

# MTE 204 Numerical Methods

## Spring 2019 Course Outline

- Instructor:** Peter Teertstra      [peter.teertstra@uwaterloo.ca](mailto:peter.teertstra@uwaterloo.ca)      E5-2105      x35610
- TAs:** Heba Alzaben      [halzaben@uwaterloo.ca](mailto:halzaben@uwaterloo.ca)  
Amir Yazdanmehr      [amir.yazdanmehr@uwaterloo.ca](mailto:amir.yazdanmehr@uwaterloo.ca)
- Lectures:** 8:30 – 9:20pm Monday, 10:30 – 11:20pm Wednesday, 9:30 – 10:20pm Friday – E7-3343  
11:30am – 12:20pm Tuesday, May 28 – E7-3343  
8:30 – 9:20am Thursday, June 13, July 11 – E7-3343
- Tutorials:** T01 1:30 – 2:20pm, Monday – E7-3343  
T02 2:30 – 3:20pm, Monday – E7-3343
- Outcomes:** On successful completion of the course students will be able to
1. Develop and implement stable and accurate numerical methods to solve linear systems of equations, find root of equations and perform curve fitting, numerical integration and differentiation [GA: KB (I)]
  2. Understand the basic concepts of partial differential equations, including initial and boundary conditions and analytical solution techniques [GA: KB (I)]
  3. Use numerical methods, including finite difference and finite element analysis, to solve ordinary differential equations and partial differential equations for engineering problems [GA: KB (I)]
- Textbook:** Steven C. Chapra and Raymond P. Canale, *Numerical Methods for Engineers*, 7th ed. McGraw Hill, ISBN: 007339792x.
- Web Site:** [learn.uwaterloo.ca](http://learn.uwaterloo.ca)
- Grades:** The course grade is based on a midterm exam, two projects and a final exam using the following weighting scheme:
- |                    |            |
|--------------------|------------|
| <b>Midterm:</b>    | <b>35%</b> |
| <b>Projects</b>    | <b>10%</b> |
| <b>Final Exam:</b> | <b>55%</b> |
- Exams:** Exams are closed book with an equation sheet permitted.
- Projects:** Two projects will be assigned during the term, one before and one after the midterm, to demonstrate mechanical engineering based applications of numerical solution methods. These projects will require the use of Matlab. All project work must be completed on an individual basis.
- Problems:** Problem sets and solutions are posted on the course website and should be worked on according to the schedule given in the course outline.
- Important Dates:**
- |                   |                                   |
|-------------------|-----------------------------------|
| Midterm Exams     | June 17 – 21                      |
| Holidays          | Monday, May 20 and Monday, July 1 |
| Lecture cancelled | Friday, June 14                   |
| Final Exams       | August 3 – 16                     |

**Academic Integrity:** In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. Check the Office of Academic Integrity website for more information.

[www.uwaterloo.ca/academicintegrity](http://www.uwaterloo.ca/academicintegrity)

**Grievance:** A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4. When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

[www.adm.uwaterloo.ca/infosec/Policies/policy70.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm)

**Discipline:** A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties check Guidelines for the Assessment of Penalties. [www.uwaterloo.ca/academicintegrity](http://www.uwaterloo.ca/academicintegrity)

[www.adm.uwaterloo.ca/infosec/Policies/policy71.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm)

[www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm](http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm)

**Appeals:** A decision made or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72, Student Appeals.

[www.adm.uwaterloo.ca/infosec/Policies/policy72.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm).

**Note for Students with Disabilities:** The AccessAbility Services, located in Needles Hall, Room 11401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

**Mental Health:** There are many mental health resources available on campus and in Waterloo Region. If you are experiencing a crisis, feeling stressed out, or just need someone to talk to, available resources can be found at:

- List of Mental Health Resources: <https://www.engsoc.uwaterloo.ca/resources/mental-health/>
- Engineering Counselling: <https://www.engsoc.uwaterloo.ca/resources/engineering-counselling/>
- UW Campus Wellness: <https://uwaterloo.ca/campus-wellness/>

If you are experiencing a mental health emergency you should go to Counselling Services, or if after hours the nearest emergency room at Grand River Hospital.

**Acknowledgement of Traditional Territory:** We acknowledge that the University of Waterloo is located on the traditional territory of the Neutral, Anishnaabeg, and Haudenosaunee people.

## Schedule of Lecture Topics

Text sections in (brackets), Practice problem sets in ***bold italics***

Week	Lecture #			
	1	2	3	4
1	Introduction Round off, truncation errors, propagation (3.1-3.4, 4.1-4.4)	Roots of equations Graphical methods (5.1)	Bisection method (5.2)	
2	Open methods for root finding, fixed point, Newton Raphson (6.1-6.2)	Secant method Application example <b><i>Problem Set #1</i></b>	Systems of linear equations, introduction (PT3.1-3.3,9.1)	
3	Gaussian elimination (9.2,9.3)	Gaussian elimination, pivoting and scaling (9.3-9.4) <b><i>Problem Set #2</i></b>		
4	Iterative methods Gauss Seidel (11.1-11.2)	Gauss Seidel with relaxation (11.1-11.2) <b><i>Problem Set #3</i></b>	Curve fitting, polynomial regression (17.1)	Linear and polynomial interpolation (18.1)
5	Spline interpolation (18.1-18.2)	Numerical integration Romberg integration (21.2)	Gaussian quadrature (21.2) <b><i>Problem Set #4</i></b>	
6	Numerical differentiation (23.1-23.2)	Numerical solution of ordinary differential equations (ODEs) (25.1)	Euler's method Runge Kutta method (25.2,3)	
7	<b>Midterm Week – lectures cancelled</b>			
8	Higher order Runge Kutta methods (25.3,4)	ODEs, Boundary value problems (27.1) <b><i>Problem Set #5</i></b>	Finite element analysis (FEA) introduction (31.1)	
9	FEA, 1D analysis (31.2)	FEA, 1D analysis (31.2) <b><i>Problem Set #6</i></b>	Partial differential equations (PDEs), introduction (PT8.1-8.2)	
10	PDEs Laplace and Wave equations	Boundary and initial conditions Solutions of PDEs	Separation of variables solution, PDEs	Separation of variables solution, PDEs <b><i>Problem Set #7</i></b>
11	Numerical solution of PDEs (29.1-29.2)	Elliptic equations and boundary conditions (29.1-29.2)	Parabolic equations, 1D heat diffusion, explicit methods (30.1-30.2)	
12	1D heat diffusion, implicit methods, Crank Nicolson (30.3-30.4)	Hyperbolic equations, 1D wave equation <b><i>Problem Set #8</i></b>	FEA, 2D systems	
13	TBD	TBD		