

# SYDE 750: Modelling Continuum Systems

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January 2021

## OBJECTIVES

The principle goal of this course is to introduce the student to the mathematical foundations of two of the most important numerical analysis tools used by the modern engineer. The finite difference method and the finite element method are used extensively in every engineering field and it is important that an engineer have an appreciation of the capabilities and limitations of these methods.

## SUGGESTED TEXTS

1. Smith, G. D., “Numerical Solution of Partial Differential Equations: Finite Difference Methods”, Third Edition, Clarendon Press, Oxford, 1985. (Call Number: QA374.S56 1985)
2. Kaliakin, V., “Introduction to Approximate Solution Techniques, Numerical Modeling, and Finite Element Methods” Dekker Marcel Inc., 2001. (Call Number: TA347.F5 K35 2002 )

Other references worthy of note:

1. Burnett, David S., “Finite Element Analysis”, Addison Wesley, 1987. (Call Number: TA347.F5B87 1987)
2. Mura, Toshio, and Koya, Tatsuhito, “Variational Methods in Mechanics”, Oxford University Press, New York, 1992. (ISBN 0-19-506830) (Call Number: TA347.F5M87 1992)
3. Cook, Robert Davis, Malkus, David S., Plesha, Michael E., “Concepts and applications of finite element analysis”, New York; Toronto: Wiley, 1989. 3rd edition (Call Number: TA646.C66 1989)

## Course Evaluation

Assignments: 50%

Assignment Schedule		
Assignment Number	Date Available	Date Due
1	Friday January 22, 2021	Monday February 8, 2021
2	Friday February 5, 2021	Monday February 22, 2021
3	Friday February 19, 2021	Monday March 8, 2021
4	Friday March 5, 2021	Monday March 22, 2021
5	Friday March 19, 2021	Monday April 5, 2021

Final Exam: 50%

## COURSE OUTLINE

Classes Begin: January 11, 2021

Classes End: April 14, 2021

The following is an approximate chronology of the material to be covered in this course. The course does not assume any prior knowledge of the areas that examples will be drawn from; usually structural analysis and heat transfer analysis. The appropriate sections of the text may be read as the course proceeds. The texts listed above are suggested because no single book covers the material to be presented in this course. The lectures are complete in themselves and it is possible to do very well without a text. However past students have consistently asked for a text so those given above have been recommended and are on reserve in the Library. Between them they cover the course material very well.

1. Introduction to Finite Difference Operators
  - (a) Backward, Central, Forward Differences
  - (b) Difference Order
  - (c) Truncation Error
  - (d) Convergence
  - (e) Consistency
  - (f) Stability
2. Finite Difference Solution of Boundary Value Problems
  - (a) Elliptic Problems
  - (b) Parabolic Problems
  - (c) Hyperbolic Problems
  - (d) Characteristic Value Problems
3. Special Initial Value Problems
4. Introduction to the Calculus of Variations
5. Methods of Weighted Residuals
6. Introduction to the Finite Element Method (FEM)
7. FEM and Structures
8. FEM and Heat Conduction Problems
9. FEM and Structural Dynamics Problems

## **UW and Faculty of Engineering Course Responsibilities<sup>1</sup>:**

[www.uwaterloo.ca/accountability/documents/courseoutline.pdf](http://www.uwaterloo.ca/accountability/documents/courseoutline.pdf)

### **Academic Integrity:**

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

### **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, [www.adm.uwaterloo.ca/infosec/Policies/policy70.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm). When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

### **Discipline:**

A student is expected to know what constitutes academic integrity [check [www.uwaterloo.ca/academicintegrity/](http://www.uwaterloo.ca/academicintegrity/)] 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, [www.adm.uwaterloo.ca/infosec/Policies/policy71.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm). For typical penalties check Guidelines for the Assessment of Penalties, [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:**

AccessAbility Services 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.

### **Turnitin.com:**

Plagiarism detection software (Turnitin) will not be used to screen assignments in this course.

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<sup>1</sup>This section is required, by the University of Waterloo, to be in the course outline