Engr-5011 Engineering Mathematics I
2023 Fall Semester (3 credit hours)

Catalog description:

This is a survey course in essential mathematics for first-year graduate students in engineering and physical sciences. Topics include analytic methods in ordinary differential equations, complex-variable theory, the laplace transform and its inversion, and initial-value problems and boundary-value problems. Matlab, numerical methods, and introductory numerical algorithm design are introduced.

Course learning objectives:

By the end of this course students will:

- develop proficiency in matlab programming, including summation of series, numerical integration, and solution visualization
- develop proficiency in classical solution methods for linear ordinary differential equations
- develop proficiency in numerical solution methods for both initial-value and boundary-value problems and partial-differential equations
- utilize complex-variable theory for definite (improper) integrals and inversion of Laplace transforms
- utilize integral-transform methods in the solution of partial-differential equations.

Prerequisites:

There are no formal prerequisites, although background in multivariate calculus, differential equations, and procedural computer programmng is assumed. Matlab is reviewed (but quite rapidly), so students new to matlab may wish to seek out online tutorials.

Reference:

There is no required textbook for this class. Instead, students are responsible for the lecture content and the notes developed in class, which are on the Canvas site within a few days of the lecture.

There are many library and web-based resources for this material. But a fairly useful reference if you already don't have a favorite is: Francis B. Hildebrand: Advanced Calculus for Applications, (1976) Prentice-Hall. This is essentially big recipe book for analytical methods in engineering mathematics, with many practical examples from engineering.

Instructional personnel contact information:

Dr. Peridier	(instructor)	peridier@temple.edu	zoom office hours 990 5019 3532	Mon 10:00-11:30
	(215-204-7143)		zoom office hours 990 5019 3532	Tue 10:00-11:30
			for other times (or in person) office hours	–>by arrangement

Topics:

Note: many topics entail substantial use of numerical software in *core*[1] matlab.

1. Introductory material [∼3 weeks]
   (a) Nomenclature: ordinary vs partial differential equations, independent vs dependent variable, linear vs nonlinear equations
   (b) Basic numerical integration in matlab (initial-value problems; definite integrals, importance of O(1) dimensionless variables)
   (c) The scaling of equations into dimensionless, computable form
   (d) Buckingham-Π theory

2. ordinary-differential equations (ODEs) [∼3 weeks]
   (a) "recipes" (kernel-integral formulae) for first and second-order ODEs
   (b) series-solutions for homogenous second-order ODEs; coding series solutions in matlab
   (c) numerical methods: 2-point boundary-value problems

3. complex-variable theory [∼2 weeks]
   (a) contour integrals in complex-variable space; residues and poles
   (b) inverting Laplace transforms from 1^{st} principles

4. orthogonal function theory [∼2 weeks]
   (a) ∇^2 and Sturm-Liouville theory
   (b) devising finite-integral transforms

5. classical analytical solutions of partial-differential equation (PDEs) [∼3 weeks]
   (a) Separation of variable (SOV) and finite-integral transforms in cartesian and cylindrical coordinate
   (b) Numerical solutions: finite difference methods; the Crank-Nicolson algorithm

[1] Do *not use "syms"* in matlab — when doing numerical work (which is what we are doing in this course). If "syms" is used for numerical computation it will be marked wrong

What to expect:

1. The in-class lectures will be "zoomed" and the lecture notes will be posted in canvas within a day (or two) .
   - Although "live" lecture participation is recommended, it is not required.
   - Students are encouraged to bring their laptops and participate in the matlab-code development.

2. There will be a homework for each major topic (5 or 6) .
   ... and *please* ask homework-related questions in class — its so efficient to give everyone the same hints at the same time!

3. It is OK to figure out the homework collaboratively .
   ... *if you acknowledge the specific contributions of your collaborants* on the relevant homework problem (see below)..

4. No tests are planned. .

Homework submission format

1. **Homework** must be **organized** as follows:
   (a) **First (top) page:** the "cover page" provided in the homework prompt
   (b) **Each problem must follow in sequence.**
   (c) **For each problem:**
      i. **1st** the "cover page"/prompt for the problem
      ii. **2nd** your *handwritten - do not typeset* solution and derivations
      iii. **3rd** .your printed-out matlab code
      the code should utilize the same notation as your derivation
      iv. **4th** your matlab plot
      v. If you collaborate (which is OK!) with another student on this problem, identify the collaborant and explain their *specific contribution t*o the homework solution

2. **Each student** should individually write up and **submit a complete individual** homework submission**.**

3. **Homework** can be **submitted** as follows:
   (a) If a physical paper copy —one side only!! — in class on the due date.
   (b) If a Canvas submission –well-imaged single-file pdf only – by the due date.
   (c) If you miss the deadline, emailed submissions (as a single scanned pdf) will be accepted as follows:
      - only once per student, and
      - only if the submission is emailed before the grades for the assignment are posted.

4. **Homework** will not be graded if:
   (a) the submission is not sequenced as described above, or
   (b) the submission is difficult to read, written sloppily, or late.

Final grade determination:

- At the end of the semester the grades are summed to obtain a "raw score" for each student.
- The class is then sorted by raw scores – highest to lowest.
  The scores always "clump" into groups: the top group gets an "A" the next an "A-", etc.
- Students who are on the borderline between two grade categories will get a "bump" if they demonstrated exceptional class participation.
- My goals for the final grade is that they reflect the following demonstrated competencies as follows:.

grade	**documentation (homework)**	**technical (math/engineering)**	**matlab**
A-range	consistently professional	can tutor peers; can do real problems	does *original* coding
B-range	good, sometimes professional	can do textbook problems	modifies working code
C-range	generally clear and concise	demonstrates understanding of concepts	uses matlab commands
D-range	adequate	genuine effort on homework	attempted all matlab

Operational specifics for the Fall 2023 semester:

1. Class is Th $5^{30}-8^{00}$ in Engineering 308.
2. Students need matlab to do this course! If you do not yet have matlab on your personal computer, download it from the Temple University down site at:
   `https://download.temple.edu`
3. Class attendance for the live lecture is recommended, but not required. The student is responsible for all content presented in class, regardless of attendance.
4. The professor will use zoom to record the lectures (though examples done on the board and conversations with students will likely not be captured).
   The zoom recordings and lecture notes developed during class will be posted in the Canvas site.
5. The student may want bring their laptop computer (with matlab installed) to class.

Regulation Temple University syllabus notifications:

1. Disability accommodations. If you require an accommodation due to a personal disability please let me know and/or contact the Disability Resource and Services center at 100 Ritter Annex (215-204-1280).

2. Academic freedom. Temple University (and this professor) subscribe to the "Student and Faculty Academic Rights and Responsibilities Policy" (Temple University Policy #03.70.02).
   Basically, this policy states that both the teacher and the student have the right to express their own views.

3. Academic misconduct.

   (a) **Plagiarism** includes (according to Temple University[2]) but is not limited to:

   - the use, by paraphrase or direct quotation, of the published or unpublished work of another person without full and clear acknowledgment.
   - the unacknowledged use of materials prepared by an agent engaged in the selling or distribution of term papers or other academic materials.

   For example, if you include matlab code that you clearly did not write yourself (except, of course, for the codes developed in class), this is plagiarism.

   Cheating includes, but is not limited to (according to Temple University[2]):

   - use of any unauthorized assistance in taking quizzes, tests, or examinations;
   - use of sources beyond those authorized by the instructor in writing papers, preparing reports, solving problems, or carrying out other assignments;
   - the acquisition, without permission, of tests or other academic material belonging to a member of the university faculty or staff;
   - engaging in any behavior specifically prohibited by a faculty member in the course syllabus, assignment, or class discussion;
   - engaging in behavior that gives the Student an unfair academic advantage including, but not limited to:
     - fabrication of data or sources,
     - resubmitting work already submitted for another academic requirement without prior authorization, or
     - other similar behavior.
   - facilitating, procuring, or encouraging another person to engage in plagiarism or cheating.

   So:

1^{st} instance of plagiarism or cheating on the homework	=	"0" for that assignment
2^{nd} instance of plagiarism or cheating on the homework	=	"F" for the course

   (b) **Generative AI tools.** Effective Fall 2023, Temple University explicitly prohibits usage of generative AI tools (unless the instructor explicitly grants permission). So:

1^{st} instance of usage of generative AI on a homework	=	"F" for the course

[2] Taken from Temple University "Student Conduct Code" (Policy #03.70.12, Article III, Part C)
Once a student has been informed that academic misconduct is suspected, the student may not drop or withdraw from the course during the investigation and adjudication process except where the drop or withdrawal is approved for exceptional circumstances.