

MECH 358

Course Outline: January 2020

Analytical and numerical solutions of ordinary and partial differential equations with emphasis on mechanical engineering applications and practical scientific computing.

Contacts

Name	Role	Email	Office
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Lectures

- Tuesday & Thursday 11-12:30pm LSK 201

Labs

- Each student should be registered in a computer lab:
 - L2A: Monday 9-10am RH123
 - L2B: Monday 11-12pm RH123
 - L2C: Wednesday 11-12pm RH123
 - L2D: Friday 11-12pm RH123
- There are 8 labs in total (see *Schedule* below)
- All labs are weighted equally however we drop the lowest grade in the final grade calculation
- All labs include MATLAB programming
- Activities include individual and pair programming, written work and peer evaluation
- MATLAB is freely available for UBC students to download and/or use MATLAB online:
 - Go to matlab.mathworks.com
 - Create an account with your UBC email address (ending in ubc.ca)

Prerequisites

MECH 222 and MECH 225 are prerequisite courses for MECH 358 and include:

- Multivariable calculus: partial differentiation and integration
- Linear algebra and matrix theory
- Ordinary differential equations and elementary numerical analysis
- MATLAB: scripts, functions, arrays, mathematical functions, plotting, logic and loops

Textbooks

There is no required textbook for the course. Online resources are provided on Canvas. The following is a list of *recommended* textbooks:

- Elementary Differential Equations and Boundary Value Problems, by W. Boyce & R. DiPrima
- Diffy Qs, by Jiri Lebl (see www.jirka.org/diffyqs)
- Applied Partial Differential Equations, by Richard Haberman
- Applied Numerical Methods with MATLAB, by Steven Chapra

Assessments

Computer Labs	20%	8 labs, equal weight, drop lab with lowest grade
Midterm Exam #1	20%	February 13, in class, formula sheet provided, calculators allowed
Midterm Exam #2	20%	March 19, in class, formula sheet provided, calculators allowed
Final Exam	40%	April 14-29, formula sheet provided, calculators allowed

Schedule

Week	Tuesday	Thursday	Lab
1	Review of ODEs: classification, analytical methods for first and second order equations, graphical methods	Numerical methods for IVPs: methods, errors, order of accuracy	–
2	Numerical methods for IVPs: explicit vs. implicit methods, amplification factor and stability	Numerical methods for higher order IVPs and systems: higher order equations as first order systems, <code>ode45</code>	Review of MATLAB: functions, scripts, array operations, mathematical functions, logic and loops
3	Numerical methods for BVPs: shooting method and finite differences	Introduction to PDEs: heat, Laplace, Poisson and wave equations, separation of variables, Fourier series	Compute solutions of IVPs; Evaluate order of accuracy of a numerical method
4	Fourier series: definition, formulas, orthogonality, even/odd extensions	Fourier series: convergence and Gibb's phenomenon	Compute solutions of BVPs by shooting method and finite differences
5	Heat equation: Fourier series solutions for homogeneous boundary conditions	Heat equation: mixed, non-homogeneous and time-dependent boundary conditions, heat sources/sinks	Compute Fourier series of a function
6	Heat equation: finite difference method, order of accuracy and stability	Midterm Exam #1	–
7	Reading week	Reading week	Reading week

8	Laplace equation: Fourier series solutions over rectangular regions, Poisson equation	Laplace equation: finite difference method, order of accuracy	Compute solutions of the heat equation
9	Laplace equation: Fourier series solutions over polar regions	Wave equation: Fourier series solutions, damping	Compute solutions of the Laplace equation
10	Wave equation: finite difference method, order of accuracy and stability	Wave equation: d'Alembert solution	–
11	Bessel functions: definition and properties	Midterm Exam #2	–
12	Wave equation in 2D: axis-symmetric solutions over polar regions	Heat equation in 2D: axis-symmetric solutions over polar regions	Compute solutions of the wave equation
13	Vibrating beams	Advanced topics: Sturm-Liouville theory, Navier-Stokes equations, CFD, ...	Compute zeros of the Bessel function; Compute axis-symmetric solutions of the heat and wave equations in 2D
14	Review	–	–

Course Policies

Missed Midterm Exam

There are no make-up midterms in this course. Missing the midterm for a valid reason normally results in the weight of the midterm being transferred to the final exam. Examples of valid reasons include illness and travel to play a scheduled game for a varsity team. Examples of reasons that are not valid include conflicts with personal travel schedules or conflicts with work schedules. Any student who misses the midterm is to present to their instructor the [Department of Mathematics self-declaration form](#) for reporting a missed assessment to their instructor within 72 hours of the midterm date. This policy conforms with the [UBC Vancouver Senate's Academic Concession Policy V-135](#) and students are advised to read this policy carefully.

Missed Final Exam

You will need to present your situation to the Dean's Office of your Faculty to be considered for a deferred exam. See the [UBC Academic Calendar](#) for detailed regulations. Your performance in a course up to the exam is taken into consideration in granting a deferred exam status (e.g. failing badly generally means you will not be granted a deferred exam). In Mathematics, generally students sit the next available exam for the course they are taking, which could be several months after the original exam was scheduled. **Note that your personal travel schedule is NOT a valid reason for missing a final exam and students who miss the MECH 358 exam for this reason will receive a grade of 0 on the exam and fail the course.**

Academic Misconduct

1. UBC takes cheating incidents very seriously. After due investigation, students found guilty of cheating on tests and examinations are usually given a final grade of 0 in the course and

suspended from UBC for one year. See [UBC Academic Calendar: Discipline for Academic Misconduct](#) for more information.

2. While students are encouraged to study together, they should be aware that blatant copying of another student's work is a serious breach of academic integrity. Please discuss with your instructors their expectations for acceptable collaboration on any assigned coursework. Cases of suspected cheating will be investigated thoroughly.
3. Note that academic misconduct includes misrepresenting a medical excuse or other personal situation for the purposes of postponing an examination or quiz or otherwise obtaining an academic concession.

University Policies

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available on the [UBC Senate website](#).