## Math 262  Applied Differential Equations

**Objectives**

To introduce Civil Engineering UBC Bridging Program students to ordinary differential equations.

**Calendar Description**

*This course is restricted to students in the Civil Engineering UBC Bridge program.*
Topics: first and second order equations, higher order linear equations, power series solutions,
Laplace transforms, linear systems, and numerical methods. Applications are stressed throughout.

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**Organization**

| | |
|---|---|
| Offered: | 3rd Quarter |
| Credit: | 4 |
| In-class workload: | 8 hours lecture/week |
| Out-of-class workload: | 8 hours/week |
| Prerequisites: | Math 260 and Math 261 |

**Text:**

Dennis G Zill, *A First Course in Differential Equations with Modeling Applications*, 7th
Edition, Brooks/Cole, 2001.

**Tentative Course Outline**

### Introduction to Differential Equations

| Hours | Text (week) | Topic |
|---|---|---|
| 1 | 1.1 (1) | Definitions and Terminology |
| 1 | 1.2 (1) | Initial-Value Problems |
| 1 Read | 1.3 (1) | Differential Equations as Mathematical Models |

### First-Order Differential Equations

| Hours | Text (week) | Topic |
|---|---|---|
| 1 | 2.1 (1) | Solution Curves Without the Solution |
| 1 | 2.2 (1) | Separable Variables |
| 2 | 2.3 (1) | Linear Equations |
| 1 | 2.4 (2) | Exact Equations |
| 1 | 2.5 (2) | Solutions by Substitutions |

## Modeling with First-Order Differential Equations

| Hours | Text (week) | Topic |
|-------|-------------|-------|
| 1 | 3.1 (2) | Linear Equations |
| 2 | 3.2 (2) | Nonlinear Equations |

## Higher Order Differential Equations

| Hours | Text (week) | Topic |
|-------|-------------|-------|
| 2 | 4.1 (2) | Preliminary Theory: Linear Equations |
| 2 | 4.2 (3) | Reduction of Order |
| 2 | 4.3 (3) | Homogeneous Linear Equations with Constant Coefficients |
| 2 | 4.4 (3) | Undetermined Coefficients---Superposition Approach |
| 2 | 4.5 (3) | Undetermined Coefficients- --Annihilator Approach |
| 2 | 4.6 (4) | Variation of Parameters |
| 1 | 4.7 (4) | Cauchy-Euler Equation |
| **2** | **Class (4)** | **Test 1 (The material of weeks 1, 2 and 3 covered)** |
| 2 | 4.8 (4) | Solving Systems of Linear Equations by Elimination |
| 2 | 4.9 (5) | Nonlinear Equations |

## Modeling with Higher-Order Differential Equations

| Hours | Text (week) | Topic |
|-------|-------------|-------|
| 1 | 5.1.1 (5) | Free Undamped Motion |
| 2 | 5.1.2 (5) | Free Damped Motion |
| 1 | 5.1.3 (5) | Driven Motion |
| 1 | 5.1.4 (5) | Series Circuit  Analogue |
| 2 | 5.2 (5) | Linear Equations: Boundary-Value Problems |
| 1 | 5.3 (6) | Nonlinear Equations |

## Series Solutions of Linear Equations

| Hours | Text (week) | Topic |
|-------|-------------|-------|
| 1 | 6.1.1 (6) | Review of Power Series |
| 2 | 6.1.2 (6) | Power Series Solutions (about ordinary points) |
| 2 | 6.2 (6) | Solutions About Singular Points |
| 2 | 6.3 (6) | Two Special Equations |

## The Laplace Transform

| Hours | Text (week) | Topic |
|-------|-------------|-------|
| 2 | 7.1 (7) | Definition of the Laplace Transform |
| 2 | 7.2 (7) | Inverse Transform and Transforms of Derivatives |
| 2 | 7.3 (7) | Translation Theorems |
| **2** | **Class (7)** | **Test 2 (The material of weeks 4, 5 and 6 covered)** |
| 2 | 7.4 (8) | Additional Operational Properties |
| 2 | 7.5 (8) | Dirac Delta Function |
| 2 | 7.6 (8) | Systems of Linear Equations |

## Systems of Linear First-Order Differential Equations

| Hours | Text (week) | Topic |
|---|---|---|
| 2 | 8.1 (9) | Preliminary Theory |
| 2 | 8.2 (9) | Homogeneous Linear Systems with Constant Coefficients |
| 1 | 8.3 (9) | Variation of Parameters |
| 1 | 8.4 (9) | Matrix Exponential |
| 1 read | 3.3 | Systems of Linear and Nonlinear Equations |

## Numerical Methods for Ordinary Differential Equations

| Hours | Text (week) | Topic |
|---|---|---|
| 1 | 2.6 (9) | A Numerical Solution |
| 2 | 9.1 (10) | Euler Methods and Error Analysis |
| 2 | 9.2 (10) | Runge-Kutta Methods |
| **2** | **Class (10)** | **Test 3 (The material of weeks 7, 8 and 9 covered)** |
| 2 | 9.3 (10) | Multistep Methods |
| 2 | 9.4 (11) | Higher-Order Equations and Systems |
| 2 | 9.5 (11) | Second-Order Boundary-Value Problems |

## Phase Plane Analysis

| Hours | Text (week) | Topic |
|---|---|---|
| 2 | Notes (11) | Introduction to Phase Plane Analysis |

**Calculator Policy**

A regular scientific (non programmable, non-graphing) calculator is allowed in term tests and final examination.

**Assessment**

To pass the course, you need to pass the final exam., and then the final grade is calculated as follows.

| | |
|---|---|
| *Assignments (10%)* | Problems will be assigned for each section (they will be posted at the class's website); they are due at the <u>beginning of the class on Tuesdays</u> (starting April 13, 2003). **Papers turned in late by the end of the due date will get a penalty of 25% off**. Solutions should be presented in a neat and clear fashion and the paper should be well organized and stapled if there is more than one page – penalty applies to "sloppy papers". Complete solutions will be posted online at http://www.camosun.bc.ca/~lai. |
| *Test (30%)* | There will be 3 2-hour tests (tentatively scheduled on **Thursday 29 April**, **Thursday 20 May**, and **Thursday 10 June**), each counts for 10%. There is NO makeup (<u>medical excuse must be accompanied by a physician's note</u>). Complete understanding of the problems of the assignments will be essential for success on the term tests.    Complete solutions will be posted online at http://www.camosun.bc.ca/~lai. |
| *Comprehensive Final Exam (60%)* | Final exam. is held from June 21 – 25. You must be available at the scheduled time. There is NO makeup. |

**Percentage to Letter Grade Conversion**

| A+ | 95-100% | A | 90-94 | A- | 85-89 |
|----|---------|---|-------|----|-------|
| B+ | 80-84   | B | 75-79 | B- | 70-74 |
| C+ | 65-69   | C | 60-64 | D  | 50-59 |
| F  | 0-49    |   |       |    |       |

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**Office hours:** As posted, or by appointment

|  | Monday | Tuesday | Wednesday | Thursday | Friday |
|---|--------|---------|-----------|----------|--------|
| 07:30-08:20 | | | | | |
| 08:30-09:20 | | | | | |
| 09:30-10:20 | | | | | |
| 10:30-11:20 | | | | | |
| 11:30-12:20 | Office Hour | Office Hour | | Office Hour | Office Hour |
| 12:30-13:20 | Office Hour | Office Hour | | Class | Office Hour |
| 13:30-14:20 | Class | Class | | Class | Class |
| 14:30-15:20 | Class | Class | | | Class |
| 15:30-16:30 | | | | | |