

CENTRAL TEXAS COLLEGE
SYLLABUS FOR MATH 2320
Elementary Differential Equations

Semester Hours Credit: 3

INSTRUCTOR: Mrs. Cabaniss

I. INTRODUCTION

- A. Elementary Differential Equations is a first course the solution of ordinary differential equations. Solutions of first and second order differential equations and their applications are introduced. Other topics include LaPlace Transforms, Initial Value Problems, Eigen Values, and Eigen Vectors.
- B. This class meets three lecture hours per week.
- C. This course can be applied for an Associate in Arts or Science with a major in Mathematics. The course will transfer to institutions offering a Bachelor=s Degree.

II. OVERALL OR GENERAL OBJECTIVES OF THE COURSE

Upon successful completion of this course, Elementary Differential Equations, the student will be able to:

- A. Solve first and second order differential equations and their applications. (F4, F8, F9)
- B. Solve Higher Order differential equations. (F4, F8, F9)
- C. Use series to solve second order Linear Equations. (F4, F8, F9)
- D. Solve differential equations using LaPlace transforms. (F4, F8, F9)
- E. Solve Systems of first order Linear Equations. (F4, F8, F9)

III. INSTRUCTIONAL MATERIALS

- A. The Instructional materials identified for this course are viewable through http://www.ctcd.edu/im/im_main.asp
- B. Other Materials: A TI-89 or TI-89 Titanium Graphing Calculator is required. The calculator is required for graphing calculator exercises. TI Graphlinks are available in the CTC Advanced Mathematics Lab.

IV. COURSE REQUIREMENTS

- A. Assignments will be made daily. All assignments are to be completed by the following class meeting.

- B. Students are expected to attend every class and to arrive at each class on time and remain in class for the entire period. Students who are absent from class 12.5% of the number of class meetings for any reason will be dropped from the class with a grade of "F".
- C. The instructor will post office hours after semester commences. Consult the instructor during office hours. If your visit may tend to be lengthy, make an appointment with the instructor so that he may set aside some time for you.

V. EXAMINATIONS

- A. Examinations will be given at appropriate intervals. Each examination will be announced at least one week in advance, and each examination will be worth 120 points. The comprehensive final examination will be worth 200 points. The number of examinations depends on class progress.
- B. Students who miss an exam should discuss with the instructor the circumstances surrounding the absence. The instructor will determine whether a make-up exam is to be given. Make-up examinations are given by appointment only.

VI. SEMESTER GRADE COMPUTATIONS

- A. Your point total is determined by adding the point earned on each examination and the homework score. Your letter grade for the course is then determined by the following formula:

$$\frac{\text{Your Point Total}}{\text{Total Points Possible}} \times 100$$

If the result is between 90 and 100, your grade is a(n) A	
80 and 89	B
70 and 79	C
60 and 69	D
0 and 59	F

** NOTE: Grade Computation is determined by instructor. Please see your instructor for how your grade will be determined. This is just an example.

VII. NOTES AND ADDITIONAL INSTRUCTIONS FROM COURSE INSTRUCTOR

- A. Withdrawal from Course: It is the student's responsibility to officially drop a class if circumstances prevent attendance. Any student who desires to, or must, officially withdraw from a course after the first scheduled class meeting must file an Application for Withdrawal or an Application for Refund. The withdrawal form must be signed by the student.

Application for Withdrawal will be accepted at any time prior to Friday of the 12th week of classes during the 16 week fall and spring semesters. The deadline for sessions of other lengths is as follows.

Friday of 3rd week for 5-week courses
Friday of 4th week for 6-week courses
Friday of 6th week for 8-week courses
Friday of 7th week for 10-week courses
Friday of 9th week for 12-week courses
Friday of 12th week for 16-week courses

The equivalent date (75% of the semester) will be used for sessions of other lengths. The specific last day to withdraw is published each semester in the Schedule Bulletin.

Students who officially withdraw will be awarded the grade of "W", provided the student's attendance and academic performance are satisfactory at the time of official withdrawal. Students must file a withdrawal application with the college before they may be considered for withdrawal.

A student may not withdraw from a class for which the instructor has previously issued the student a grade of "F" or "FN" for nonattendance.

- B. An Administrative Withdrawal: An administrative withdrawal may be initiated when the student fails to meet College attendance requirements. The instructor will assign the appropriate grade on the Administrative Withdrawal Form for submission to the registrar.
- C. An Incomplete Grade: The College catalog states, "An incomplete grade may be given in those cases where the student has completed the majority of the course work but, because of personal illness, death in the immediate family, or military orders, the student is unable to complete the requirements for a course..." Prior approval from the instructor is required before the grade of "I" is recorded. A student who merely fails to show for the final examination will receive a zero for the final and an "F" for the course.
- D. The use of cellular phones/beepers will not be tolerated in class.
- E. Students are expected at all times to conduct themselves in a manner that is supportive to classroom activities. Each instructor may have additional instructions regarding classroom requirements.
- F. The Math Department operates an Advanced Mathematics Lab in Building 152, Room 145. All courses offered by the Math Department are supported in the lab with appropriate tutorial software. Walk-in tutoring is also available in Building 152, Room 236. Calculators and Graphlink are available for student use in the lab. Students are encouraged to take advantage of these opportunities. See posted hours

for the Walk-in tutoring and Math Lab.

VIII. COURSE OUTLINE

A. Unit One: Introduction and First Order Differential Equations.

1. Unit Objectives: Upon successful completion of this unit, the student will be able to:

- a. Classify differential equations and explain historical remarks.
- b. Define and discuss linear equations.
- c. Be able to solve equations by separation of variables.
- d. Explain the differences between linear and non-linear equations.
- e. Be able to model with linear equations.
- f. Be able to solve problems involving population dynamics.
- g. Be able to solve some problems in mechanics.
- h. Be able to solve exact equations using integrating factors.
- i. Be able to solve Homogeneous Equations.
- j. Be able to solve miscellaneous problems and applications.
- k. Be able to apply the existence and uniqueness theorems.
- l. Be able to solve First order Difference Equations.

2. Learning Activities:

- a. Read Chapter 1 and 2
- b. Work problems assigned by the instructor
- c. Complete assigned lab activities.

3. Unit Outline:

- a. Classification of Differential Equations.
- b. Historical Remarks.
- c. Linear Equations.
- d. Further Discussion of Linear Equations.
- e. Separable Equations.
- f. Difference Between Linear and Non-linear Equations.
- g. Modeling with Linear Equations
- h. Population Dynamics and Some Related Problems
- i. Some Problems in Mechanics
- j. Exact Equations and integrating factors.
- k. Homogeneous Equations.
- l. Miscellaneous Problems and Applications
- m. The Existence and Uniqueness Theorem.
- n. First Order Difference Equations.

B. Unit Two: Modeling, Applications, and Second Order Equations.

1. Unit Objectives: Upon successful completion of this unit, the student will be able to:
 - a. Solve Homogeneous solutions with constant coefficients.
 - b. Determine fundamental solutions of Linear Homogeneous Equations.
 - c. Explain and identify Linear Independence and the Wronskian and solve equations using the proper techniques.
 - d. Determine the complex roots of the characteristic equation.
 - e. Find repeated roots and utilize reduction of order.
 - f. Solve Homogeneous Equations with Constant Coefficients
 - g. Solve nonhomogeneous equations and use the method of undetermined coefficients.
 - h. Solve equations using variation of parameters.
 - i. Solve applications involving population growth.
 - j. Solve problems involving personal finance.
 - k. Solve problems involving electrical circuits.

2. Learning Activities:
 - a. Read Chapter 3 and 4.
 - b. Work problems as assigned by the instructor
 - c. Complete assigned lab activities.

3. Unit Outline:
 - a. Modeling Population Growth.
 - b. Models and the Real World.
 - c. Personal Finance.
 - d. Electrical Circuits.
 - e. Definitions and Examples.
 - f. Second-Order Equations and Systems.
 - g. Linear Homogenous Equations with Constant Coefficients.
 - h. Harmonic Motion.
 - i. Nonhomogeneous Equations; Method of Undetermined Coefficients.
 - j. Variation of Parameters
 - k. Forced Harmonic Motion

C. **Unit Three:** Laplace Transforms and Numerical Methods

1. Unit Objectives: Upon successful completion of this unit, the student will be able to:
 - a. Define the LaPlace Transform.
 - b. Find solutions of Initial Value Problems.
 - c. Solve differential equations with discontinuous forcing functions.
 - d. Solve problems involving impulse functions.

- e. Solve problems involving the Convolution Integral.
- f. Apply the Euler or Tangent line method.
- g. Use the Runge-Kutta Method.
- h. Discuss errors in numerical methods.
- i. Discuss practical use of Solvers.

2. Learning Activities:

- a. Read Chapter 5 and 6.
- b. Work problems assigned by the instructor
- c. Complete assigned lab activities

3. Unit Outline:

- a. Definition of the LaPlace Transform.
- b. Solutions of Initial Value Problems
- c. Step functions.
- d. Differential Equations with Discontinuous Forcing Functions.
- e. Impulse Functions.
- f. The Convolution Integral.
- g. Euler's Method
- h. Runge-Kutta Methods
- i. Numerical Error Comparisons
- j. Practical Use of Solvers.

D. **Unit Four:** Introduction to Systems and Linear Systems with Constant Coefficient.

1. Unit Objectives: Upon successful completion of this unit, the student will be able to:

- a. Define systems.
- b. Discuss examples.
- c. Discuss the Geometric Interpretation of Solutions of Systems.
- d. Discuss and Define Linear Systems.
- e. Discuss properties of Linear Systems.
- f. Solve problems involving systems of Linear Algebraic Equations, Linear Independence, Eigen values, and Eigen vectors.
- g. Discuss the Basic Theory of First Order Linear Equations.
- h. Solve problems involving Homogeneous Linear Systems with Constant Coefficients.
- i. Solve equations involving complex and repeated Eigen values.
- j. Solve problems involving Fundamental matrices.
- k. Solve nonhomogeneous linear systems.

2. Learning Activities:

- a. Read Chapter 8 and 9.
- b. Work problems as assigned by the instructor.
- c. Complete assigned lab activities.

3. Unit Outline:

- a. Definitions and Examples.
- b. Geometric Interpretations of Solutions.
- c. Qualitative Analysis.
- d. Linear Systems.
- e. Properties of Linear Systems.
- f. Overview of the Technique.
- g. Planar Systems.
- h. Phase Plane Portraits.
- i. The Trace-Determinant Plane
- j. Higher-Dimensional Systems.
- k. The Exponent of a Matrix.
- l. Qualitative Analysis of Linear Systems.
- m. Higher-Order Linear Equations.
- n. Inhomogeneous Linear Systems.

E. Unit Five: Nonlinear Systems and Series Solutions to Differential Equations.

1. Unit Objectives: Upon successful completion of this unit, the student will be able to:

- a. Solve problems involving the linearization of nonlinear systems.
- b. Discuss Long Term Behavior of Solutions.
- c. Discuss Invariant Sets.
- d. Solve problems involving the use of Nullclines.
- e. Discuss the Long Term Behavior of Solutions to Planar Systems.
- f. Solve problems involving Conserved Quantities.
- g. Solve application problems involving Nonlinear Mechanics, The Method of Lyapunov, and Predator-Prey Systems.
- h. Review Power Series.
- i. Find series solutions near ordinary points.
- j. Discuss Legendre's Equation.
- k. Discuss types of Singular Points.
- l. Find solutions near singular points.
- m. Solve problems involving Bessel's Equation and Bessel Functions.

2. Learning Activities:

- a. Read chapters 10 and 11.
- b. Work problems assigned by the instructor.

- c. Complete assigned lab activities.

3. Unit Outline

- a. The Linearization of a Nonlinear System.
- b. Long-Term Behavior of Solutions.
- c. Invariant Sets and the Use of Nullclines.
- d. Long-Term Behavior of Solutions to Planar Systems.
- e. Conserved Quantities.
- f. Nonlinear Mechanics.
- g. The Method of Lyapunov.
- h. Predator-Prey Systems.
- i. Review of Power Series.
- j. Series Solutions Near Ordinary Points.
- k. Legendre's Equation.
- l. Types of Singular Points—Euler's Equation.
- m. Series Solutions Near Regular Singular Points.
- n. Series Solutions Near Regular Singular Points—The General Case.
- o. Bessel's Equation and Bessel Functions.