MATH 242 Spring 2018

Sections 005 and 010

Section		Schedule	Location
005	**TTh**	11:40 AM - 12:55 PM	LeConte 405
010	**TTh**	2:50 PM - 4:05 PM	LeConte 112

Instructor: Francisco Blanco-Silva
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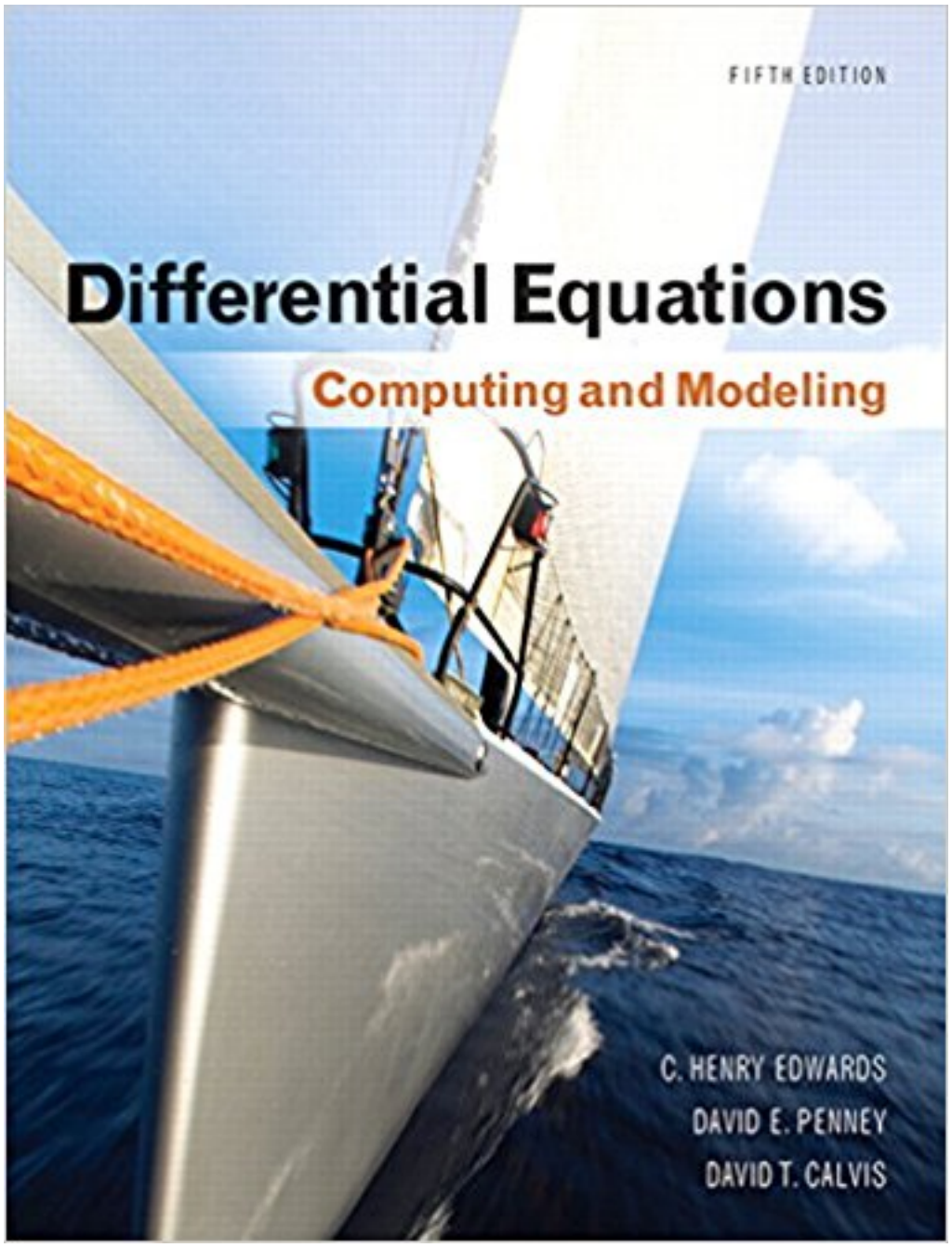
Office: LeConte 314D
Office Hours: MWF 2:00 PM - 4:00 PM



Textbook

Differential Equations:
Computing and Modeling (5th Edition)
(Edwards/Penney/Calvis Differential Equations)

Important deadlines you need to know

General Dates	
Classes begins	January 16, 2018
Last day of classes	April 30, 2018
Academic Deadlines	
Last Day to Change/Drop	January 22, 2018
First Day 'W' Grade Assigned	January 23, 2018

Last Day 'W' Grade Assigned	March 9, 2018
First Day 'W/F' Grade Assigned	March 10, 2018

Prerequisites

A grade of **C** or better in MATH 142

Course Structure and Grading Policies

Your final grade will be computed as follows:

```
F = 0.25 * (T1 + T2 + T3 + T4)
```

In-class tests:
There will be four in-class tests scheduled as follows:

Test #	Date
1	Tue Feb 20
2	Thu Mar 08
3	Thu Mar 29
4	Thu Apr 12

Final Exam:
If you have taken at least three of the in-class exams, and are unhappy with your potential final score (as computed with the formula above), notify me **by email on Thursday, April 26, before 6:00 PM.** You will have an opportunity to change your course grade by taking a (comprehensive) final exam. **The score of the final will substitute your previous grade**.

- **Section 005:** Thursday, May 3, 2018. 12:30 PM
- **Section 010:** Tuesday, May 8, 2018. 12:30 PM

No make-up tests will be given. Only the following reasons are valid excuses for missing class or assignments, and must be verified by letter from a doctor, guardian or supervisor.

- Participation in an authorized University activity (such as musical performances, academic competitions, or varsity athletic events in which the student plays a formal role in a University sanctioned event)
- Required participation in military duties
- Mandatory admission interviews for professional or graduate school which cannot be rescheduled

- Participation in legal proceedings or administrative duties that require a student's presence
- Death or major illness in a student's immediate family
- Illness of a dependent family member
- Religious holy day if listed on www.interfaithcalendar.org
- Illness that is too severe or contagious for the student to attend class
- Weather-related emergencies

Students should notify faculty members at least two weeks prior to the absence when possible. In all cases, students must contact the faculty member to request an accommodation upon return to class.

The course grade will be determined as follows:

GRADE	RANGE
A	90%-100%
B+	85%-89%
B	80%-84%
C+	75%-79%
C	70%-74%
D+	65%-69%
D	60%-64%
F	below 60%

Further Information

Honor Code: The Honor Code applies to all work for this course. Please review the Honor Code at [this link]. Students found violating the Honor Code will be subject to discipline.

Class notes and other additional material will be stored in Dropbox. In that case, you may need an account to retrieve it. If you do not have one already, sign-in through [this link] with your academic e-mail address to receive a base 4GB storage, plus an extra 500MB, free of charge.

Remember to change your e-mail address on Blackboard if necessary [blackboard.sc.edu]

Student Disability Resource Center: If you have special needs as addressed by the *Americans with Disabilities Act* and need any assistance, please notify the instructor immediately.

Student Success Center:

In partnership with University of South Carolina faculty, the Student Success Center (SSC) offers a number of programs to assist you in better understanding your course material and to aid you on your path to success. SSC programs are facilitated by trained undergraduate peer leaders who have previously excelled in their courses. Resources available to students in this course include:

- **Peer Tutoring:** You can make a one-on-one appointment with a peer tutor by going to www.sc.edu/success. Drop-in Tutoring and Online Tutoring may also be available for this course. Visit the previous website for a full schedule of times, locations, and courses.
- **Success Connect:** I may communicate with the SSC regarding your progress in the course. If contacted by the SSC, please schedule an appointment to discuss campus resources that are available to you. Success Connect referrals are not punitive and any information shared by me is confidential and subject to FERPA regulations.

SSC services are offered to all USC undergraduates at no additional cost. You are invited to call the Student Success Hotline at (803) 777-1000 or visit www.sc.edu/success to check schedules and make appointments. Success Consultants are available to assist you in navigating the University and connecting to available resources.

Learning Outcomes

Many of the principles or laws underlying the behavior of the natural World are statements or relations involving rates at which things happen. When expressed in mathematical terms, the relations are equations and the rates are derivatives. Equations containing derivatives are called differential equations. Therefore, to understand and to investigate different problems it is necessary to be able to solve or study differential equations.

Some examples of situations where this happens involve the motion of particles, the flow of current in electric circuits, the dissipation of heat in solid objects, the propagation and detection of seismic waves, or the change of populations.

We will focus mainly in the resolution of some particular kind of differential equations. In the case where we are not able to solve them, we will learn numerical approaches to obtain approximations to the solutions.

Summarizing: A student who successfully completes Elemental Differential Equations (MATH 242) will be able to master concepts and gain skills needed to accomplish the following:

- Solve initial value problems and find general or particular solutions to ordinary differential equations of the following types:
  - Separable
  - Exact
  - Nonlinear homogeneous
  - First- and higher-order linear equations, both homogeneous and inhomogeneous, especially those with constant coefficients
- Develop skill at using solution methods such as
  - integrating factors
  - substitution
  - variation of parameters
  - undetermined coefficients
  - Laplace transform

    - approximations
- Use differential equations to solve problems related to
    - population models
        - exponential growth
        - logistic growth
        - harvesting
    - Torricelli's Law
    - acceleration/velocity
    - mixture
    - cooling
    - mechanical vibrations
    - electrical circuits.

Lesson Plan

First part: Introduction to Differential Equations

- **Tue Jan 16: 1.1, 1.2.** [Review: Integration]
  General Introduction to Differential Equations.
  Integrals as general and particular solutions.
  [p.8 #1--31,37--42, p.15 #1--10]
- **Thu Jan 18: 1.3, 2.4, 2.5.**
  Slope fields.
  Numerical Approximation: Euler's methods.
  [p.24 #1--10, p.113 #1,4,6,10]
- **Tue Jan 23: 1.4, 1.6.** [slide | slide]
  Separable equations. Singular Solutions.
  Homogeneous First-Order equations.
  [p.40 #1--28, p.69 #2,3,7--10,12--14]
- **Thu Jan 25: 1.5, 1.6.** [slides]
  Linear first-order differential equations. Bernoulli equation.
  [p.53 #1--25, and the equations below]
  1. $xy' + y = y^2 \ln x xy' + y = y^2 \ln x$
  2. $y' + y\frac{x+\frac{1}{2}}{x^2+x+1} = \frac{(1-x^2)y^2}{(x^2+x+1)^{3/2}} y' + y\frac{x+\frac{1}{2}}{x^2+x+1} = \frac{(1-x^2)y^2}{(x^2+x+1)^{3/2}}$
  3. $(1+x^2)y' = xy + x^2y^2 (1+x^2)y' = xy + x^2y^2$
  4. $x^2y' + 2x^3y = y^2(1+2x^2) x^2y' + 2x^3y = y^2(1+2x^2)$
  5. $3y' + y\frac{x^2+a^2}{x(x^2-a^2)} = \frac{1}{y^2}\frac{x(3x^2-a^2)}{x^2-a^2} 3y' + y\frac{x^2+a^2}{x(x^2-a^2)} = \frac{1}{y^2}\frac{x(3x^2-a^2)}{x^2-a^2}$
  6. $y' + \frac{y}{x+1} = -\frac{1}{2}(x+1)^3y^2y' + \frac{y}{x+1} = -\frac{1}{2}(x+1)^3y^2$
- **Tue Jan 30: 1.6.** [slides]
  General Substitution Methods.
  [p.74 #1,4--6,15--18]
- **Thu Feb 01: 1.6** [slide|slides]

Exact equations. Reducible Second-order Differential Equations.
[p.74 #31--54]

- **Thu Feb 06: 3.1, 3.2, 3.3.** [slides]
  Intro to linear differential equations of Higher Order.
  Second-Order Linear Equations.
  [p.147 #1--16]
- **Tue Feb 08: 3.5.** [slide | slide | slide]
  Homogeneous linear second-order differential equations with constant coefficients.
  Particular solutions for Second-order linear differential equations with constant coefficients:
  - Variation of parameters.
  [p.147 #33--42, p.170 #1--9,21,22,23, p.195 #1,2,3,6,10]
- **Thu Feb 13: 3.5.** [slide]
  Particular solutions for Second-order linear differential equations with constant coefficients:
  - Undetermined coefficients.
  [p.195 #21,23,26,31--35,53--55]
- **Thu Feb 15:** Review
- **Tue Feb 20:** First Test

Second Part: Laplace Transform

- **Thu Feb 22: 7.1, 7.2.** [slides]
  Improper integrals revisited. The Laplace Transform
  [p.445 #2,3,4,6,35]
  Find the Laplace transform of $f(x) = \cos \beta x f(x) = \cos \beta x$, and $f(x) = 1/\sqrt{x}$ $f(x) = 1/\sqrt{x}$ using the definition.
- **Tue Feb 27: 7.4, 7.3** [slide | slide]
  The Gamma Function.
  Linearization and Translation on the s-axis.
  Assignment
  Use the table of transforms to find the Inverse Laplace Transform of the following functions:

1. $F(s) = \frac{3}{s^4}, (s > 0) F(s) = \frac{3}{s^4}, (s > 0)$
2. $F(s) = \frac{5}{s+5}, (s > -5) F(s) = \frac{5}{s+5}, (s > -5)$
3. $F(s) = \frac{3}{s-4}, (s > 4) F(s) = \frac{3}{s-4}, (s > 4)$
4. $F(s) = \frac{3s+1}{s^2+4}, (s > 0) F(s) = \frac{3s+1}{s^2+4}, (s > 0)$
5. $F(s) = \frac{5-3s}{s^2+9}, (s > 0) F(s) = \frac{5-3s}{s^2+9}, (s > 0)$
6. $F(s) = \frac{9+s}{4-s^2}, (s > 2) F(s) = \frac{9+s}{4-s^2}, (s > 2)$

7. $F(s) = \frac{1}{s(s-3)}, (s > 3) F(s) = \frac{1}{s(s-3)}, (s > 3)$

8. $F(s) = \frac{3}{s(s+5)}, (s > 0) F(s) = \frac{3}{s(s+5)}, (s > 0)$

9. $F(s) = \frac{1}{s(s^2+4)}, (s > 0) F(s) = \frac{1}{s(s^2+4)}, (s > 0)$

10. $F(s) = \frac{2s+1}{s(s^2+9)}, (s > 0) F(s) = \frac{2s+1}{s(s^2+9)}, (s > 0)$

11. $F(s) = \frac{1}{s(s^2-9)}, (s > 3) F(s) = \frac{1}{s(s^2-9)}, (s > 3)$

12. $F(s) = \frac{1}{s(s+1)(s+2)}, (s > 0) F(s) = \frac{1}{s(s+1)(s+2)}, (s > 0)$

13. $F(s) = \frac{2(s-4)+3}{(s-4)^2+25}), (s > 4) F(s) = \frac{2(s-4)+3}{(s-4)^2+25}), (s > 4)$

14. $F(s) = \frac{5s-6}{s^2-3s}, (s > 3) F(s) = \frac{5s-6}{s^2-3s}, (s > 3)$

15. $F(s) = \frac{5s-4}{s^3-s^2-2s}, (s > 2) F(s) = \frac{5s-4}{s^3-s^2-2s}, (s > 2)$

16. $F(s) = \frac{1}{s^4-16}, (s > 2) F(s) = \frac{1}{s^4-16}, (s > 2)$

Find the Laplace Transform of the following functions:

1. $f(x) = x^4 e^{\pi x} f(x) = x^4 e^{\pi x}$

2. $f(x) = e^{-2x} \sin(3\pi x) f(x) = e^{-2x} \sin(3\pi x)$

- **Thu Mar 01: 7.2.** [slide | slide]
  Differentiation of Transforms.
  Laplace transform of derivatives.
  Transformation of Initial Value Problems.
  [p.456 #1--10, p.464 27--30, p.473 #15,16,17]
- **Tue Mar 06: 7.3** [slides]
  Integration of Transforms.
  The Convolution property
  [p.481 #1--16]

  Review
  [p.446 #11,12,14, p.464 #2,4]
  Find the Laplace transform of $f(x) = \sin 3x \cos 3x f(x) = \sin 3x \cos 3x$. **Hint:** Use the formula for the trigonometric function of the double angle.
  Find the inverse Laplace transform of $F(s) = (s^2+4)^{-2} F(s) = (s^2+4)^{-2}$. **Hint:** FF looks like the derivative of another function.
- **Thu Mar 08:** Second Test

Third Part: Applications to Mathematical Modeling

- **Tue Mar 20: 2.1, 2.2.**
  Population models

Equilibrium solutions and stability
[p.40 #33,34,37, p.82 #15,16,21,22,23,26]

- **Thu Mar 22: 1.2, 2.3.**
  Acceleration-velocity models
  [p.100 #2,4,6,9,11,17,18,20]
- **Tue Mar 27:** Review
- **Thu Mar 29:** Third Test
- **Tue Apr 03: 3.4.**
  Mechanical vibrations:
  - Free undamped motion
  - Free damped motion
  [p.181 #1--4,13]
- **Thu Apr 05: 3.6.**
  Mechanical vibrations:
  - Undamped forced oscillations
  - Damped forced oscillations
  [p.181 #15--21, p.206 #1--4]
- **Tue Apr 10:** Review
- **Thu Apr 12:** Fourth Test
- **Tue Apr 17: 3.7.**
  Electrical circuits
- **Thu Apr 19: 1.4.**
  Applications of Torricelli's Law
  [p.42 #54--64]

Reviews

- **Tue Apr 24:** Review (1|2)
- **Tue Apr 26:** Review (2|2)