JOHNS HOPKINS
WHITING SCHOOL
of ENGINEERING

Applied Mathematics and Statistics 553.291
Linear Algebra and Differential Equations
Fall, 2020 (4 credits, EQ)

3rd draft, 09/15/20 – PLEASE READ THIS!

Instructor
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Office hours for Instructors and TAs: see Blackboard.

Meetings
Mon., Wed., Fri., 1:30–2:20 pm (Charon, Sections 03, 04, and 06): https://wse.zoom.us/j/91333617152
Mon., Wed., Fri., 12:00pm-12:50pm (Micheli, Sections 01, 02, and 05): https://wse.zoom.us/j/98068317823

Recitation sections *(Note: given the amount of material, part of the syllabus will be covered in these sections)*
Section 01 (Micheli): Tuesday, 1:30–2:20pm (led by Michael),
Section 02 (Micheli): Tuesday, 3:00–3:50pm (led by Lillie),
Section 03 (Charon): Tuesday, 1:30–2:20pm (led by Oliver),
Section 04 (Charon): Tuesday, 3:00–3:50pm (led by Thabo),
Section 05 and 06 (Micheli & Sharon): Tuesday, 8:00-8:50pm (led by Jianyu),
Zoom links: see Blackboard

Textbook
No textbook is really required. We will be distributing our own notes and we will type up homework problems. In order to have a more comprehensive reference, we strongly suggest that you download the following books:

[1] *Matrix Theory and Linear Algebra*, by Peter Selinger
https://www.mathstat.dal.ca/~selinger/linear-algebra/

[2] *Notes on Diffy Qs: Differential equations for engineers*, by Jiri Lebl
https://www.jirka.org/diffyqs/

These are for free (!) and of great quality, with good extra problems for you to solve. You can also order a printed and bounded version of the books for about $15-$20 each. The only caveat is that these books are meant for two full one-semester courses, one in Linear Algebra and the other in Differential Equations. However, we only have one semester: so we will *not* cover all the material in these books, but only some chapters. It will be your job to use these books appropriately as reference books, i.e. by searching the topics that we will cover.

If you already own a copy of the textbook that was used in the past few semesters, namely:

C.H. Edwards, D.E. Penney. *Differential Equations & Linear Algebra*, 4th Edition. Pearson Prentice Hall, 2017,

it will certainly do the job as a reference book and a source of additional problems. In fact, *any* earlier, used, and cheaper edition of the book will do the job. (You'll find some 3rd editions at $15-$20 each on Amazon.com).

Assignments, Readings, and Online Resources
Log in to Blackboard for all materials related to this course.

Course Information

- This course is an introduction to the basic concepts of linear algebra, matrix theory, and differential equations that are used widely in modern engineering and science. The discussion will be augmented by topics from linear algebra and the use of computer software (primarily MATLAB). It is intended for engineering and science majors whose program does not permit taking both AS.110.201 and AS.110.302.
- **Prerequisites:** Calculus I (AS.110.106 or AS.110.108 or equivalent), and Calculus II (AS.110.107 or AS.110.109 or equivalent).

Course Goals

Specific Outcomes for this course are that
- Students will: (1) recognize and solve a variety of first order differential equations, via analytical and/or numerical methods; (2) recognize and solve a variety of higher order linear differential equations, via analytical and/or numerical methods; (3) learn about concepts from linear algebra used in the analysis and solution of differential equations.

This course will address the following Criterion 3 Student Outcomes
- An ability to apply knowledge of mathematics, science and engineering (Criteria 3(a))
- An ability to identify, formulate and solve engineering problems (Criteria 3(e))
- An understanding of professional and ethical responsibility (Criteria 3(f))
- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context (Criteria 3(h))
- A recognition of the need for and an ability to engage in life-long learning (Criteria 3(i))
- A knowledge of contemporary issues (Criteria 3(j))
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (Criteria 3(k))

Course Topics

- *Linear Algebra:* systems of linear equations, matrices, Reduced Echelon Form (REF), consistent matrices, homogeneous matrices, matrix operations, scalar product, norm, linear independence, matrix inverses, determinants, null spaces, range, spanning subsets, bases, dimension and rank, orthogonal and orthonormal bases, Gram-Schmidt orthogonalization, linear transformations, eigenvalues and eigenvectors, characteristic polynomials, complex eigenvalues, diagonalization.
- *Differential Equations:* Basic DE terminology, separable equations, linear 1st order equations, integrating factors, equilibrium and stability, higher-order differential equations, homogeneous equations with constant coefficients, undetermined coefficients, variation of parameters, numerical solutions, systems of first order differential equations, Laplace transforms.
- *Programming:* While this will not be the main focus of the course, you will learn how to perform some basic linear algebraic operations with MatLab, as well as how to solve some differential equations numerically.

Course Expectations & Grading

The student's final grade will be based on weekly homework assignments, two midterm exams, and one final exam. The breakdown will be as follows: **Homework: 30%, Midterm 1: 20%, Midterm 2: 20%, Final: 30%.** The course average (typically a B) will depend on how satisfied we will be about the outcome of the class.

Regarding the homework: there will be one homework assignment due every week, for a total of 13 homework assignments. (On the weeks of midterms, the assignments may be a bit shorter.) In any case, *the two worst homework assignments will be dropped* in the computation of your final grade.

Homework will be typically assigned every Friday evening and will be due on the next Friday, in class, at the beginning of class (except for the first week, when the homework will be due on Monday on the following week, and the last full week, when the 13th homework assignment will be due on Wednesday, December 9 instead of Friday, December 4), by 11:59pm. *The two worst homework assignments will be dropped* in the computation of your final grade. Homework will be assigned approximately one week before it is due (except for the first homework, which will be due on Monday 9/7 at 11:59pm and will be posted on Monday 8/31). Homework will be due on *GradeScope*: this means you will have to *scan and upload your solutions*, and "tag" the problems on the PDF file so to make the graders' work a bit easier (this is pretty straightforward).

Regarding scanning: make sure that the file that you upload is of reasonable size. Typically, taking high-resolution pictures and converting them into PDF is not a good idea. We recommend using mobile apps such as *CamScanner* or *GeniusScan*, that allow you to convert your documents into black and white (*not* grayscale!). Of course, you can also use a regular scanner. Alternatively, if you have a tablet device, you can write your solutions on electronic paper (e.g. using *Notability* or *OneNote*), and upload the resulting PDF. Again, make sure that the file is of reasonable size.

Under special and documented circumstances (e.g. medical and personal reasons) we give homework extensions. However, if you are granted such an extension, you will have to turn in your homework within 24 hours from the original due date. It is the student's responsibility to check Blackboard regularly to make sure their grades have been correctly recorded. Grade changes will not be made without documentation. A blank grade in Blackboard should be considered as a grade of zero for the assignment/exam.

Key Dates

Midterm 1: Monday 10/05/2020 (**8:00-9:00 pm**)
Midterm 2: Monday 11/09/2020 (**8:00-9:00 pm**), not cumulative
Final: TBA, cumulative!

Because this course has 2 different class times per day, with a number of students taking the course from overseas (especially in countries located in the GMT+8 and GMT +9), in order to have all students taking the exam *at the same time,* the instructor has decided that the first two midterms will be taken **in the evenings**. On those days, there will be no class, and class time will be used to provide extra office hours to the students. If, for some reason, you cannot take the exam at the specified time, please contact the instructor and reasonable arrangements will be made.

We should warn you that Midterms are sometimes a bit of a time crunch: they are meant to test your ability to solve simple problems quickly, so to leave you enough time to ponder more deeply about a couple of more challenging problems: so, be prepared (and well rested). On the other hand, the Final exam, which lasts three hours, is normally designed to take about two hours, so to leave you enough time to double-check your work.

Exam rules: The exams will be open-book, open-notes, pretty much open-everything. You're allowed to use a calculator, of any type. *We strongly recommend that, for each exam, you prepare a cheat sheet* (of any length) as it is an excellent way to review the material. The exam will be made available on Blackboard and emailed to you, 5 minutes before the start of the exam. Like the homework, you will have to scan an upload it on GradeScope. We will not require you to use "lockdown browsers" during the exams, and we will not require to be able to look at you during the test (I personally find this too invasive). The only expectation that we have is that you will work on your own and not communicate with others during the exams.

Ethics

The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition.

In addition, specific ethics guidelines for this course are:

1. In this course, you may collaborate with other students on homework. However, you are ALWAYS to write up your solutions individually, even when you work in a group.
2. Use of previous course material is prohibited (except as provided by the instructor.) If you have questions about this policy, please ask the instructor.
3. Use of solutions manuals and other instructor materials are ALWAYS prohibited.
4. Attendance may be taken at random points during the semester. Students are reminded that mis-representing information about their personal circumstances to a university official, including a faculty member, constitutes academic dishonesty and is grounds for action by the Academic Ethics Board.
5. If you are aware of any classmates involved in behavior of questionable ethics with regards to this class, you should contact the instructor or a teaching assistant immediately Report any violations you witness to the instructor.

You can find more information about university misconduct policies on the web at these sites: http://e-catalog.jhu.edu/undergrad-students/student-life-policies/

Personal Wellbeing

- If you are sick, in particular with an illness that may be contagious, notify me by email but do not come to class. Rather, visit the Health and Wellness: 1 East 31 Street, 410-516-8270. See also http://studentaffairs.jhu.edu/student-life/support-and-assistance/absences-from-class/illness-note-policy/
- All students with disabilities who require accommodations for this course should contact me at their earliest convenience to discuss their specific needs. If you have a documented disability, you must be registered with the JHU Office for Student Disability Services (385 Garland Hall; 410-516-4720; http://web.jhu.edu/disabilities/) to receive accommodations.
- If you are struggling with anxiety, stress, depression or other mental health related concerns, please consider visiting the JHU Counseling Center. If you are concerned about a friend, please encourage that person to seek out our services. The Counseling Center is located at 3003 North Charles Street in Suite S-200 and can be reached at 410-516-8278 and online at http://studentaffairs.jhu.edu/counselingcenter/

Appendix 1: Regrading policies for exams

Please rest assured that the utmost effort is made by the TAs and the instructor so that problems are graded *consistently*: if a number of points are deducted for a certain type of error, then anyone else making that same error will have the same deduction. Do not assume that your exam was graded in a "harsher" manner than others'. However, if you feel that somehow your exam was graded incorrectly, you should submit *to the instructor* **a written paragraph** of a few lines explaining why you think that a particular problem in your exam should be graded differently. Once a submission has been received, the instructor reserves the right to look at the entire exam, and (though this happens rarely!) to *deduct* points if he thinks that the grading was indeed incorrect, but the partial credit given by the grader was too generous.

Appendix 2: Miscellanea

Resources: Use all of the support that JHU is going to provide you! Between the instructors and the TAs, there will be about **15 hours** of combined office hours each week. Come see us often! If you cannot make it to the regular office hours, send us an email and we will do our best to arrange a one-on-one meeting. Also, if you cannot make it to office hours or you have an impelling question about the material, please do not hesitate to email the TAs or the instructors.

Do not start homework during office hours! Office hours are meant to help you after you have put some honest effort into a problem set. To make best use of office hours, you must have some understanding of what is being asked: this will be beneficial to all those attending office hours at the same time. By the way, office hours are not just meant to help you with homework problems, but also with the understanding of the theoretical concepts: we encourage you to ask us questions that will help you with such understanding. In fact, *understanding the theory is central in succeeding in this course*. Just solving problems will *not* suffice. Therefore, make sure you spend a good chunk of time learning and understanding the lecture notes.

The PILOT tutoring program will be available for LADE students (schedule and PILOT leader T.B.A). The PILOT leader is student Amol Khanna, akhann13@jhu.edu.

No extra work for extra credit: In order to be fair to everyone, we will not assign any individual student extra work to get "extra credit" to boost their grade (otherwise we'd have to give everyone the same opportunity).

Absences from exams: If you do not show up on the day of an exam, we will need a note from the Student Health Center, or a note from your doctor (we must be strict about this). In fact, if you *are* sick on the day of an exam, I encourage you to see a doctor, take good care of yourself, and contact us (if at all possible, *before* the text takes place) to reschedule the exam. We have seen too many times students coming to take their exam while sick, and consequently underperform.

Social Media: Please do not befriend the instructors on Facebook—at least until *after* your graduation!