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| CAMOSUN COLLEGE | **School of Arts & Science**<br>**MATHEMATICS DEPARTMENT**<br>**MATH 252**<br>**Applied Differential Equations**<br>**Quarter 1, 2010** |

# COURSE OUTLINE

## 1. Instructor Information

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| (a) | Instructor: | Gilles Cazelais | | |
| (b) | Office Hours: | http://pages.pacificcoast.net/~cazelais/schedule.html | | |
| (c) | Location: | CBA 158 | | |
| (d) | Phone: | 370-4495 | Alternative Phone: | |
| (e) | Email: | Cazelais@camosun.bc.ca | | |
| (f) | Website: | http://pages.pacificcoast.net/~cazelais/252.html | | |

## 2. Intended Learning Outcomes

*(No changes are to be made to these Intended Learning Outcomes as approved by the Education Council of Camosun College.)*

Upon completion of this course the student will be able to:

1. Classify a differential equation (DE) by type (ordinary differential equation ODE vs. partial differential equation PDE), order, and linearity.
2. Verify an implicit or explicit solution of an ODE/initial value problem (IVP).
3. Determine the existence and uniqueness of a solution of a first-order IVP.
4. Model real-life phenomenon with linear/non-linear DE (for example, vibration problems such as the spring-mass system, population dynamics [logistic equation], radioactive decay, Newton's law of cooling/warming, spread of a disease, chemical reactions, mixture problems, draining a tank – Torricelli's law, series circuits, falling bodies with/without air resistance, slipping chain).
5. Model real-life phenomenon with a system of linear or nonlinear DE's (for example, radioactive series, mixture problems, population dynamics (predator-prey model, competition model), electrical networks.
6. Sketch approximate solution curves for a first-order IVP using a direction field.
7. Sketch solution curves of an autonomous first-order DE by drawing and analyzing the one-dimensional phase portrait.
8. Solve various types of first-order DE: separable DE, linear DE (using integrating factor), exact DE and non-exact DE (by making it exact), homogeneous DE of a certain degree, Bernoulli DE.
9. Determine the existence and uniqueness of a solution of a $n^{th}$-order IVP.
10. Solve $2^{nd}$-order linear homogeneous and nonhomogeneous DE using the method of reduction of order.
11. Solve higher-order linear homogeneous and nonhomogeneous DE with constant coefficients.
12. Solve $2^{nd}$-order nonhomogeneous DE using the method of variation of parameters.
13. Solve Cauchy-Euler equations.
14. Solve systems of linear equations.
15. Sketch trajectories of a system of two linear first order DE by drawing and analyzing the two-dimensional phase portrait.
16. Classify a point for a DE as an ordinary point, regular singular point, or irregular singular point.
17. Find power series solution of a DE about an ordinary point.
18. Find series solution of a DE about a regular singular point.
19. Apply the Frobenius Theorem to find series solution of a DE about a regular singular point.
20. Use a Laplace transform and its properties to solve an IVP.

## 3. Required Materials

Dennis G. Zill, *A First Course in Differential Equations with Modeling Applications*, 9th Edition

## 4. Schedule

See: http://pages.pacificcoast.net/~cazelais/schedule.html

## 5. Basis of Student Assessment (Weighting)

- Four tests: 50%
- Comprehensive Final Exam: 50%

## 6. Grading System

*(No changes are to be made to this section unless the Approved Course Description has been forwarded through the Education Council of Camosun College for approval.)*

**Standard Grading System (GPA)**

| Percentage | Grade | Description | Grade Point Equivalency |
|---|---|---|---|
| 90-100 | A+ | | 9 |
| 85-89 | A | | 8 |
| 80-84 | A- | | 7 |
| 77-79 | B+ | | 6 |
| 73-76 | B | | 5 |
| 70-72 | B- | | 4 |
| 65-69 | C+ | | 3 |
| 60-64 | C | | 2 |
| 50-59 | D | Minimum level of achievement for which credit is granted; a course with a "D" grade cannot be used as a prerequisite. | 1 |
| 0-49 | F | Minimum level has not been achieved. | 0 |

**Temporary Grades**

Temporary grades are assigned for specific circumstances and will convert to a final grade according to the grading scheme being used in the course. See Grading Policy E-1.5 at **camosun.ca** for information on conversion to final grades, and for additional information on student record and transcript notations.

| Temporary Grade | Description |
|---|---|
| **I** | *Incomplete*: A temporary grade assigned when the requirements of a course have not yet been completed due to hardship or extenuating circumstances, such as illness or death in the family. |
| **IP** | *In progress*: A temporary grade assigned for courses that, due to design may require a further enrollment in the same course. No more than two IP grades will be assigned for the same course. *(For these courses a final grade will be assigned to either the 3rd course attempt or at the point of course completion.)* |
| **CW** | *Compulsory Withdrawal:* A temporary grade assigned by a Dean when an instructor, after documenting the prescriptive strategies applied and consulting with peers, deems that a student is unsafe to self or others and must be removed from the lab, practicum, worksite, or field placement. |

## 7. Recommended Materials or Services to Assist Students to Succeed Throughout the Course

**LEARNING SUPPORT AND SERVICES FOR STUDENTS**

There are a variety of services available for students to assist them throughout their learning. This information is available in the College calendar, at Student Services, or the College web site at camosun.ca.

**STUDENT CONDUCT POLICY**

There is a Student Conduct Policy **which includes plagiarism**.
It is the student's responsibility to become familiar with the content of this policy.
The policy is available in each School Administration Office, at Student Services,
and the College web site in the Policy Section.

## Topics Covered

1. Introduction to Differential Equations
· Definitions and Terminology (section 1.1)
· Initial-Value Problems (section 1.2)

2. First-Order Differential Equations
· Separable Variables (section 2.2)
· Linear Equations (section 2.3)
· Exact Equations (section 2.4)
· Solutions by Substitutions (section 2.5)

3. Modeling with First-Order Differential Equations
· Linear Models (section 3.1)

4. Higher-Order Differential Equations
· Preliminary Theory – Linear Equations (section 4.1)
· Reduction of Order (section 4.2)
· Homogeneous Linear Equations with Constant Coefficients (section 4.3)
· Undetermined Coefficients — Superposition Approach (section 4.4)
· Variation of Parameters (section 4.6)
· Cauchy-Euler Equations (section 4.7)

5. Modeling with Higher-Order Differential Equations
· Linear Models: Initial-Value Problems (section 5.1)
- Spring/Mass Systems: Free Undamped Motion (5.1.1)
- Spring/Mass Systems: Damped Motion (5.1.2)
- Spring/Mass Systems: Driven Motion (5.1.3)
- Series Circuit Analogue (5.1.4)

6. Series Solutions of Linear Equations
· Solutions About Ordinary Points (section 6.1)
· Solutions about Singular Points (section 6.2)

7. Laplace Transforms
· Definition of the Laplace Transform (section 7.1)
· Inverse Transforms and Transforms of Derivatives (section 7.2)
· Operational Properties I (section 7.3)
- Translation of the s−Axis (7.3.1)
- Translation of the t−Axis (7.3.2)
· Operational Properties II (section 7.4)
- Derivatives of a Transform (7.4.1)
- Transforms of Integrals (7.4.2)
- Transforms of a Periodic Function (7.4.3)
· The Dirac Delta Function (section 7.5)

8. Systems of Linear First-Order Differential Equations
· Preliminary Theory – Linear Systems (section 8.1)
· Homogeneous Linear Systems (section 8.2)
- Distinct Real Eigenvalues (8.2.1)
- Repeated Eigenvalues (8.2.2)
- Complex Eigenvalues (8.2.3)
· Nonhomogeneous Linear Systems (section 8.3)
- Variation of Parameters (8.3.2)