Leiden University, Semester 1 2020
Analyse 3 NA

Lecturer: Dr. Timothy Faver
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Website: `https://tefaver.com/teaching/analyse-3-na-fall-2020`
Lecture time/location: Asynchronous (more information below)
Practice time/location: Tuesday 11:15–13:00, Kaltura Live Room (via `Brightspace`)
Office: Snellius Building, Room 206d
Teaching assistants: Christian Hamster (`c.h.s.hamster@math.leidenuniv.nl`), Wouter Mulders, Dock Staal, Delion Tholens

Course materials. We will follow my lecture notes, available on the website. Additional recommended (but optional) readings will be assigned from *Mathematical Methods of Physics and Engineering: A Comprehensive Guide* (third edition) by K.F. Riley, M.P. Hobson,& S.J. Bence and, periodically, several Springer books available online via Leiden's library. You are not required to purchase any of these books; I will write and distribute my own problem sets. Further references are provided in the lecture notes. I am happy to suggest alternate treatments of particular topics on request.

Lecture structure. Each week I will write you a "letter" outlining the week's topics and detailing the corresponding portions of the lecture notes that you should read and, no less important, strategies for *how* to read my notes. The letter will be available by Monday morning each week. The reading assignments per week will correspond roughly to what I have covered in the space of a week (4×45-minute sessions) in the last two years of teaching this class.

I will also upload about 4 short videos (≤ 10 minutes each) to the website in which I solve a particular example from the lecture notes or work through a proof. The videos will not contain material not found in the notes, so watching them is optional. However, my hope is that the videos will provide a refreshing alternative to solitary reading of the text. You are welcome to make requests for future short videos.

Last, in this letter I will also assign 10 practice problems for you to complete in conjunction with the reading. You are encouraged, but not required, to submit 2 of these problems for grading by the following Wednesday (see below).

Beginning Monday, 7 September, I will be available via the Kaltura live room in Brightspace each Monday during our formally scheduled time (14:15–16:00) for "drop-in" consultation. I will be at my computer with the live room open, so you can pop in without an appointment to discuss any matters mathematical that you want. I will also have my email open then and can respond in real time. (You can email me at other times, too.)

Practice sessions. Beginning Tuesday, 8 September, practice sessions will be held online during the scheduled meeting time in the Kaltura live room. The TAs will be available then to answer your questions live, and you may use this time to consult with each other, too. You will be assigned to breakout rooms at the start of the session; please inform the TAs via the Kaltura chat if there are particular people with whom you would like to be grouped.

Zulip. Our course has a discussion forum available at `Zulip.com`. An invitation link and the password are available in the announcements on Brightspace. The format of Zulip offers some advantages over Brightspace's discussion board, notably the ability to write in LaTeX. You are encouraged to post questions about course topics, practice problems, and homework in Zulip — if you have a question, it's likely other people do, too. To keep the chat organized, please review the different available streams and select the appropriate one before posting. Feel free not to use your real name when posting. The TAs and I will monitor Zulip posts and respond throughout the week (I can only read and respond to posts in English).

Of course, you should contact me individually via email for any private or personal matters related to the course. When writing in public or in private, please treat others with the same respect that you desire for yourself.

Sticky matters. "We live within the stranger's land," claims one of the cantos of Tennyson's *In Memoriam*, and this new academic year still finds us all within the stranger's land for sure. There are many new pressures and worries far beyond math pounding down our lives. Please contact me if anything is going on that might adversely affect your success in the course. It is very likely that, with sufficient notice and consideration, we can work it out together.

Grading. Your grade will be based on six homework assignments, two exams, and certain practice problems. You may write in Dutch or in English (or in both!) on any assignment or exam, but I will only be able to comment on work written in English; the TAs will read and grade material in both English and Dutch.

- **Homework** will be assigned on certain Mondays and due, in general, at 15:00 on the Monday two weeks later (see the calendar below for precise dates). Late homework will not be accepted, OLD: but your lowest homework score will be dropped. There are now 7 homework assignments, not 6; your homework grade will be the average of the best 5. So if you only submit the "original" 6, your lowest score will still be dropped; if you submit all of the "new" 7, your two lowest scores will be dropped. The last homework assignment will be a "review" assignment to make you consider problems from throughout the course. Homework is optional in the sense that there exists a grade scheme that does not count it; however, homework, and the feedback that you will receive on it, is essential to your success. You may work in groups on homework, but each person should submit an individually written assignment; please indicate any collaborators on particular problems. If you get an idea from our Zulip chat, please cite the username, post title, and date.

- There are 14 weeks of lectures in the term. From each week's **practice problems**, I will ask you to submit 2 specified problems for grading, for a total of 28 submitted. Problems will be due at 15:00 on the Wednesday of the week after they are assigned so that you have enough time to discuss them in a practice session. Each problem will be graded on a scale of 0 to 5 points (no submission = 0, incoherent submission = 1, submission with major errors but some correct ideas = 2, submission with minor errors and mostly correct ideas = 3, otherwise correct submission with arithmetic/"calculus" errors = 4, perfect submission = 5). Thus there are 140 problem points available. Your total problem score will be taken out of 110 points; points left over will count

as extra credit. Like homework, submission of practice problems is optional, but I am adding this grade option in the hope that it will encourage you to keep up with regular weekly practice and reward you for doing so.

Homework problems alone will not provide enough engagement with course topics, so doing the practice problems really is essential to your success as well. I will typically give short numerical or symbolic answers to problems in the original posting; full solutions will be available the following Wednesday after the request practice problems are submitted.

- I will announce details about **Exam 1** no later than 12 October and about **Exam 2** by 7 December. In particular, I will discuss in advance the precise structure and time limits of the exams (the time limits may be more generous than what the schedule states), as well as submission directions. Both Exam 2 and the **retake** in January are comprehensive.

- THIS IS OLD: Exam 1 is optional (in the sense that there exists a final grade option that doesn't count its score), so there will be no retake for this exam. I encourage you to take Exam 1 nonetheless so that you have more options for your grade and to see how well you've learned the material up to that point. Taking Exam 1 cannot hurt your grade!

  Literally. Exam 1 is cancelled.

- THIS IS OLD: To **calculate your final grade**, let E_1 be your score on Exam 1, E_2 your score on Exam 2, H your homework score, and P your practice problem score, all scaled out of 10. Then your final grade will be the largest of the five numbers below:

$$E_2,\ (0.3\cdot E_1)+(0.7\cdot E_2),\ (0.1\cdot H)+(0.9\cdot E_2),\ (0.1\cdot H)+(0.3\cdot E_1)+(0.6\cdot E_2),$$
$$(0.1\cdot H)+(0.1\cdot P)+(0.25\cdot E_1)+(0.55\cdot E_2).$$

  If you take the retake, let R be your grade on the retake and replace E_2 with $\max\{E_2, R\}$ in the above.

  Here is the new grading policy. To **calculate your final grade**, let E_2 be your score on Exam 2, H your homework score, and P your practice problem score, all scaled out of 10. Then your final grade will be the largest of the three numbers below:

$$E_2,\ (0.1\cdot H)+(0.9\cdot E_2),\ (0.1\cdot H)+(0.1\cdot P)+(0.8\cdot E_2).$$

  If you take the retake, let R be your grade on the retake and replace E_2 with $\max\{E_2, R\}$ in the above.

Submission of graded materials. These are broad guidelines for submitting homework assignments, practice problems, and exams. First, I *strongly* encourage you to write homework and practice problem solutions in LaTeX. I will provide a basic LaTeX template for our course, which you are welcome to modify according to your preferences.

If you elect to write solutions by hand, you must scan your solutions as a `pdf` via either a scanner (such as those available at the university) or a phone app. Scans must be legible, and you are responsible for ensuring their legibility in advance. The TAs have the right to refuse to grade illegible submissions of any assignment or exam.

You will then submit your scans via Brightspace. I encourage you not to wait until the last minute to submit work online in case of internet and/or Brightspace failure. In the event of disaster, send a copy of your work to Christian with an explanation and submit to Brightspace as soon as possible. *Submitting assignments via email to Christian is not the norm and should only be done under extreme duress.*

Calendars. Here is a (tentative) list of dates for the homework assignments and the exams. The optional selected weekly practice will be due each Wednesday beginning 9 September and continuing through 9 December. Practice problems assigned on Monday, 12 October, will be due on Wednesday, 28 October, so as not to conflict with Exam 1 preparation. Practice problems assigned on Monday, 7 December, will be due on Monday, 14 December, so that they are graded in advance of Exam 2.

7 September	HW1 assigned
21 September	HW1 due, HW2 assigned
5 October	HW2 due, HW3 assigned
19 October	HW3 due, HW4 assigned
23 October	Exam 1
9 November	HW4 due, HW5 assigned
23 November	HW5 due, HW6 assigned, HW7 assigned (review assignment)
7 December	HW6 due
15 December	HW7 due
17 December	Exam 2
27 January	Exam 2 retake

Below is a (tentative) list of topics and reading assignments from the lecture notes. These will be discussed in much greater detail in the weekly overviews, in which additional supplementary references will be given. Letter references are to the appendices of the lecture notes, e.g., A.1 is Appendix A.1.

Week begins	Topics
31 August	• Basic ODE definitions (§1.1) • First-order linear ODEs (§1.2) • Nonlinear first-order ODEs and separation of variables (§1.3) • Constant-coefficient second-order linear ODEs (§1.4.1) • Review: complex numbers (A.1, A.2, A.3), vector spaces (C.1), and linear operators (C.2)
7 September	• Existence and uniqueness for second-order linear ODEs (§1.4.2–1.4.4) • Nonhomogeneous ODEs: variation of parameters (§1.4.5) • Higher-order linear constant-coefficient ODEs (§1.5.1) • Undetermined coefficients (§1.5.2) • Optional: further topics in ODE (§1.5.3)
14 September	• Fundamentals of PDEs (§2.1) • Separation of variables for PDEs (§2.2) • The heat equation (§2.3) • Trigonometric polynomials (§2.4.1) • Basic Fourier definitions (§2.4.2)
21 September	• Computation of Fourier series (§2.4.3)

	• Pointwise convergence of Fourier series (§2.4.4) • L^2-convergence theory (§2.4.5) • Optional reading: normed spaces (C.3), inner product spaces (C.4), orthonormal bases and generalized Fourier series (C.5)
28 September	• The Parseval and Plancherel theorems (§2.4.6) • Fourier sine and cosine series (§2.4.7) • Solving ODEs with Fourier series (§2.4.8) • Solving PDEs with Fourier series (§2.4.9) • Motivation for and definition of the Fourier transform (§2.5.1)
5 October	• Properties of the Fourier transform (§2.5.2) • The inverse Fourier transform (§2.5.3) • Convolution (§2.5.4) • Parseval/Plancherel theory (§2.5.5)
12 October	• Fourier transforms and differential equations (§2.5.6) • The wave equation: D'Alembert's formula (§2.6.1)
19 October	No new material: exam week
26 October	• The wave equation: separation of variables (§2.6.2) • Homogeneous boundary value problems (§2.7.1, 2.7.2) • Eigenvalues and adjoints of linear operators (C.6, C.7, C.8)
2 November	• Nonhomogeneous boundary value problems (§2.7.3, 2.7.4) • Review complex fundamentals (A.1, A.2, A.3) • Polar coordinates (§3.1.1)
9 November	• Complex roots (§3.1.2) • Functions of a complex variable (§3.2) • Complex limits and continuity (§3.3) • The complex derivative (§3.4.1)
16 November	• The Cauchy-Riemann equations (§3.4.2) • Curves in $\mathbb{C}$ (§3.5.1) • Line integrals (§3.5.2)
23 November	• Path independence of line integrals (§3.5.3) • The Cauchy theorems (§3.6)
30 November	• Analytic functions (§3.7) • Liouville's theorem (§3.8.1) • The fundamental theorem of algebra (§3.8.2)
7 December	• The zeros of an analytic function (§3.8.3, 3.8.4) • Series solutions to ODEs (§1.6)