NOVA COLLEGE-WIDE COURSE CONTENT SUMMARY
MTH 289 – DIFFERENTIAL EQUATIONS EXTENDED (3 CR.)

Course Description

Presents systems of differential equations, power series solutions, Fourier series, Laplace transform and Fourier transform, partial differential equations, and boundary value problems. Designed as math elective course for mathematical, physical, and engineering science programs.
Lecture 3 hours. Total 3 hours per week.

General Course Purpose

The purpose of the course is to provide for a smooth transition of STEM students to 4-year colleges and introduce them to advanced topics of mathematics, physics and engineering: numerical methods for solving differential equations, classical partial differential equations, methods for solving PDEs and boundary-value problems (BVPs).

Course Prerequisites/Corequisites

Prerequisite: Completion of MTH 267 with a grade of C or better or equivalent.

Course Objectives

- System of Linear First Order Differential Equations
    - Define system of linear first-order differential equations, Initial value problem (IVP) and its solution vector, linear dependence/independence, fundamental set of solutions
    - Check that a vector of functions is a solution of a system or an initial value problem (IVP)
    - Apply criterion for linearly independent solutions and find general solution for homogeneous and nonhomogeneous systems (for the 3 types of eigenvalues: distinct real, complex, repeated)
    - Solve nonhomogeneous linear systems by the methods of undetermined coefficients and variation of parameters
- Numerical solutions of Ordinary Differential Equations
    - Understand the concept of local and global truncation errors, stability of numerical method
    - Use single-step and multistep methods(Euler's Method, Improved Euler's Method, 1st, 2nd and 4th-order Runge-Kutta Method, Adams-Bashforth-Moulton Method) and finite difference method to approximate ivp and bvp solutions
- Plane Autonomous Systems
    - Explain the concept of autonomous systems of first-order des (linear and nonlinear)
    - Find critical points and classify critical points of linear and nonlinear systems (stable/unstable nodes, saddle point, degenerate unstable node, center, stable/unstable spiral points), identify equilibrium solution and periodic solution
    - Use stability criterion for plane autonomous systems
    - Apply the concept of linearization of differentiable function and classify stable and unstable critical points
    - Perform stability analysis for linear/nonlinear systems for various applications
- Orthogonal Functions
    - Define orthogonal functions and sets of orthogonal functions
    - Write the definition of the Fourier Series and expansion of functions in a Fourier Series
    - Define Sturm-Liouville problem and solve it
    - Write the definitions and expand the function in Fourier-Bessel Series
- Boundary-Value Problems in Rectangular Coordinates
    - Define linear/nonlinear, homogeneous/nonhomogeneous partial differential equations
    - Classify the linear second-order pdes as hyperbolic, parabolic or elliptic
    - Use the method of separation of variables to find particular solution of pdes

- Identify classical and modified pdes and bvps (1d heat equation, 1d wave equation and 2d form of Laplace?s Equation) and solve them
    - Use the concept of orthogonal series expansions or generalized Fourier Series and solve bvps by using orthogonal series expansions
- Integral Transforms
    - Find the Laplace transform of partial derivatives of functions of two variables, use Laplace transform to solve bvps
    - Define a Fourier integral of function and conditions for convergence, the Fourier integral of even/odd functions
    - Use the definitions of three Fourier transform pairs (direct and inverse integral transforms)
    - Solve bvps using the Fourier transform

Major Topics to be Included

- System of Linear First Order Differential Equations
- Numerical solutions of Ordinary Differential Equations
- Plane Autonomous Systems
- Orthogonal Functions
- Boundary-Value Problems in Rectangular Coordinates
- Integral Transforms