD Counseling Center (see https://counseling.umd.edu); or one of many other mental health resources on campus.

COVID-19 related policy: According to university regulations: "**Wearing a mask is not required while indoors.** However, masks are a significant defense against the spread of COVID-19 and other respiratory viruses, so wearing a high-quality mask is recommended while indoors for added protection." See https://umd.edu/4Maryland#masks

On Excused Absences: The University policy on excused absences can be found at: https://policies.umd.edu/policy/9abcecc4-1d3a-41a1-8d50-033655a3d486/

RELIGIOUS OBSERVANCES. If you plan to be absent from class because of religious observances, please submit to Instructor a list of the dates in the first week of classes.