Math 2320.02E, Differential Equations

CLASS SYLLABUS: Spring 2024

INSTRUCTOR INFORMATION

Instructor: Dr. Tingxiu Wang, Professor of Mathematics
Office Location: Binnion 306   Office Hours: MWF 11:00am-12:00pm in Binnion 306
                                                                   Or by appointment
Office Phone: 903-886-5958   Office Fax: 903-886-5945
Email Address: Tingxiu.wang@tamuc.edu   Preferred Form of Communication: **email**
Communication Response Time: usually within 24 hours during weekdays, M-F.

COURSE INFORMATION

Course Materials: Elementary Differential Equations with Boundary Value Problems, previously published by Brooks/Cole Thomson Learning, 2000. Free download at http://digitalcommons.trinity.edu/mono/9/. Tentatively, we will cover Chapters 1, 2, 3.1-3.2, 4.1-4.4, 5, 6.1-6.2, 7.1-7.4, 8.1-8.5, 9, and 10.1-10.4.

Student Solutions Manual for Elementary Differential Equations with Boundary Value Problems, previously published by Brooks/Cole Thomson Learning, 2000. http://digitalcommons.trinity.edu/mono/10/

Course Description: First order differential equations, higher order differential equations, series solutions, the Laplace transformations, systems of first order linear equations, initial-value problems. Prerequisites: Math 2414.

Student Learning Outcomes: Upon successful completion of this course, students will be able to:
1. Classify differential equations into partial differential equations and ordinary differential equations, linear or nonlinear, homogeneous or nonhomogenous, first order, second order or higher order differential equations.
2. Explain a general solution and a particular solution, an initial-value problem, the Existence and Uniqueness Theorem; Wronskian Determinants and fundamental set of solutions; Explain Growth-Decay Model and Predator-and-Prey Model that use differential equations to model real world problems.
3. Use methods such as Separating Variables, Variation of parameters, Finding a Potential Function, Substitution and Euler's Method to solve 1st order differential equations for explicit solutions and approximation solutions.
4. Explain the solution structure of higher order linear differential equations and solve some higher order linear differential equations with constant coefficients, some second order linear differential equations with general coefficients, and some system of first order linear differential equations.

COURSE REQUIREMENTS

Attendance: Attendance is required. You are responsible for all announcements and materials presented in the class.

Time for this course: It is said that education is an investment. In addition to the tuition, a student invests the time for education. The time for study is essential for the success of your education or investment. How much time do you need for this class? A thumb of rules in education is that you need to spend the number of hours equal to at least three times of the credit hours per week in a regular semester, which means that a

fulltime student is to take at least 12 credit hours, spending 12x3=36 hours per week, a fulltime job. This is a three-credit hour class. So, you need to spend at least 9 hours per week. For 9 hours per week, you will spend three hours in the classroom and six hours outside the classroom. After each class, you would need two hours to review lecture notes and do homework. If one has a weaker math background or rusty on the prerequisite, or wants to learn well for a better grade, more time is necessary.

Homework: *Without practice, no one can learn. Without sufficient practice, no one can learn well*. Thus, please do homework. Homework assignments for each week are worth of 10 points. The total for homework is 120 points. Please see homework assignments in Appendix A. They will not be graded but will be checked for how many questions are completed and if necessary work is presented. This is because you can find solutions at http://digitalcommons.trinity.edu/mono/10/. Missing questions and answers without work do not earn credit. <mark>Homework for each week will be collected on each Tuesday class</mark>. Late submission for each week will have an additional deduction of 2 points. The assignment you submit must be your own work. Plagiarism is prohibited.

Tests&Final: There will be three tests and a final. Each test is worth 80 points. The final is worth 120 points. Please see Appendix for the date of each test. The final exam is at 8:00 AM – 10:00 AM, Thursday, May 9, 2024.

Grading: The maximum possible points available in this course are:

Homework	120 points
Tests	240 points
Final	120 points
Total	480 points

Your course grade will be based on the percentage of the points you make to the total points available in the course:

A >= 90%,   B >= 80%,   C >= 70%   D >= 60%   F < 60%.

TECHNOLOGY REQUIREMENTS

- D2L/LMS: All course sections offered by Texas A&M University-Commerce have a corresponding course shell in the myLeo Online Learning Management System (LMS). Course materials will be posted on D2. You cannot distribute the course materials without permission of the instructor. To access LMS, go to myLeo, then Apps, then My Leo Online D2L Brightspace. You also have an email account via myLeo - all my emails sent from D2L (and all other university emails) will go to this account, so please be sure to check it regularly.
- TI-NSPIRE or other calculators with similar capability is highly recommended.
- We use D2L to post some course materials and collect homework. You need Scanner/digital camera/cell phone for making PDF files of your work and submit them to D2L. Make one PDF file for homework of each week. Please visit the following video clips for making one PDF file:
  - Using CamScanner: https://www.youtube.com/watch?v=sZFcQJCmtMI
  - Android: https://www.youtube.com/watch?v=FWlVYd2Zc-E
  - iPhone: https://www.youtube.com/watch?v=10XH6VfGLqI

Below are technical requirements
- LMS Requirements: https://community.brightspace.com/s/article/Brightspace-Platform-Requirements
- LMS Browser Support: https://documentation.brightspace.com/EN/brightspace/requirements/all/browser_support.htm

ACCESS AND NAVIGATION

You need your campus-wide ID (CWID) and password to log into the course. If you do not know your CWID or have forgotten your password, contact the Center for IT Excellence (CITE) at 903.468.6000 or helpdesk@tamuc.edu**.**

Course materials and grades are posted through LMS. Your homework needs to turned in through LMS. The course materials are only for this course. You cannot distribute the course materials without permission of the instructor.

Note: Computer and internet connection problems do not excuse the requirement to complete all course work in a timely and satisfactory manner. Each student needs to have a backup method to deal with these inevitable problems. These methods might include the availability of a backup PC at home or work, the temporary use of a computer at a friend's home, the local library, office service companies, Starbucks, a TAMUC campus open computer lab, etc.

COMMUNICATION AND SUPPORT

Math Lab: Free tutoring service offered by the Mathematics department (Binnion Hall Room 328). Please visit the web site for the hours of operation and more details.
http://www.tamuc.edu/academics/colleges/scienceEngineeringAgriculture/departments/mathematics/students/default.aspx

The TAMUC One Stop Shop- provides as many student resources as possible in one location.
http://www.tamuc.edu/admissions/oneStopShop/

The TAMUC Academic Success Center provides academic resources to help you achieve academic success.
http://www.tamuc.edu/CampusLife/CampusServices/AcademicSuccessCenter/default.aspx

Technical Support
If you are having technical difficulty with any part of Brightspace, please contact Brightspace Technical Support at 1-877-325-7778. Other support options can be found here:
https://community.brightspace.com/support/s/contactsupport

Syllabus Change Policy
The syllabus is a guide. Circumstances and events, such as student progress, may make it necessary for the instructor to modify the syllabus during the semester. Any changes made to the syllabus will be announced in advance.

University Specific Procedures

Student Conduct
- All students enrolled at the University shall follow the tenets of common decency and acceptable behavior conducive to a positive learning environment. The Code of Student Conduct is described in detail in the Student Guidebook.
  http://www.tamuc.edu/Admissions/oneStopShop/undergraduateAdmissions/studentGuidebook.aspx
- Students should also consult the Rules of Netiquette for more information regarding how to interact with students in an online forum: https://www.britannica.com/topic/netiquette

TAMUC Attendance
- For more information about the attendance policy please visit the Attendance webpage and Procedure 13.99.99.R0.01. http://www.tamuc.edu/admissions/registrar/generalInformation/attendance.aspx

- http://www.tamuc.edu/aboutUs/policiesProceduresStandardsStatements/rulesProcedures/13students/academic/13.99.99.R0.01.pdf

Academic Integrity

Students at Texas A&M University-Commerce are expected to maintain high standards of integrity and honesty in all of their scholastic work. For more details and the definition of academic dishonesty see the following procedures:

http://www.tamuc.edu/aboutUs/policiesProceduresStandardsStatements/rulesProcedures/13students/undergraduates/13.99.99.R0.03UndergraduateAcademicDishonesty.pdf

Graduate Student Academic Dishonesty 13.99.99.R0.10

http://www.tamuc.edu/aboutUs/policiesProceduresStandardsStatements/rulesProcedures/13students/graduate/13.99.99.R0.10GraduateStudentAcademicDishonesty.pdf

Students with Disabilities-- ADA Statement

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you have a disability requiring an accommodation, please contact:

Office of Student Disability Resources and Services

Gee Library- Room 162
Phone (903) 886-5150 or (903) 886-5835
Fax (903) 468-8148
Email: studentdisabilityservices@tamuc.edu
Website: Office of Student Disability Resources and Services
http://www.tamuc.edu/campusLife/campusServices/studentDisabilityResourcesAndServices/

Counseling Service:

The Counseling Center at A&M-Commerce, located in the Halladay Building, Room 203, offers counseling services, educational programming, and connection to community resources for students. Students have 24/7 access to the Counseling Center's crisis assessment services by calling 903-886-5145. For more information regarding Counseling Center events and confidential services, please visit www.tamuc.edu/counsel.

Nondiscrimination Notice

Texas A&M University-Commerce will comply in the classroom, and in online courses, with all federal and state laws prohibiting discrimination and related retaliation on the basis of race, color, religion, sex, national origin, disability, age, genetic information or veteran status. Further, an environment free from discrimination on the basis of sexual orientation, gender identity, or gender expression will be maintained.

Campus Concealed Carry Statement

Texas Senate Bill - 11 (Government Code 411.2031, et al.) authorizes the carrying of a concealed handgun in Texas A&M University-Commerce buildings only by persons who have been issued and are in possession of a Texas License to Carry a Handgun. Qualified law enforcement officers or those who are otherwise authorized to carry a concealed handgun in the State of Texas are also permitted to do so. Pursuant to Penal Code (PC) 46.035 and A&M-Commerce Rule 34.06.02.R1, license holders may not carry a concealed handgun in restricted locations.

For a list of locations, please refer to the Carrying Concealed Handguns On Campus

document and/or consult your event organizer. Web url:

Pursuant to PC 46.035, the open carrying of handguns is prohibited on all A&M-Commerce campuses. Report violations to the University Police Department at 903-886-5868 or 9-1-1.

Appendix A: Homework Assignments

Section 1.2:   2(d, f), 3(c, d, e), 4(e, f), 6(b)
Section 1.3:   3(also sketch a solution curve passing through (1, 1), use the method of isoclines: 15, 17
Section 2.1:   do not do slope fields for these questions: 3, 7, 13, 21, 33, 37
Section 2.2:   do not do slope fields for these questions: 3, 7, 15, 23, 29, 35
Section 2.3:   4, 10, 11, 19, 20
Section 2.4:   1, 3, 7, 9, 17, 23, 31. Also solve $y'+1 = e^{-(x+y)} \sin x$

Section 2.5:   3, 7, 11, 13, 21. Also solve $\left(x^2 y^3 - \dfrac{1}{1+9x^2} \right) \dfrac{dx}{dy} + x^3 y^2 = 0$

Section 3.1:   7, 21, just do the question for h=0.1.
Section 3.2:   7, 21, just do the question for h=0.1. (Compare to the solutions you did in Section 3.1)

Test 1 covers Chapters 1, 2, and 3

Section 4.1/4.2:
1. A tank initially contains 100 gal of pure water. Brine containing 2 lb of salt per gallon enters the tank at 4 gal/min, and the (perfectly mixed) solution leaves the tank at 6 gal/min. Let A(t) be the amount of salt at time t. Find the solution for this model. How much salt and solutions in the tank at the moment of t=20 minutes?
2. Payments are made on a mortgage (original loan) of P_0 dollars continuously at the constant rate of m dollars per month. Let P(t) denote the remaining principal (amount still owned) after t months, and let r denote the annual interest rate paid by the borrower. The differential equation for this model is

$$\frac{dP}{dt} = \frac{r}{12} P - m, P(0) = P_0.$$

   Solve this equation. Determine the monthly payment if the amount of the original loan is 150,000 dollars, the annual interest rate is 3.36%, and the term is 30 years.
3. A small metal bar with an initial temperature of 30°C is dropped into a large container of boiling water. How long with it take the bar to reach 95°C if it is known that its temperature increases $2^\circ C$ in 2 seconds? You need to set up the differential equation and solve it.
4. The population of bacteria in a jar grows at a rate proportional to the number of bacteria present at time t. Initially the jar has 20 bacteria. After 8 hours, it is observed that 50 bacteria are present. How many bacteria will there be after 72 hours? You need to set up the differential equation and give an explicit solution.

Section 5.1/9.1: We study Chapters 5 and 9 together as Higher Order Differential Equations
1. Determine if each of the following sets of functions is linearly dependent or linearly independent:
   a. $f_1(x) = x^2 - 1, f_2(x) = x + 1, f_3(x) = x$
   b. $f_1(x) = 2x + 20, f_2(x) = x + 1, f_3(x) = 10$
   c. $f_1(x) = e^{2x} - 1, f_2(x) = e^{-x} + 1, f_3(x) = x$
2. Section 5.1: 1, 3, 5 (a, b, f. Use Wronskian to determine if the functions are linearly dependent or linearly independent.)
3. Section 9.1: 5 (a, b-just do the first set of initial values), 6 (c)

Section 5.2/9.2: Section 5.2, 1, 5, 7, 13
           Section 9.2, 1, 3, 5, 23
Section 5.4/5.5/9.3: Section 5.4, 5, 7, 15, 17, 25
           Section 5.5: 1, 5, 12
           Section 9.3, 1, 7, Make assumption for y_p : 51, 54

Test 2 covers Sections 4.1, 4.2, 5.1, 5.2, 5.3, 5.4, 5.5, 9.1, 9.2, 9.3

Section 5.6:   2, 9, 21, 25
Section 5.7, 9.4: Section 5.7, 1, 3, 5, 11; Section 9.4, 3, 6
Section 6.1:   2, 3, 6, 7, 10
Section 6.2:   2, 3, 4
Section 7.1:   3(b, c, d, e), 11, 13, 14
Section 7.2:   1, 4, 16, 17
Section 7.3:   1, 3
Section 7.4:   1, 3, 5, 12
Section 7.5:   23, 33

Section 10.1/10.2/10.3

1. Solve the following system of linear differential equations: $\begin{cases} 2x' + y' - y = t \\ x' + y' = t^2 \end{cases}$

2. Solve the following system of linear differential equations with the initial values $x(0) = 0, y(0) = 0$
   $\begin{cases} 2x' + y' - 2x = 1 \\ x' + y' - 3x - 3y = 2 \end{cases}$

3. Consider two tanks in the following figure. Assume Tank A has 50 gallons of water with 20 pounds of salt, and Tank B has 50 gallons of water with 10 pounds of salt. Use the information given in the figure to set up a mathematical model for the number of pounds of salt $x_1(t)$ and $x_2(t)$ at time t in Tanks A and B respectively. Then solve the system. How much salt in each of the tanks when $t = 10$ minutes?

4. For the electrical circuit, let E=60 volts, R_1 =2 Ohms, R_2 =3 Ohms, L_1=1 Henry, L_2 = 1 henry, and i_2 and i_3 are initially zero. Develop a system of differential equations based on the circuit, and solve the system.

pure water 3 gal/min   mixture 1 gal/min

mixture 4 gal/min   mixture 3 gal/min
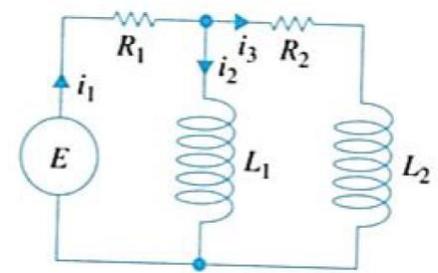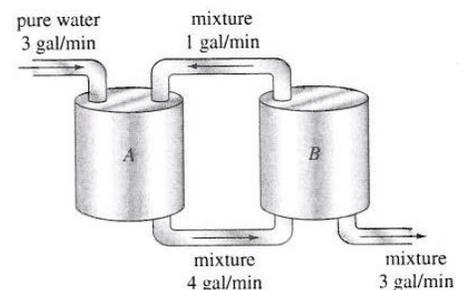
Test 3 covers Sections 5.6, 5.7, 9.4, 6.1, 6.2, 7.1-7.5, 10.1-10.3.
The Final covers all we learn in this semester.

Appendix: Suggested Day-by-Day Schedule

This schedule gives you an idea how much you need to learn each day. In case you miss a class, it shows what you should learn by yourself. Please attend to see what is exactly covered in a lass. We may modify this Schedule based on actual coverage. **The homework for each week is collected on each Tuesday class.**

Week of		Mon.	Tues.	Wed.	Thurs.	Fri.
Week 1	Jan. 8				Syllabus 1.1, 1.2	
Week 2	Jan. 15	No classes Martin Luther King Day	1.2, 1.3		2.1	
Week 3	Jan. 22		2.2		2.3	
Week 4	Jan. 29		2.4		2.5	
Week 5	Feb. 5		3.1, 3.2		Review	
Week 6	Feb. 12		Test 1		4.1	
Week 7	Feb. 19		4.2		5.1/9.1	
Week 8	Feb. 26		5.2/9.2		5.3/5.4	
Week 9	March 4		5.5/9.3		5.6, 5.7	
	March 11	Spring Break, Spring Break, Spring Break, Spring Break, Spring Break, Spring Break,				
Week 10	March 18		Review		Test 2	
Week 11	March 25		9.4		6.1	
Week 12	April 1		6.2		7.1, 7.2	
Week 13	April 8		7.3, 7.4		10.1, 10.2	
Week 14	April 15		10.3		Review	
Week 15	April 22		Test 3		Review for the final	
Week 16	April 29		Review for the final		Study Time, No Classes	
Week 17	May 6				**Final Exam, 8:00 AM-10:00 AM**	