

COURSE SYLLABUS

MATH 314: NUMERICAL ANALYSIS 3 (3 CREDIT UNITS)

Catalogue Description

Numerical differentiation and integration, initial-value, and boundary-value problems for ordinary differential equations, introduction to numerical solutions to partial differential equations.

- Prerequisite(s):** MATH 211 and MATH 238
- Note:** Students may receive credit for a maximum of two of MATH 313, MATH 314, and MATH 315.
- Class Time and Location:** Tue / Thu 10:00–11:20 a.m., MURR 299
- Website:** <http://www.cs.usask.ca/~spiteri/M314.html>

Instructor Information

- Instructor:** Prof. Raymond J. Spiteri
- Contact:** Email: raymond.spiteri@usask.ca
(normal response time no later than end of next business day)
Phone: 306-966-2909
- Office Hours:** Location: THORV S425
Times: Tue/Thu 9:00–10:00 a.m. or by appointment (one business day's notice)

Course Objectives

Ordinary differential equations (ODEs) are indispensable in mathematical models for applications in science and engineering. Typically, solutions of ODEs can only be approximated numerically with the aid of a computer. Solutions to these problems appear in many places, from underwater robots to space exploration to motion picture animation to nanotechnology. This course is about obtaining numerical solutions to ODEs both in the context of initial-value and boundary-value problems as well as arising from discretizations of partial differential equations. To this end, we will make extensive use of problem-solving software environments such as Matlab, Maple, and Mathematica.

Student Evaluation

Grading Scheme

Class Contribution	10%
Assignments (4; due every 2–3 weeks)	20%
Midterm Exam (Thu Oct 17, 2013, in class)	10%
Course Project (due on day of final exam)	20%
Final Exam	40%
Total	100%

Class Contribution

Students are expected to attend class at the scheduled meeting times. The class contribution grade assigned is necessarily linked to attendance.

The “Class Contribution” portion of your grade will be calculated according to the following guidelines:

- excellent (mid-80s–100): Contributed frequently and insightfully; demonstrated critical understanding of readings/videos; showed awareness of how readings/videos relate to each other and to overarching themes; interacted with other students and built on their comments.
- good (70–low 80s): Contributed regularly; grasped main points of readings/videos; showed awareness of interrelationships between readings/videos and themes or interacted with other students.
- adequate (50s–69): Contributed occasionally; demonstrated partial understanding of readings/videos; some comments unconnected to main subject or restatements of those offered by other students.
- substandard (0–49): Remained silent or contributed minimally; demonstrated little or no understanding of readings/videos; made irrelevant or erroneous comments; absent without excuse.

Course Project

An important part of the course is a project on a topic of your choice that is closely related to the course material. You are welcome to work individually or in groups of up to three people. Examples of eligible projects include review papers, tutorials, and software (in a relevant programming language or problem-solving environment). Brief in-class presentations are encouraged as a means of demonstrating project outcomes. Expectations for project outcomes are associated with group size. Milestones of the projects will be incorporated with the assignments. Projects are required to have final written reports of approximately 20 pages per group member. Use of \LaTeX is required.

Final Exam Scheduling

The Registrar schedules all final examinations, including deferred and supplemental examinations. Students are advised not to make travel arrangements for the exam period until the official exam schedule has been posted.

Note: All students must be properly registered in order to attend lectures and receive credit for this course.

Textbook Information

Required Text

- U.M. Ascher and L.R. Petzold, *Computer Methods for Ordinary Differential Equations and Differential-Algebraic Equations*, Society for Industrial and Applied Mathematics, 1998.

Recommended Texts

- L.F. Shampine, I. Gladwell, S. Thompson *Solving ODEs with MATLAB*, Cambridge University Press, 2003.

Lecture Schedule

Topic	Topic/Subtopics
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Introduction (1 week)	<ul style="list-style-type: none"> • Introduction to ordinary differential equations, initial-value problems, boundary-value problems • Fundamental theoretical concepts: existence, uniqueness, well-posedness • Fundamental practical concepts: conversion to standard form, error control (local vs. global)
Initial-Value Problems (6 weeks)	<ul style="list-style-type: none"> • Quadrature; one-step methods; multi-step methods • Event location; ODEs with a mass matrix; singularities • Introduction to partial differential equations; method of lines; implicit-explicit methods
Boundary-Value Problems (4 weeks)	<ul style="list-style-type: none"> • The shooting method and its pitfalls; multiple shooting • Finite difference methods; collocation • Deferred correction; residual control • Boundary conditions at singular points and infinity; automatic differentiation
Special Topics (2 weeks)	<ul style="list-style-type: none"> • Stiffness; singular perturbation problems; differential-algebraic equations; delay differential equations • Direct methods for high-order differential equations • Methods that preserve solution invariants • Parallel methods

Course Overview

- There are no formal labs associated with this course. However, the classes will mainly be conducted in a lab/tutorial style.
- By the end of the course, students will be expected to be able to not only correctly solve non-trivial problems involving differential equations numerically but also to have an appreciation for the theory and the issues involved in solving such problems.

Policies

Late Assignments

Late assignments are subject to a penalty of 10% for up to 24 hours late and 20% for up to 48 hours late. Assignments that are more than 48 hours late are not accepted without valid justification.

Missed Examinations

1. "Students who have missed an exam or assignment must contact their instructor as soon as possible. Arrangements to make up the exam may be arranged with the instructor. Missed exams throughout the year are left up to the discretion of the instructor if a student may make up the exam or write at a different time. If a student knows prior to the exam that she/he will not be able to attend, they should let the instructor know before the exam."

2. "Final exams - a student who is absent from a final examination through no fault of his or her own, for medical or other valid reasons, may apply to the College of Arts and Science Dean's office. The application must be made within three days of the missed examination along with supporting documentary evidence. Deferred exams are written during the February mid-term break for Term 1 courses and in early June for Term 2 and full year courses."

(2007/08. <http://www.arts.usask.ca/students/transition/tips.php>)

Incomplete Course Work and Final Grades

When a student has not completed the required course work, which includes any assignment or examination including the final examination, by the time of submission of the final grades, they may be granted an extension to permit completion of an assignment, or granted a deferred examination in the case of absence from a final examination. Extensions for the completion of assignments must be approved by the Department Head, or Dean in non-departmentalized Colleges, and may exceed thirty days only in unusual circumstances. The student must apply to the instructor for such an extension and furnish satisfactory reasons for the deficiency. Deferred final examinations are granted as per College policy.

In the interim, the instructor will submit a computed percentile grade for the course which factors in the incomplete course work as a zero, along with a grade comment of INF (Incomplete Failure) if a failing grade. In the case where the instructor has indicated in the course's outline that failure to complete the required course work will result in failure in the course, and the student has a computed passing percentile grade, a final grade of 49% will be submitted along with a grade comment of INF (Incomplete Failure).

If an extension is granted and the required assignment is submitted within the allotted time, or if a deferred examination is granted and written in the case of absence from the final examination, the instructor will submit a revised computed final percentage grade. The grade change will replace the previous grade and any grade comment of INF (Incomplete Failure) will be removed. For provisions governing examinations and grading, students are referred to the University Council Regulations on Examinations subsection of the Calendar.

(2011 University of Saskatchewan Calendar/Academic Courses Policy)

Academic Honesty

The University of Saskatchewan is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Student Conduct & Appeals subsection of the University Secretary Website and avoid any behaviour that could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.

All students should read and be familiar with the Regulations on Academic Student Misconduct, http://www.usask.ca/university_secretary/honesty/StudentAcademicMisconduct.pdf, as well as the Standard of Student Conduct in Non-Academic Matters and Procedures for Resolution of Complaints and Appeals, http://www.usask.ca/university_secretary/honesty/StudentNon-AcademicMisconduct2012.pdf.

For more information on what academic integrity means for students see the Student Conduct & Appeals subsection of the University Secretary Website at http://www.usask.ca/university_secretary/pdf/dishonesty_info_sheet.pdf

Examinations with Disability Services for Students (DSS)

Students who have disabilities (learning, medical, physical, or mental health) are strongly encouraged to register with Disability Services for Students (DSS) if they have not already done so. Students who suspect they may have disabilities should contact DSS for advice and referrals. In order to access DSS programs and supports, students must follow DSS policy and procedures. More information is available at <http://www.students.usask.ca/disability/>, or contact DSS at 306-966-7273 or dss@usask.ca.

Students registered with DSS may request alternative arrangements for mid-term and final examinations. Students must arrange such accommodations through DSS by the stated deadlines. Instructors shall provide the examinations for students who are being accommodated by the deadlines established by DSS.