

## MTH 444/544 Fundamentals of Applied Mathematics II - Spring 2012

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### **Office Hours:**

**Course Description:** The mathematical description of material behavior for solids, liquids and gases using the unified framework of continuum mechanics. There are two main themes:

1. derivation of the equations governing material behavior
2. application of the equations to describe material phenomena

### **Prerequisites:**

- It is not necessary to have taken MTH 443/543.
- Students must have completed MTH 141, 142, 241, 306 with minimum grade C, (preferably with grade B or above) - students should feel comfortable with lengthy calculations involving 1 or more pages of work, and have good working knowledge of "gradient, divergence and curl", as well as how to solve differential equations.
- While not required, some exposure to partial differential equations (e.g. MTH418 or other courses) is very beneficial.

### Course Materials

**Books:** The required portions of [LS] and [S] are available as a "coursepack" at Great Lakes Graphics & Printing in the UB Commons. Both books are also on 2-hour reserve in the Capen Library.

[LS] C.C. Lin and L.A. Segel, "Mathematics Applied to Deterministic Problems in the Natural Sciences" (SIAM, 1988), Chapters 13-15.

[S] L.A. Segel, "Mathematics Applied to Continuum Mechanics" (Dover, 1987), Chapters 1-6.

Some students might find this supplementary online text useful for additional explanations and/or examples of some topics: W. M. Lai, D. Rubin and E. Krempl, "Introduction to Continuum Mechanics" (4th ed, Elsevier, 2010). It is available online through the UB library at [http://www.knovel.com/web/portal/browse/display?\\_EXT\\_KNOVEL\\_DISPLAY\\_bookid=3187](http://www.knovel.com/web/portal/browse/display?_EXT_KNOVEL_DISPLAY_bookid=3187)

**UBlearns:** contains homework assignments, announcements, Maple programs for lecture and assignments, and occasional copies of lecture notes.

**Maple:** Maple is a symbolic mathematics package which we will use occasionally to solve equations and graph/animate solutions. The Maple program is on all CIT public computers on campus. Maple for your own computer is available by download at <http://ubit.buffalo.edu/software/win/maple>

### Coursework

**Exams:** 2 exams given on dates listed in Lecture Plan

**Homework:** Assigned homework is due about once per week. Homework points are based on difficulty/effort required (5pts = easy, 10pts = moderate, 15-20pts = hard). The overall homework grade is based on the total points of all assignments.

**Late Homework Policy:** Assignments are due in lecture on the due date. Late assignments are accepted up to one day late but with the following penalties:

-20% if turned in by 5pm same day

-40% if turned in by 5pm next day

**MTH 544 Students:** In accordance with the policy of the graduate school, graduate students will have additional coursework consisting of additional homework and/or exam questions.

### Grades

**Course grades** will be determined by averaging the grades with the weightings:

Homework      40%

Exam #1        30%

Exam #2        30%

MTH444 and MTH544 will have separate grading scales.

**5-point grading scale:** For keeping track of course grades on exams and homework a 5-point scale is used:

A+ = 4.66-5.00

A = 4.33-4.66

A- = 4.00-4.33

B+ = 3.66-4.00

B = 3.33-3.66

B- = 3.00-3.33

C+ = 2.66-3.00

C = 2.33-2.66

C- = 2.00-2.33

D+ = 1.66-2.00

D = 1.33-1.66

D- = 1.00-1.33

+/- grades will be used in assigning course grades. Note the university does not permit A+ or D- grades.

**Academic Honesty:** Students are expected to adhere to the university policy on academic honesty. Cheating, plagiarism, or misrepresentation of your work will result in formal charges.

**Incompletes:** Incompletes will be given only under extraordinary circumstances (like surgery during the last week of class).

### Other

**Important dates:**

Mon Jan 23 – Last day to drop the course – no record appears on transcript.

Fri Mar 30 – Last day to resign from the course – an “R” appears on the transcript.

**Students with Disabilities:** If you have a diagnosed disability (physical, learning or psychological) which will make it difficult for you to carry out the course work as outlined, or requires accommodations such as recruiting note takers, readers or extended time on exams and/or assignments, please advise me during the first two weeks of the course so that we may review possible arrangements for reasonable accommodations.

## Lecture Plan

### **The Continuous Medium [LS] Ch 13**

- 1/17 intro to course, 13.1 the continuum model
- 1/19 13.2 kinematics of deformable media
- 1/24 13.3 material derivative, 13.4 Jacobian of deformation

### **Field Equations of Continuum Mechanics [LS] Ch 14**

- 1/26 14.1 conservation of mass
- 1/31 14.2 conservation of linear momentum
- 2/2 14.3 conservation of angular momentum
- 2/7 14.4 conservation of energy
- 2/9 14.5 constitutive equations

### **Inviscid Fluid Flow [LS] Ch 15**

- 2/14 15.1 inviscid fluids
- 2/16 15.2 stability of stratified fluids
- 2/21 15.2 stability of stratified fluids
- 2/23 15.3 compression waves in gasses
- 2/28 15.4 flow past a cylinder
- 3/1 Review for Exam
- 3/6 **Exam #1** on [LS] Ch 13-15

### **Viscous Fluid Flow [S] Ch 3**

- 3/8 Ch 1,2 tensors and tensor notation
- 3/13 SPRING BREAK
- 3/15 SPRING BREAK
- 3/20 3.1 Navier-Stokes equations
- 3/22 3.2 exact solutions to Navier-Stokes equations
- 3/27 3.2 exact solutions to Navier-Stokes equations
- 3/29 3.6 slow viscous flow past a small sphere
- 4/3 3.3 boundary layers – introduction

### **Foundations of Elasticity [S] Ch 4**

- 4/5 4.1 analysis of strain
- 4/10 4.2 Hooke's law and elasticity solutions
- 4/12 4.3 linear elasticity formulation

### **Static Problems in Elasticity [S] Ch 5**

- 4/17 5.1 bending of beams
- 4/19 5.1 bending of beams

### **Dynamic Problems in Elasticity [S] Ch 6**

- 4/24 6.1 elastic waves
- 4/26 Review for Exam
- tba **Exam #2** on [S] Ch 3-6 + tensor notation (during final exam week)