# Introduction to Differential Equations

**CATALOG DESCRIPTION:** Introduction to ordinary differential equations; solutions by power series, phase planes, and Laplace transforms, linear algebra, Fourier Series, complex variables.

**REQUIRED TEXT:**
- Differential Equations & Linear Algebra, 2nd Edition, Edwards and Penney.

**TESTS:** Five or six tests will be given during the term.  These will usually cover one chapter of material and each test will take one class period.  The lowest of these test scores may be replaced with the final exam.  Students are allowed to use **one** 3" x 5" index card for notes to use during each test.  These notes must be handwritten (no duplicated material pasted onto the card) and may not include examples.  The instructor will randomly check these cards while the exam is going on and all note cards will be stapled to the exam when it is turned in. **There are no makeups for missed tests!**

**GRADING:**    60%        Exams
                30%        Homework
                10%        Final Exam

**HOMEWORK**:  Homework exercises will be collected on the first class meeting of each week (Monday unless there is a holiday).  An assignment sheet will be passed out at the beginning of each unit.   Each assignment collected will be worth 10 points and will be graded on completeness, neatness, and effort.  Problems must be written out (except word problems) and **all work must be shown** in order to receive credit.  When necessary, diagrams and graphs must be included and should be **_clear and neat._** All late homework will receive a maximum of five (5) points. **Any homework turned in more than one class session late will receive no credit!**

**FINAL EXAM**:  A two hour comprehensive final exam worth 100 points will be given at the end of the semester during finals week.  This final exam is a mandatory part of your grade. If you have missed a previous exam or had a low score, the final exam grade may be used to **_replace_** a low test score or a missed test.  The final exam may **_not_** be used to replace the homework grade.

**ATTENDANCE:**  Attendance is mandatory.  Class attendance will be recorded.  If you miss more than six class sessions, you may be dropped.  If you decide to drop the course it is **your** responsibility to make the drop official in the Admissions and Records Office or else possibly receive a grade of F.

**Grading Scale:**     90 – 100          A
                       80 – 89.9         B
                       70 – 79.9         C
                       60 – 69.9         D
                       < 60%             F

*__Important Dates:__*
*January 19, 2009 – Martin Luther King Holiday*
**January 25, 2009 – Last day to add**
*February 17, 2009 – Last day to file for Pass/No Pass grading basis*
*February 13 – 16, 2009 – Presidents' Day Holiday*
*April 6 – 10, 2009 – Spring Recess*
**March 13, 2009 – Last day to drop**

---

*FINAL EXAM DATE:  Wednesday, May 20, 2009 – 10:00-11:50 a.m.*

---

## COURSE OBJECTIVES:

Upon completion of this course, students will be able to:

A.  Use matrices and their applications to solve linear systems of equations.
B.  Find the solutions to first order and second order differential equations by graphical, numerical and analytic methods, and apply them to various application problems.
C.  Find the solutions to systems of differential equations using matrix methods.
D.  Use the expansion of functions in a Laplace transformation, find the inverse transformation, and apply these techniques to solutions of differential equations with periodic and other driving functions.
E.  Use power series solution methods to solve differential equations.
F.  Find the expansion of a periodic function in a Fourier Series and apply this to problems in electricity and mechanics.
G.  Manipulate and use complex numbers and functions of complex variables.

## COURSE CONTENT OUTLINE:

A.  Linear Algebra
    1.  Scalars and vectors
    2.  Vector spaces, linear dependence, and linear independence
    3.  Gaussian Reduction, Inverses, Determinants
    4.  Eigenvalves, Eigenvectors
B.  First Order Differential Equations
    1.  Basic concepts and ideas
    2.  Separable Equations
    3.  Modeling
    4.  Equations reducible to separate form
    5.  Exact differential equations
    6.  Integrating factors
    7.  Linear first-order differential equations
    8.  Families of curves and orthogonal trajectories
    9.  Slope fields

    C. Second Order Linear Differential Equations
1. Homogeneous linear equations of the second order
2. Homogeneous second order equations with constant coefficients
3. General solution and fundamental system
4. Complex roots of the characteristic equation
5. Double root of the characteristic equation
6. Free oscillations
7. Non-homogeneous linear equations
8. Methods for solving non-homogenous linear equations
9. Forced oscillations and resonance
10. Application to electric circuits

    D. Higher Order Linear Differential Equations
1. Homogeneous
2. Non-homogeneous

    E. Systems of Differential Equations
1. Review of matrix operations
2. Homogeneous linear systems
3. Phase plane, critical points and stability
4. Non-linear systems
5. Non-homogeneous systems

    F. Series Solutions to Differential Equations
1. Theory of power series method
2. Legendre equations and polynomials
3. Bessel's Equation and functions
4. Frobenius method

    G. Laplace Transforms
1. Intro to transform and inverse transform
2. Transforms of derivative and integrals
3. Exponential shift
4. Step function and delta function
5. Differentiation and integration of transforms
6. Convolution
7. Systems of equations
8. Periodic functions and applications

    H. Fourier Series
1. Periodic functions and trigonometric series
2. Fourier series and Euler formulas
3. Functions of arbitrary period
4. Even and odd functions
5. Half-range expansions
6. Determination of Fourier coefficients without integration
7. Forced oscillation
8. The Fourier integral

    I. Complex Variables
1. Complex numbers and the triangle inequality
2. Limit and derivatives
3. Rational functions
4. Trigonometric and hyperbolic functions
5. Logarithmic functions

---