USC University of Southern California

Center for the Instruction
in Mathematics to Engineering Students

MATH245

Mathematics of Physics & Engineering I
Units: 4
Spring 2024
MWF: @ 10:00 - 10:50 am in ZHS 163 (#39605D)
MWF: @ 11:00 - 11:50 am in WPH B28 (#39609D)

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I will respond to emails within 48 hours.

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Disclaimer: This syllabus is subject to change based on the needs of the class. Verbal or written changes announced in class, are considered as an addendum to this syllabus. Students will be held responsible for all changes.

Course Description

This course introduces mathematical models that govern the laws of universe. These laws are formulated in terms of differential equations. Differential equations involve functions and their derivatives which are often with respect to time. Engineers and scientists should understand, construct, solve and interpret differential equations using contemporary analytical and numerical methods.

Learning Objectives and Outcomes

- Understand the concept of differential equations and their classification
- Develop, select and apply solutions for 1st order, 2nd order and higher order homogeneous and non-homogeneous equations by manual and numerical-based methods
- Apply Laplace transforms to solve ordinary linear differential equations (ODEs)
- Find solutions to systems of differential equations using eigenvalues, matrix of exponents and diagonalization
- Solving and approximating non-linear ODEs using analytical and numerical methods
- Demonstrate proficiency in using MATLAB to solve, analyze and interpret ordinary differential equations.

Pre-requisite

Calculus III Math 226 or 227 or 229

Textbook

Polking, J., Boggess, A., Arnold, D. (2017) *Differential Equations* Classic Version 2^{nd} ed. Pearson Education, ISBN: 9780134689586

Free-licensed textbooks

- Jiří Lebl, Notes on Diffy Qs: Differential Equations for Engineers (2020) UBC-database
- Trench, William F., "Elementary Differential Equations with Boundary Value Problems" (2013). Faculty Authored and Edited Books & CDs. 9. https://digitalcommons.trinity.edu/mono/9

Resources

Gradescope Homework, quizzes and exams are submitted and graded via Gradescope.

Campuswire We use Campuswire platform to post announcements, Q&A and discussions Copies of lecture notes, and other class information will be posted on Campuswire.

Blackboard Final Grades are posted on Blackboard

Technological Proficiency and Hardware/Software Required

This course requires use of MATLAB. An introduction regarding installation, activation and basic operations will be provided during the first two weeks of class. Alternative open-source : Julia

Communication

I want you to feel comfortable asking questions and giving me feedback on the course. If you have questions or comments, please speak to me directly after class or during my posted office hours. You can also email me (sheikhha@usc.edu). I will respond to all emails within 48 hours.

Description and Assessment of Assignments

Homework

At least 12 problem sets will be assigned. Problems will be submitted to Gradescope.

Late Work Policy

No late homework will be accepted. Two of the lowest grades in homework assignments will be discarded.

Quizzes

Weekly quizzes conducted in the discussion and/or lecture, with problems extracted from assigned homework or similar problems. There will be a quiz each week with exception of the first week and the midterm weeks. NO "make-up" of any of the quizzes will be offered. Two of the lowest quiz grades will be discarded before a final course grade is calculated.

Simulations

Numerical simulations are assigned weekly. Simulations are performed with Matlab. Instructions will be provided during the discussion sessions. There will be about 7-8 simulation assignments and 2-3 projects. Assignments are due within a week and projects are to be completed within two weeks. No late work will be accepted.

Examinations

Two midterm examinations are scheduled for the regular lecture periods. The format will be similar to the assigned homework assignments; successful completion of the homework will be a good indicator of your success on the exams.

a. Midterm examinations:

i. Midterm 1: W, Feb 14, class time

ii. Midterm 2: F, Mar 29, class time

b. Final Examination :

Monday, May 6th, 8 a.m-10 a.m (39605D)

Wednesday, May 1st 11 a.m.-1 p.m. (39609D)

The final examination will be comprehensive, covering all topics presented in the course. Extra emphasis will be placed on the material covered after the second midterm.

A respectable performance on quizzes and exams can be realized by all students if attention and energy are given to the timely completion of assigned homework problems.

Dates

Midterm dates are tentative and may change depending on how the class progresses. Any change will be announced two weeks before. The final examination date and time are set by the office of registration and cannot be changed.

Grading Breakdown

Assignments	Points	%
Homework	100	5
Simulations	100	10
Quiz	100	20
Max(MT#1,#2)	100	22
Min(MT#1,#2)	100	18
Final	100	25
Total	500	100

If there is any extra-credit assignment or project it will be applied to the final exam.

Grading Scale

Course final grades will be determined using the following scale.

Grade	Total
A	93-100
A-	90-92.99
B+	88-89.99
B	83-87.99
B-	80-82.99
C+	78-79.99
C	73-77.99
C-	70-71.99
D+	68-69.99
D	63-67.99
D-	60-62.99
F	59.99 and below

The overall score will not be rounded and the letter grade will be assigned within three days of grading the final. The grade letters are based on a class average performance of B. If the mean falls below the grade cutoffs of B, the grades will be curved.

Grading Dispute

Grading disputes are to be resolved within two days after returning the exam. To receive a fair score all of the problems in disputed exam will be re-graded and the score might increase or decrease. Moreover, no extra-credit or curve will be applied toward the disputed exam.

Additional Course Policies

Class attendance is strongly encouraged. The approach to specific subjects in the lecture might be different from the text. Students will be responsible for the methods outlined in the class.

Cellphones, laptops, tablets (except for note-taking purposes) and anything else electronic are to be turned off during class.

Final grade will depend entirely on the performance on the above components and be independent of the financial support requirements (e.g., minimum grade requirement for tuition reimbursement).

Work-related travel must be scheduled outside of the mid-term and final examinations periods. Accommodation to take exams on different dates will be made only for family emergencies, religious observance and documented illness or health-related emergencies.

DSP approved students should inform the instructor at the beginning of the semester for any requested accommodation.

Course evaluation

Two surveys will gather student opinions about the course: the mid-semester evaluation and the standard USC course evaluation survey at the end of the semester. Your opinion is valued and can make a difference in how this course is conducted; please give your honest and constructive recommendations.

Table 1: Tentative Schedule : a weekly breakdown

Lec*	Date	Principal Topics	Readings	Problem Set
1		Intro, Classification, Separable 1st order, dir-field	1.1,2.1	
2		Linear 1st order, constant coefficient ODE	2.2	
3		Linear 1st order, variable coefficient ODE: Integral factor	2.4-5 and 2.7-9	
4		Bernoulli's equations. Stability/Instability		
5		2nd Order: Characteristic and Fundamental solutions	4.1	
6		2nd Order homogeneous ODE: Real roots, Abel's theorem	4.3	HW1
7		Characteristic repeated roots	4.3	
8		Characteristic complex roots	4.3	
9		Application: vibration	4.4	HW2
10		Amplitude-phase form, Free damped motion	4.4	
11		2nd Order non-homogeneous: Undetermined coefficients	4.5	HW3
12		2nd Order non-homogeneous: Undetermined coefficients	4.5	
13		Variation of Parameters	4.6	
14		Forced motion, Electrical circuits. Resonance	4.5-7	
15		Higher order ODE		HW4
	W Feb 14	Midterm #1		
16		Intro to Laplace transforms	5.1	
17		Properties of Laplace	5.2	HW5
18		Properties of Laplace	5.2	
19		Inverse Laplace	5.3	
20		ODEs with Laplace	5.4	HW6
21		ODE with unit step	5.5	
22		Laplace of Periodic functions	5.5	HW7
23		Delta Dirac function	5.6	
24		Impulse response	5.6	
25		Convolution	5.7	HW8
26		Linear systems and feed-back control		
27		Review of Laplace		
28		Intro to system of ODE	8.1,8.4	
29		Review of matrices, vectors and linear systems	7	
	Fi Mar 29	Midterm #2		HW9
30		Eigenvalues and eigenvectors	9.1	
31		Eigenvalues and eigenvectors	9.1	
32		System of ODEs	9.1-2	HW10
33		System of ODEs: complex eigenvalues	9.2	
34		System of ODEs: repeated eigenvalues	9.2-3	
35		Non-homogeneous system of ODE,	9.6,	HW11
36		Non-homogeneous system of ODE	9.6	
37		Exponential of a matrix	9.9	
38		Intro to non-linear system of ODEs	10.1	
39		Analysis of fixed points of non-linear systems	10.6	
40		Exact Equations	2.6	
41		Exact Equations	2.6	HW12
		Final	Comprehensive	

A review session will be offered for each examination. Dates and time will be announced accordingly.

Table 2: Academic sanctions

Violation	USC – Recommended sanction	Recommended sanction
Copying answers from other students ** on any course work	F for course	First offense: F on assignment Second offense: F for course
One person allowing another to cheat from his/her exam or assignment	F for course for both persons	If assignment: First offense: F on assignment Second offense: F for course If exam: F for course
Possessing or using material during exam (crib sheets, notes, books, etc.) which is not expressly permitted by the instructor.	F for course.	First offense: F on exam. Second offense: F for course.
Continuing to write after exam has ended.	F for course.	F on exam
Taking exam from room and later claiming that the instructor lost it.	F for course and recommendation . for further disciplinary action (possible suspension)	F for course
Changing answers after exam has been returned.	F for course and recommendation for further. disciplinary action (possible suspension)	F for course
Fraudulent possession of exam prior to administration.	F for course and recommendation for suspension.	F for course
Obtaining a copy of an exam . or answer key prior to administration	Suspension or expulsion from the university for both students F for course.	F for course
Having someone else complete course work for oneself.	Suspension or expulsion from the university for both students; F for course.	F for course
Plagiarism — Submitting other's work as one's own or giving an improper citation.	F for course.	First offense: F on assignment. Second offense: F for course.
Submission of purchased term papers or papers done by others	F for course and recommendation for further disciplinary action (possible suspension).	F for course
Submission of the same assignment , to more than one instructor where no previous approval has been given	F for both courses.	F for both courses
Unauthorized collaboration on an assignment.	F for the course for both students.	First offense: F on assignment. Second offense: F for course
Falsification of information in admission applications (including supporting documentation).	Revocation of university admission without opportunity to reapply	Revocation of university admission . without opportunity to reapply without opportunity to reapply
Documentary falsification (e.g., petitions and supporting materials; medical documentation.)	Suspension or expulsion from the university; F for course when related to a specific course.	Suspension or expulsion from the university; F for course when related to a specific course.
Plagiarism in a graduate . thesis or dissertation	Expulsion from the university when discovered prior to graduation; revocation of degree when discovered subsequent to graduation.***	Expulsion from the university when discovered prior to graduation; revocation of degree when discovered subsequent to graduation.***

*Assuming first offense

**Exam, quiz, tests, assignments or other course work.

***Applies to graduate students

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" policy. http://usc.edu/scampus-part-b

Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

Support Systems

Student Health Counseling Services - (213) 740-7711 – 24/7 on call

http://engemannshc.usc.edu/counseling

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call

http://suicidepreventionlifeline.org

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 – 24/7 on call

http://engemannshc.usc.edu/rsvp

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) — Title IX - (213) 740-5086

http://equity.usc.edu,

http://titleix.usc.edu

Information about how to get help or help a survivor of harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following protected characteristics: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations.

Bias Assessment Response and Support - (213) 740-2421

http://studentaffairs.usc.edu/bias-assessment-response-support Avenue to report incidents of bias, hate crimes, and microaggressions for appropriate investigation and response.

The Office of Disability Services and Programs - (213) 740-0776

http://dsp.usc.edu

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Support and Advocacy - (213) 821-4710

http://studentaffairs.usc.edu/ssa

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101

http://diversity.usc.edu

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

http://dps.usc.edu

http://emergency.usc.edu

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call

http://dps.usc.edu