

Differential Equations Sec 1

Spring 2020

Course Syllabus

Course Description

Differential equations are an important branch of mathematics. They have a rich mathematical formalization, as well as a very successful history of being applied to important problems in physics, chemistry, engineering, and biology. This course will introduce primarily linear, first and second order differential equations. Solution techniques for separable equations, homogeneous and inhomogeneous equations, as well as an intuition for modeling-based applications will be presented. The application of Laplace transforms to differential equations, systems of linear differential equations, linearization of nonlinear systems, and phase plane methods will be introduced. Fourier series and their application to simple partial differential equations will be treated. MATLAB based numerical solution and visualization will be briefly covered.

Schedule

Lecture/Studio

Section 01: Wednesdays 08:15 – 11:00 Room 3-102

Instructor

Prof. Tony Ho tonyho@scu.edu.cn

Teaching Assistant:

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When emailing the instructors, include "MATH" in the subject field of your message. Use your university email account (student_number@stu.scu.edu.cn); mail from other accounts such as qq.com and 163.com will be stopped by the SCU spam filter.

Textbook

Differential Equations with Boundary Value Problems, 2nd Edition, by John Polking, Al Boggess, and David Arnold (published by Pearson).

We will cover approximately two or three sections per week. Textbook reading assignments will be posted to the class website. Read the assigned chapter BEFORE class.

Software

We will use a powerful software tool, MATLAB, to perform calculations and draw graphs. MATLAB is installed on the class computers, and you will also need a copy for your own computer.

MATLAB is a potent tool, used worldwide by engineering and science professionals in many fields. The effort you put in to master it will repay you many times over in this class and others. To make learning it easier, there is a wealth of information, examples, and documentation available within the program and on the web. Learn to tap into these resources so you can make the best use of the program.

Web Site

This course uses the Blackboard system; the web site is

<https://learn.scupi.cn/>

(Note: the **https** is important, otherwise it may not load.) There you will find the course syllabus, studio and homework assignments, and other materials. Current announcements and assignments will be posted on the home page. All assignments will be uploaded through the Blackboard system. Please check the class page frequently.

Class Format and Studio Assignments

The students often give me an impression, that the reasons we are taking courses at a university, are to learn and to try to get as close to a 4.0 grade point average as we possibly can. Of course, a good grade point average can help us further our career up to a point. Early on, institutions can look at our past grade point average to determine whether they would admit us into their institutions or organizations.

But, of what is a good grade point average an indication? One can say that those of us, who have a great grade point average, can learn very well the materials given to us. Is this your goal for coming to a university, to let the world know that we can learn very well the materials given to us? If that is the case, can we see where our world is going? And what do we think how our world sees us? Do we believe that the people of establishments in our world only wish that they can find someone who can learn well and no more than that? Perhaps this is true for a trade like plumbing. But, were we coming to a university because we want to learn a trade?

I would like to supplement the idea of showing the world how good you are at learning. I would also like you to think that coming to a university is to find out what we do not currently know how to do, and we would like you to try to figure out how you may change our world by your imagination and your intelligence. Once you understand the materials given to you, can you imagine something that is far better than anyone has ever thought of before? That is the goal that I would like you to set for yourself. So, during our class, do not be afraid to explore the endless possibilities that are out there in our world. As it is quoted by Shakespeare, "The world is your oyster." Therefore, let us begin with the famous Daoist-inspired sayings: "I hear, I forget. I see, I remember. I do, I understand."

Class Participation

As members of an academic community, all students are expected to actively participate in and contribute to class discussions. You are expected to engage with the class during the lecture/studio time, and to be prepared to think and answer questions on your feet. There is no penalty for not knowing the answer to a question, but you need to be able to "think out loud" and demonstrate the procedure you will follow to arrive at a solution. So, if you're asked a question in class, be prepared to figure out the answer.

You are also expected to follow and critique the presentations of your classmates and provide useful feedback to them so they can learn from the experience.

It is imperative that you spend the class time finding out what you do not understand. My expectation is that you will ask questions once you find out that you do not understand something. Since there is no way for me to tell whether you are spending time finding out what you do not understand, or whether you even ask questions about what you do not understand, I will, occasionally, give a 10-minute quiz. These quiz scores will count as studio assignments and class participation.

Presentations

Whenever two or more classmates find it difficult to agree on a solution, you can volunteer to come up to the board to present a solution for which you believe to be correct. Priorities will be given to harder problems and whoever has not volunteered as many times as before.

When you are selected to present, follow these guidelines:

- Introduce yourself.
- Succinctly state the problem and the appropriate definition(s), theorem(s) or principle(s), etc. you used to solve the problem.
- Describe your solution as if your audience is unfamiliar with the problem.
- Describe how you verified your solution if necessary.
- Speak as LOUDLY and clearly as possible or use the microphone. The people at the back of the room must hear and understand every word.

If I do not see that you are working toward a solution, I will ask you to step down.

Following the presentation, however, the entire class will critique your presentation. Five minutes can be allotted for questions and discussions following your presentation, although we may continue past five minutes if necessary. Here are our evaluation criteria: (1) Use of English: 30% (2) Preparation of the presentation: 30%, (3) Correctness: 20%, (4) Time limit: 20%. Good presentations that help more people understand will earn extra credits towards your total score. **Please also make sure to turn in a copy of your presentation on paper afterwards for possible extra credit.**

Homework Assignments

Homework assignments are some of the exercise problems at the end of each section we cover, and we will assign them every week except the examination weeks. We will begin each lecture by looking at the exercise problems at the end of each section to discover what we can or cannot do yet. Working on homework assignment is the key to get a good grade.

If you believe an error has been made in the grading of an assignment, bring it to either my or your TA's attention within ONE WEEK of its submission.

Exams and Grading

There will, tentatively, be two 135-minute major exams tentatively scheduled during the weeks of April 6 and May 18, and a comprehensive final examination at the end of the semester. Each major exam will be cumulative with more emphasis on the material since the previous test.

Your grade will be based on studio assignments and class participation (extra credit), homework (10%), quizzes (10%), major exams (50%), final examination (30%). Here is an example: if a student's scores are: presentation extra credit (5), homework (80), quiz (80), exams (70, 80), final (84), and playing games on phones during class (-10), then the student grade determination is $5 + 80 \times 20\% + (70+80)/2 \times 50\% + 84 \times 30\% - 10 = 83.7$. There is NO makeup for all the quizzes and exams.

The final letter grade is determined from the following table:

A: 90 – 100	A-: 85 – 89	B+: 80 – 84	B: 76 – 79	B-: 73 – 75	
C+: 70 – 72	C: 66 – 69	C-: 63 – 65	D+: 61 – 62	D: 60	F: < 60

Office Hours

If you do not understand something, and talking to your classmates does not help, then you should be seeking help from me or your TA. My office is 3-324B.

Office hours are times we have specifically set aside to be available to students. During office hours, you can come to my office; you do not need an appointment. I am usually in my office in the afternoons after 16:45 on Mondays, Wednesdays and Thursdays, or after 10:10 on Tuesdays. I am also available at other times; please email to schedule a time.

Plagiarism and Academic Misconduct

Collaboration on studio problems and homework assignments is permitted and encouraged. Collaboration on exams is not permitted.

Plagiarism, copying, and any other form of academic misconduct or dishonesty will not be tolerated. Cite all references, including books, technical reports, and web sites you have used. You may discuss the homework with other people currently taking this class, the instructors, and teaching assistants.

Examples of disallowed sources include websites that offer homework help; course documents from previous semesters; people or agencies that do your work for you.

You are not to share materials distributed in class with people outside the University. Uploading of course materials, including homework, handouts, homework and test solutions, etc. to the web is prohibited.

To reiterate: use of homework or test solutions from previous semesters or the web is not allowed. Getting homework help from the instructors and fellow students in the class is okay; looking up things on the Google, Baidu, and the Wikipedia is okay; getting help from websites offering homework help and problem solutions is NOT okay.

If you have any questions about referencing material, or the boundaries of acceptable collaboration, please talk to me.

Phones and Laptops

Out of respect for your fellow students, please mute and put away your phones, and close your laptops when class begins.

Web surfing, emailing, text messaging, and the like during lecture is distracting to other students and the instructor, and is likely to result in your missing some important information. Don't do it. If caught playing games on phones, we'll deduct points.

Although restroom breaks are allowed during exams, you are not allowed to take any phone(s) or laptop(s) with you.

Other Useful Information

Although there are no formal prerequisites for this class, you are expected to know how, or learn how, to do the following:

- Use an internet browser to find things on the web.
- Use MATLAB to evaluate numerical results, make graphs, and do multistep calculations.
- Open, read, and print Acrobat pdf files.
- Be proficient in basic pre-calculus mathematics, including plane geometry, trigonometry, and algebra.

For most of you, this will be your first introduction to calculus with analytic geometry where, I ask you to take a more active role in learning. You are not going to have an instructor showing you how to make mathematical calculations all your life. At times, you might not even be able to find a textbook showing you how to solve your problems.

By virtue of your being admitted to SCUPI, we know that you are smart, capable, and hardworking. You may find this course challenging and demanding and might even wonder if you've made a mistake coming here. Fear not! You will do okay if keep a few things in mind:

- This and other classes at SCUPI are being taught using a Western-style approach. This involves a lot of questioning and interaction with the instructor, probably much more than you are used to.
- It's okay to be frustrated. You will be learning a lot of new things, at a fast pace, in a language you're still getting comfortable with. The best way to learn is to ask lots of questions. If you don't understand something in class, ASK! Remember that if you're unsure about something, there is a good chance that many of the people sitting around you are also unsure.
- Develop a good studying habit. Don't fall behind on your course material.
- When working with equations, use variables to denote the quantities and parameters specific to the problem. Delay substituting numerical values if possible; this will make it easier to check your work and find errors.

An important skill to acquire is the art of baloney detection (also known as BS detection). Statements are called baloney (or BS) when they are unsupported by facts and are often used to deceive unwary people. For example, a salesperson might make unjustified claims regarding the performance of a system or product to make a sale; as a mathematics student, you need to learn how to be skeptical about unsupported claims. To acquire this skill, you need to always be questioning: how do you know a calculation is correct? Do you understand why it is true? Are there counterexamples that show it is not true?

When you get your graded homework back, you should go over any problems you did not do well on. Homework solutions will not be distributed, but you may contact your teaching assistant if you need help in understanding where you went wrong.

You should be having fun and learning mathematics because figuring out something in mathematics is fun.

Course Goals

Students will develop a good understanding of solving differential equations. Students will acquire basic skills needed to apply techniques to solve a wide range of differential equations. Students will develop a basic understanding of Laplace and Fourier transforms and their applications to solve differential equations. Evaluation of students will be determined by in-Class presentation, quizzes, homework and test.

Learning Outcomes for This Course

- Students will develop a basic understanding of linear first order and second-order differential equations.
- Students will learn various techniques of solving differential equations.
- Students will develop a basic understanding of Laplace and Fourier transforms and their applications to solve differential equations.

Approximate Schedule

Tentative sequence of the sections covered in this class is:

Week	Contents	Descriptions
1 (2/24)	2.1 – 2.2	Differential Equations & Solutions, Solutions to Separable Equations
2 (3/2)	2.3 – 2.4	Models of Motion, Linear Equations
3 (3/9)	2.6 – 2.7	Exact Differential Equations, Existence & Uniqueness
4 (3/16)	4.1 – 4.2	Definition and Examples, Second-order Equations and Systems
5 (3/23)	4.3, 3.4, 4.4	Linear; Homogeneous Equations with Constant Coefficients, Electrical Circuits, Harmonic Motion, Inhomogeneous Equations
6 (3/30)	4.5 – 4.6	Inhomogeneous Equations: Method of Undetermined Coefficients, Variation of Parameters
7 (4/6)		Exam 1
8 (4/13)	5.1 – 5.2	The Definition of the Laplace Transform, Basic properties of the Laplace Transform
9 (4/20)	5.3 – 5.4	Inverse Laplace Transform, Using Laplace Transform to solve Equations
10 (4/27)	5.5 – 5.7	Discontinuous Forcing Terms, The Delta Function, Convolution
11 (5/4)	8.4 – 8.5	Linear Systems, Properties of Linear Systems
12 (5/11)	9.6, 9.9	The Exponential of a Matrix, Inhomogeneous Linear Systems
13 (5/18)		Exam 2
14 (5/25)	11.1 – 11.2	Power Series, Series Solutions Near Ordinary Points
15 (6/1)	11.3, 12.1	Legendre's Equation, Fourier Series
16 (6/8)	12.2 – 12.3	Convergence of Fourier Series, Fourier Cosine and Sine Series