MATH 242 Fall 2018. Section 001

Meeting Times

Section		Schedule	Location
001	**MWF**	09:40 AM - 10:30 AM	LeConte 112

Instructor information

Instructor: Francisco Blanco-Silva
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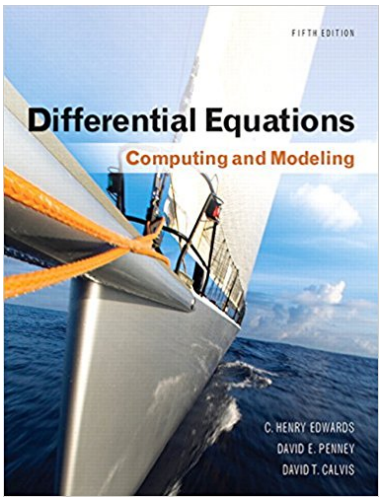
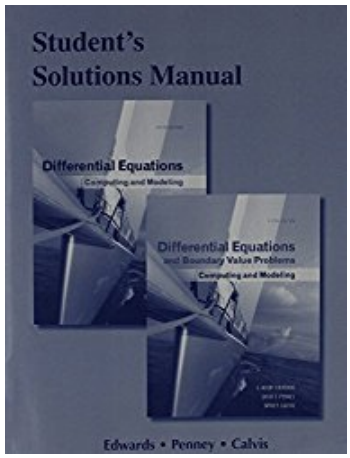
phone: `777-0283`
Office: LeConte 314D
Office Hours: MW 2:20 — 3:10 PM, TTh 1:15 — 2:30 PM

Textbook



Textbook

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



Solutions Manual

Student Solutions Manual for Differential Equations: Computing and Modeling and Differential Equations and Boundary Value Problems: Computing and Modeling 5th edition by Edwards, C. Henry,

Penney, David E., Calvis, David (2014) Paperback

Important deadlines you need to know

General Dates	
Classes begin	Aug 23, 2018
Labor Day Holiday	Sep 3, 2018
Fall Break	Oct 18—19, 2018
General Election Day	Nov 6, 2018
Thanksgiving Recess	Nov 21—25, 2018
Last Day of Classes	Dec 7, 2018
Academic Deadlines	
Last Day to Change/Drop without **W**	Aug 29, 2018
First Day **W** Grade Assigned	Aug 30, 2018
Last Day to Drop/Withdraw without **WF**	Oct 15, 2018
First Day **WF** Grade Assigned	Oct 16, 2018

Students withdrawing from courses after the WF deadline (including past semesters) must process a petition through the withdrawal website [www.sc.edu/withdrawal]

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

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 Monday, November 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**.
The final exam is scheduled on **Friday, December 14, at 9:00 AM**.

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+	86%-89%
B	80%-85%
C+	76%-79%
C	70%-75%
D+	66%-69%
D	60%-65%

GRADE	RANGE
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. Classical Methods

- **Fri Aug 24:** 1.1. General Introduction to Differential Equations
  [p.8 #1--26]
- **Mon Aug 27:** [Review: Integration] 1.1 & 1.2. Integrals as general and particular solutions.
  [p.9 #27--36; p.17 #1--10]
- **Wed Aug 29:** 1.3 & 2.4. Slope fields and numerical approximation. Euler's method
  [p.27 #1--10; p.121 #1,4,6,10]
- **Fri Aug 31:** 1.5. Improved Euler's Method
  [p.132 #1--10,27,28]
- **Wed Sep 05:** [slides] 1.4. Separable equations. Singular Solutions.
  [p.43 #1--28]
- **Fri Sep 07:** [slides] 1.6. Homogeneous equations.
  [p.74 #2,3,7--10,12--14]

- **Mon Sep 10:** [slides] 1.5 & 1.6. Linear first-order differential equations. Bernoulli equation
  [p.56 #1--21 and the equations below]
  1. $xy' + y = y^2 \ln x$
  2. $y' + y\dfrac{x+\frac{1}{2}}{x^2+x+1} = \dfrac{(1-x^2)y^2}{(x^2+x+1)^{3/2}}$
  3. $(1+x^2)y' = xy + x^2y^2$
  4. $x^2y' + 2x^3y = y^2(1+2x^2)$
  5. $3y' + y\dfrac{x^2+a^2}{x(x^2-a^2)} = \dfrac{1}{y^2}\dfrac{x(3x^2-a^2)}{x^2-a^2}$
  6. $y' + \dfrac{y}{x+1} = -\frac{1}{2}(x+1)^3y^2$
- **Wed Sep 12:** [slides] 1.6. General substitution methods.
  [p.74 #1,4--6,15--18]
- **Fri Sep 14:** [slides] 1.6. Exact equations
  [p.74 #31--42]
- **Mon Sep 17:** [slides] 1.6. Reducible Second-order Differential Equations
  [p.74 #43--54]
- **Wed Sep 19:** [slides] 3.1. Intro to second-order linear differential equations
  [p.158 #1--16]
- **Fri Sep 21:** [slides] Homogeneous linear second-order differential equations with constant coefficients
  [p.158 #33--42]
- **Mon Sep 24:** [slides] 3.5. Particular solutions for Second-order linear differential equations with constant coefficients: the method of variation of parameters.
  [p.210 #1--56] Use exclusively the method of variation of parameters
- **Wed Sep 26:** [slides] 3.5. Particular solutions for Second-order linear differential equations with constant coefficients: the method of undetermined coefficients (Part I: the easy examples)
  [No HW today]
- **Fri Sep 28:** [slides] 3.5. Particular solutions for Second-order linear differential equations with constant coefficients: the method of undetermined coefficients (Part II: the hard examples). General solutions to Second-order linear differential equations with constant coefficients
  [At this point, you should be able to do problems #1--56 in p.210 using both methods]
- **Mon Oct 01:** First Test. Classical Methods

Second Part: Methods based on the Laplace Transform

- **Wed Oct 03:** [slides] 7.1. Laplace transform: Improper integrals revisited.
  [p.450 #11--32]
  Find the Laplace transform of $f(x) = \cos \beta x$, and $f(x) = 1/\sqrt{x}$ using the definition.
- **Fri Oct 05:** [slides] 7.2. Laplace transform: The Gamma

function.
[p.462 #1--16]

- **Mon Oct 08:** [slides] 7.4. Laplace transform: Linearization, Differentiation of Transforms and Translation on the s-axis.
  [p.462 #17--22; p.472 #1--22, 27--38]
  Use the table of transforms to find the Inverse Laplace Transform of the following functions:
  1. $F(s) = \frac{3}{s^4}, (s > 0)$
  2. $F(s) = \frac{5}{s+5}, (s > -5)$
  3. $F(s) = \frac{3}{s-4}, (s > 4)$
  4. $F(s) = \frac{3s+1}{s^2+4}, (s > 0)$
  5. $F(s) = \frac{5-3s}{s^2+9}, (s > 0)$
  6. $F(s) = \frac{9+s}{4-s^2}, (s > 2)$
  7. $F(s) = \frac{1}{s(s-3)}, (s > 3)$
  8. $F(s) = \frac{3}{s(s+5)}, (s > 0)$
  9. $F(s) = \frac{1}{s(s^2+4)}, (s > 0)$
  10. $F(s) = \frac{2s+1}{s(s^2+9)}, (s > 0)$
  11. $F(s) = \frac{1}{s(s^2-9)}, (s > 3)$
  12. $F(s) = \frac{1}{s(s+1)(s+2)}, (s > 0)$
  13. $F(s) = \frac{2(s-4)+3}{(s-4)^2+25}), (s > 4)$
  14. $F(s) = \frac{5s-6}{s^2-3s}, (s > 3)$
  15. $F(s) = \frac{5s-4}{s^3-s^2-2s}, (s > 2)$
  16. $F(s) = \frac{1}{s^4-16}, (s > 2)$

  Find the Laplace Transform of the following functions:
  1. $f(x) = x^4 e^{\pi x}$
  2. $f(x) = e^{-2x}\sin(3\pi x)$
- **Wed Oct 10:** [slides] 7.3. Laplace transform: Integration of Transforms. The Convolution property
  [p.481 #1--16]
  Find the Laplace transform of $f(x) = \sin 3x \cos 3x$. **Hint:** Use the formula for the trigonometric function of the double angle.
  Find the inverse Laplace transform of $F(s) = (s^2+4)^{-2}$. **Hint:** F looks like the derivative of another function.
- **Fri Oct 12:** [slides] 7.2. Laplace transform: Laplace transform of derivatives. Transformation of Initial Value Problems

- **Mon Oct 15:** Review
- **Wed Oct 17:** Second Test. Methods based on Laplace Transform

Third Part: Applications to Mathematical Modeling

- **Mon Oct 22:** Geometric Applications
  [Notes and Homework]
- **Wed Oct 24:** More Geometric Applications
- **Fri Oct 26:** 2.1. Population models
  [p.87 #9--12, 21--24]
- **Mon Oct 29:** 2.2. More population models. Equilibrium solutions and stability
  [p.98 #1--18 For all these problems, solve the equation explicitly (finding the equilibria), compute a few particular solutions around the equilibria using Maple/Mathematica, and state the stability from this information]
- **Wed Oct 31:** Review
- **Fri Nov 02:** Third Test. Geometric Applications and Population Models
- **Mon Nov 05:** 1.2 & 2.3. Acceleration-velocity models (Part I)
  [p.18 #24--29,33,37]
- **Wed Nov 07:** 2.3. Acceleration-velocity models (Part II)
  [p.108 #7--10,17--20]
- **Fri Nov 09:** 3.4. Mechanical vibrations: Free undamped motion
  [p.195 #1--4 and if you are brave, try 10,11]
- **Mon Nov 12:** 3.4. Mechanical vibrations: Free damped motion
  [p.195 #13--23]
- **Wed Nov 14:** 3.6. Mechanical vibrations: Undamped forced oscillations
  [p.222 #1--6]
- **Fri Nov 16:** 3.6. Mechanical vibrations: Damped forced oscillations. 3.7. Electrical circuits
  [at this point, you should be able to solve all problems in page 222. p.231 #1--10]
- **Mon Nov 19:** Fourth Test. Acceleration/Velocity and Mechanical Vibrations
- **Mon Nov 26:** 1.4. Applications of Torricelli's Law
  [p.44 #54--65]

Reviews

- **Wed Nov 28:** Review (1|5) Integration skills
- **Fri Nov 30:** Review (2|5) Classical Methods
- **Mon Dec 03:** Review (3|5) Methods based on Laplace Transform
- **Wed Dec 05:** Review (4|5) Geometric Applications, Population Models
- **Fri Dec 07:** Review (5|5) Acceleration/Velocity, Mechanical Vibrations