



**MATH245: Mathematics of Physics & Engineering I**

**Units: 4**

**Spring 2019**

MWF: @ 9:00 - 9:50 am in THH 116 (class # 39601)

MWF: @ 11:00 -11:50 am in VKC 102 (class # 39609)

**Instructor:** Ramtin Sheikhhassani

**Office:** VHE418

**Office Hours:** TBD

**Contact Info:** [sheikhha@usc.edu](mailto:sheikhha@usc.edu) – Include MATH245 in subject

**TA:** TBD

**Grader:** TBD

## 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 1<sup>st</sup> order, 2<sup>nd</sup> order and higher order homogenous and non-homogenous 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.

**Prerequisite:** Calculus III Math 226 or 227

## Required Readings

*Differential Equations: An Introduction to Modern Methods and Applications.* 3rd Edition  
James R. Brannan, William E. Boyce, ISBN: 978-1-118-53177-8, Jul 2015 Wiley

## Description and Assessment of Assignments

- 1- HomeWorks: at least 10 HWs will be assigned. Problems will be posted on blackboard.
- 2- Quizzes: weekly quizzes conducted in the discussion sessions, with problems extracted from assigned homework or similar problems. and NO “make-up” of any of the quizzes will be offered.
- 3- Exams:
  - a. Midterm exams:
    - i. **Midterm 1:** Monday, February 11, class time
    - ii. **Midterm 2:** Monday, Apr 1, class time

**b. Final Exam:**

the final exam is comprehensive and will be held at the time specified in the University Schedule of Classes:

Friday, May 3, 8-10 a.m. for class # 39601  
Wednesday, May 1, 11-1 p.m. for class # 39609

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.

## Grading Breakdown

Assignment	% of Grade
HWs	5
Simulations	10
Quizzes	20
Midterm#1	20
Midterm#2	20
Final	25
<b>TOTAL</b>	<b>100</b>

## Grading Scale

Course final grades will be determined using the following scale

A	90-100
A-	80-89
B+	70-79
B	60-69
B-	55-59
C+	50-54
C	45-49

**Assignment Submission Policy**

No late homework will be accepted. One of the lowest grades in homeworks will be dropped.

**Additional Policies**

Some topics in class will be handled differently from the book. You will be responsible for the way things are done in class. Class attendance is strongly encouraged.

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).

Please schedule your work-related travel during time periods outside of the mid-term and final exams. Accommodation to take exams on different dates will be made only for family emergencies, religious observance and documented illness or health-related emergencies.

**Course Schedule:** A Tentative Weekly Breakdown subjected to adjustments

Lec	Date	Principle Topics	Reading	HomeWorks
1	Mon Jan 7	Intro, Classification, Separable 1 <sup>st</sup> order, dir-field	1.1-3	
2	Wed Jan 9	Linear 1 <sup>st</sup> order, constant coefficient ODE	2.2	
3	Fri Jan 11	Linear 1 <sup>st</sup> order, variable coefficient ODE: Integral factor	2.4	
4	Mon Jan 14	Bernoulli's equations. Stability/Instability		
5	Wed Jan 16	2 <sup>nd</sup> Order: Characteristic and Fundamental solutions	4.1-2	
6	Fri Jan 18	2 <sup>nd</sup> Order homogenous ODE: Real roots, Abel's theorem	4.2	
8	Wed Jan 22	Characteristic repeated roots	4.3	
9	Fri Jan 24	Characteristic complex roots	4.3	
10	Mon Jan 28	application: vibration	4.4	
11	Wed Jan 30	Amplitude-phase form, Free damped motion	4.4	
12	Fri Feb 1	2 <sup>nd</sup> Order nonhomogeneous: Undetermined coefficients	4.5	
13	Mon Feb 4	2 <sup>nd</sup> Order nonhomogeneous: Undetermined coefficients	4.5	
14	Wed Feb 6	Applications: Electrical circuits. Resonance	4.6	
15	Fri Feb 8	Higher order ODE		
	Mon Feb 11	<b>Midterm #1</b>		
16	Wed Feb 13	Variation of Parameters	4.7	
17	Fri Feb 15	Intro to Laplace transforms	5.1	
18	Wed Feb 20	Properties of Laplace	5.2	
19	Fri Feb 22	Properties of Laplace	5.2	
20	Mon Feb 25	Inverse Laplace	5.3	
21	Wed Feb 27	ODEs with Laplace	5.4	
22	Fri Mar 1	Unit step function	5.5	
23	Mon Mar 4	ODE with unit step	5.6	
24	Wed Mar 6	Laplace of Periodic functions	5.5	
25	Fri Mar 8	Delta Dirac function	5.7	
26	Mon Mar 18	Impulse response	5.7	
27	Wed Mar 20	Convolution	5.8	
28	Fri Mar 22	Convolution	5.8	
29	Mon Mar 25	Linear systems and feed-back control	5.9	
30	Wed Mar 27	Review of Laplace		
31	Fri Mar 29	Intro to system of ODE		
	Mon Apr 1	<b>Midterm #2</b>		
32	Wed Apr 3	Review of matrices, vectors and linear systems	3.1 and App A	
33	Fri Apr 5	Eigenvalues and eigenvectors		
34	Mon Apr 1	System of ODEs	3.2	
35	Wed Apr 3	System of ODEs	3.3	
36	Fri Apr 5	System of ODEs: complex eigen values	3.4	
37	Mon Apr 8	System of ODEs: repeated eigen values	3.5	
38	Wed Apr 10	Non-homogenous system of ODE	3.6	
39	Fri Apr 12	Non-homogenous system of ODE	6.5	
40	Mon Apr 15	Exponential of a matrix	6.6	
41	Wed Apr 17	Intro to non-linear system of ODEs	7.1	
42	Fri Apr 19	Analysis of fixed points of non-linear systems	7.2	
43	Mon Apr 22	Exact Equations	2.1	
44	Wed Apr 24	Exact equations	2.6	
45	Fri Apr 26	Review		

**Discussion MATLAB schedule:**

- Introduction to MATLAB and Plotting
- Introduction to Runge-Kutta Method
- Use ODE45 to solve 1<sup>st</sup> order ODEs
- Plotting direction fields
- Apply ODE45 for parametric ODEs
- ODE45 and 2<sup>nd</sup> order ODEs
- Phase plots
- Nonlinear ODEs
- Higher Order ODEs and ODE45
- Laplace transforms and Inverses with MATLAB
- Transfer function and stability
- Eigenvalues, Eigenvectors and system of ODEs
- Predator and Prey

## 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.usc.edu/scampus-part-b](http://policy.usc.edu/scampus-part-b). Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, [policy.usc.edu/scientific-misconduct](http://policy.usc.edu/scientific-misconduct).

### Support Systems:

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

[engemannshc.usc.edu/counseling](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*

[suicidepreventionlifeline.org](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*

[engemannshc.usc.edu/rsvp](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*

[equity.usc.edu](http://equity.usc.edu), [titleix.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*

[studentaffairs.usc.edu/bias-assessment-response-support](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*

[dsp.usc.edu](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*

[studentaffairs.usc.edu/ssa](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*

[diversity.usc.edu](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*

[dps.usc.edu](http://dps.usc.edu), [emergency.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*

[dps.usc.edu](http://dps.usc.edu)

Non-emergency assistance or information.