Degree Applicable
Course ID 003252

Glendale Community College
November 2016

COURSE OUTLINE

Mathematics 108H (C-ID Number: Math 240)
Honors Ordinary Differential Equations (C-ID Title: Ordinary Differential Equations)

Catalog Statement
MATH 108 covers the solution of ordinary differential equations using various techniques including variation of parameters, the Laplace transform, power series, and numerical methods. Systems of linear differential equations and an introduction to nonhomogeneous linear systems are also covered. Applications are drawn from the physical sciences. The honors section of this course features more theory and proof, and one or more projects related to the topics of this course.

Total Lecture Units: 5.0
Total Laboratory Units: 0.0
Total Course Units: 5.0

Total Lecture Hours: 80.0
Total Laboratory Hours: 0.0
Total Laboratory Hours To Be Arranged: 0.0
Total Faculty Contact Hours: 80.0

Prerequisite: MATH 104
Recommended Preparation: MATH 105

Course Entry Expectations

Prior to enrolling in the course, the student should be able to:
- graph logarithmic and exponential functions;
- graph equations in polar parametric form;
- graph conic sections;
- integrate functions using variety of techniques;
- differentiate inverse trigonometric functions;
- apply L'Hospital's rule to find limits of indeterminate forms;
- evaluate improper integrals;
- model differential equations;
- solve separable differential equations;
- solve differential equations using slope fields and Euler's Method;
- work with exponential and logistic models of growth and decay;
- determine divergence or convergence of infinite series;
- differentiate and integrate power series;
- find Taylor and Maclaurin series for a function.

Course Exit Standards

Upon successful completion of the required coursework, the student will be able to:

- select the appropriate method of solution, given a list of first order differential equations;
- solve both homogeneous and nonhomogeneous differential equations with constant coefficients of second or higher order;
- use the Laplace transform to solve nonhomogeneous differential equations with constant coefficients and initial conditions;
- use power series to solve differential equations with variable coefficients;
- use eigenvalues of matrices to solve systems of linear differential equations;
- approximate solutions to first order differential equations by using numerical methods on a computer;
- apply the techniques of solution to applications from at least two different areas of the physical sciences.

Course Content — Total Faculty Contact Hours = 80.0

Introduction to Differential Equations **(4 hours)**
- Some basic mathematical models: Direction fields
- Solutions of some differential equations
- Classification of differential equations

First Order Differential Equations **(16 hours)**
- Linear equations with variable coefficients
- Separable equations
- Modeling with first order equations
- Differences between linear and nonlinear equations
- Autonomous equations and population dynamics
- Exact equations and integrating factors
- Numerical approximations: Euler's method
- The existence and uniqueness theorem

Second Order Linear Equations **(12 hours)**
- Homogeneous equations with constant coefficients
- Fundamental solutions of linear homogeneous equations
- Linear independence and the Wronskian
- Complex roots of the characteristic equation
- Repeated roots; reduction of order
- Nonhomogeneous equations: Method of undetermined coefficients
- Variation of parameters
- Mechanical and electrical vibrations
- Forced vibrations

Series Solutions of Second Order Linear Equations **(12 hours)**
- Review of power series
- Series solutions near an ordinary point
- Regular singular points
- Euler equations

The Laplace Transform **(10 hours)**
- Definition of the Laplace transform

Solutions of initial value problems
Step functions
Differential equations with discontinuous forcing functions
Impulse functions
The convolution integral

Systems of First Order Linear Equations **(15 hours)**

Review of matrices
Systems of linear algebraic equations: Linear independences, eigenvalues, eigenvectors
Basic theory of systems of first order linear equations
Homogeneous linear systems with constant coefficients
Complex eigenvalues
Fundamental matrices
Repeated eigenvalues
Nonhomogeneous linear systems

Numerical Methods **(6 hours)**

The Euler or tangent line method
Improvements on the Euler method
The Runge-Kutta method

Partial Differential Equations and Fourier Series **(5 hours)**

At least two of the following topics should be covered by the instructor:
Two-point boundary value problems
Fourier series
The Phase Plane: Linear Systems
Autonomous systems and stability
Series solutions near a regular point
Bessel's equations

<u>Methods of Instruction</u>

The following methods of instruction may be used in this course:

- lectures/discussions;
- computer (or other technological) explorations;
- group work/student presentations;
- online presentations.

<u>Out of Class Assignments</u>

The following out of class assignments may be used in this course:

- homework (e.g. problem sets related to course content);
- projects (e.g. prove a theorem stated in the textbook and present the proof to the instructor).

<u>Methods of Evaluation</u>

The following methods of evaluation may be used in this course:

- quizzes;

- in-class presentations;
- four or more exams are required;
- a comprehensive final examination is required.

Textbooks

Nagle, R. Kent, and Edward B. Saff, and Arthur D. Snider. *Fundamentals of Differential Equations and Boundary Value Problems.* 6th ed. Boston: Addison-Wesley, 2012. Print.
15th Grade Textbook Reading Level. ISBN #978-0-321-74774-7

Student Learning Outcomes

Upon successful completion of the required coursework, the student will be able to:

- solve a variety of rudimentary first and second order linear and non-linear differential equations;
- utilize series solutions around ordinary points and regular singular points in order to solve second order linear differential equations;
- utilize Laplace transforms in order to solve initial value problems;
- solve systems of homogeneous and non-homogeneous linear differential equations using matrix methods;
- utilize numerical methods to solve first order differential equations.