

## **BSE 3144: Engineering Analysis for Biological Systems (Numerical Methods)**

*Syllabus and Course Outline*  
*Spring 2016*

Location: Saunders 409  
Meeting Day/Time: MW 11:15am – 12:05pm

Instructor: Ryan S. Senger  
Office: 301C HABB1  
Office Phone: 540-231-9501  
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Office Hours:  
Thursday, 4-5pm, 301C HABB1

Homework Problem Session:  
Monday, 5:30-6:30pm, Saunders 409

TA: Mehdi Ketabchy  
Email: kmehdi87@vt.edu  
Office Hours: Wednesday, 4-6pm, Seitz 202A

TA: Akin Akinola  
Email: akinola1@vt.edu  
Office Hours: Tuesday, 3:30-5:30pm, Seitz 202A

Course (Catalog) Description:

### **3144: Engineering Analysis for Biological Systems Using Numerical Methods**

Solving engineering problems related to biological systems using numerical analysis including root finding, numerical integration, differentiation, interpolation, and numerical solution of ordinary differential equations. Error analysis and programming with engineering software. (2H, 2C)

**Course Description:** This course focuses on the process of solving engineering problems related to biological systems using numerical analysis including root finding, numerical integration, differentiation, interpolation, numerical solution of ordinary differential equations, error analysis, and programming with MATLAB. The numerical methods included in this course are used by many types engineers, and this class will include examples relevant for biological systems engineers.

We will spend a significant portion of this course learning the basics of MATLAB programming. Although we focus on MATLAB, the techniques developed here are applicable to other computer languages. Furthermore, the techniques provide a

logical approach to addressing complex problems, breaking them down into manageable (and solvable) pieces.

**Co-requisites:** BSE 2004, Introduction to Biological Systems Engineering; MATH 2214, Introduction to Differential Equations

**Textbook:** Chapra, S.C. (2012) Applied Numerical Methods with MATLAB. 3<sup>rd</sup> ed.

**Computer Requirements and Policies:**

- A student version of MATLAB (<http://ita.vt.edu/studentsoftware/website/>)
- A functioning laptop computer, with you at class
- Class material will be posted on Canvas (<https://canvas.vt.edu>)
- While in class, only view class materials on your laptop, tablet, phone, etc.

**Course Objectives:** Upon successful completion of this course, students shall be able to do the following:

1. Apply the following numerical techniques to solve problems in biological systems engineering:
  - a. Root finding
  - b. Solution of systems of linear equations
  - c. Interpolation
  - d. Differentiation and integration
  - e. Solution of ordinary differential equations
2. Define and quantify sources of error in numerical techniques
3. Write programs, using engineering software, that involve loops, logical block constructs, functions, plotting, and input/output

**Evaluation and Grading:**

Item	Percentage
Homework	20%
Exam 1	20%
Exam 2	20%
Exam 3	20%
Final Exam	20%
Total	100%

Letter Grade	Percentage	Letter Grade	Percentage
A+	97-100	C+	77-79
A	93-97	C	73-76
A-	90-92	C-	70-72
B+	87-89	D+	67-69
B	83-86	D	63-66
B-	80-82	D-	60-62
		F	0-59

**Grade Curve:** The average for each exam and the total homework average will be at least 80%. If the class average is below 80%, a simple curve will be applied (i.e., everyone gets the same number of points). If the class average is above 80%, that is great. At no time will points be deducted due to a curve. You can only gain points from a grade curve.

**Extra Credit:** There is no extra credit in this course. The grade curve is designed to eliminate the need for extra credit.

**Canvas:** The course syllabus, lectures, schedule, and other relevant materials will be placed on the Canvas website developed for this course. Students unable to access this website should contact the instructor immediately. <https://canvas.vt.edu/>

**Homework:** Assignments will be posted on Canvas at least one week before the due date. Students are encouraged to work in teams and consult with classmates regarding homework problems. However, each student must submit his or her own homework assignments. Any assignment submitted with two or more names will not be graded. Even though teamwork is encouraged, all submitted homework assignments must be the student's own work. In other words, no two homework assignments should be identical. Homework assignments must be submitted as a single file in pdf format to Canvas, and assignments can be submitted at any time on the due date.

**Class Attendance:** It is strongly recommended that students attend all class periods and participate in class discussions. This will be reflected in the student's grade through better performance on homework assignments and exams. Spontaneous class discussions may not appear in the pre-prepared lecture notes posted on the Canvas website; however, this material may appear in a homework or exam question. Students are encouraged (but not required) to let the instructor know when they need to miss class.

**Virginia Tech Honor System:** As a University requirement, all incidents of cheating and plagiarism must be reported by the course instructor to the VT Honor Code Panel. This includes the use of unapproved wireless devices during tests and multiple students submitting identical homework assignments. Any incidence of cheating must be reported. For more information, please see: <http://www.honorsystem.vt.edu/>.

**Late Assignments:** Homework assignments must be submitted electronically to Canvas. Homework assignments can be uploaded at any time on the due date. Homework assignments received after the due date will receive a 10% penalty per day.

**Make-Up Exams:** In the event that an exam must be taken at an earlier or later date or time, written notice is required 1 week before the scheduled exam date. In the case

of an emergency or illness, special arrangements will be allowed as long as written documentation or a doctor's note is submitted.

**Students with Disabilities:** Any student who feels he or she may need accommodation because of a disability (e.g., learning disability, attention deficit disorder, psychological, physical, etc.), please make an appointment to see me during office hours.

**Principles of Community:** A learning environment will be created strictly adhering to the Virginia Tech Principles of Community. <http://www.vt.edu/diversity/principles-of-community.html>

**Course Outline (Tentative):** The following schedule is subject to change.

<b>Date (2016)</b>	<b>Lecture</b>	<b>Reading Assignment</b>
1/20	1. Introductions; Mathematical models	Chapter 1
1/25	2. Conservation laws and numerical methods	Chapter 1
1/27	3. MATLAB Fundamentals; <b>HW1 Due</b>	Chapter 2
2/1	4. MATLAB Fundamentals	Chapter 2
2/3	5. Programming with MATLAB; <b>HW2 Due</b>	Chapter 3
2/8	6. MATLAB examples	Chapter 3
2/10	7. Roundoff and truncation errors; <b>HW3 Due</b>	Chapter 4
2/15	8. Examples and review	
2/17	<b>Exam 1</b> (In class)	
2/22	9. Roots: Bracketing methods	Chapter 5
2/24	10. Roots: Open methods	Chapter 6
2/29	11. Optimization	Chapter 7
3/2	12. Optimization; <b>HW4 Due</b>	Chapter 7
3/7	No Class (Spring Break)	
3/9	No Class (Spring Break)	
3/14	13. Linear algebraic equations and matrices	Chapter 8
3/16	14. Gauss elimination; <b>HW5 Due</b>	Chapter 9
3/21	15. Linear regression	Chapter 14
3/23	16. Linear least-squares; <b>HW6 Due</b>	Chapter 15
3/28	17. Examples and review	
3/30	<b>Exam 2</b> (In class)	
4/4	No Class	
4/6	18. Numerical integration	Chapter 19
4/11	19. Numerical integration	Chapter 19
4/13	20. Numerical differentiation; <b>HW7 Due</b>	Chapter 21
4/18	21. Ordinary differential equations	Chapter 22
4/20	22. Ordinary differential equations; <b>HW8 Due</b>	Chapter 22
4/25	23. Examples and review	
4/27	<b>Exam 3</b> (In class)	
5/2	No Class	
5/4	24. Review	
5/11	<b>Final Exam</b> (10:05am – 12:05pm)	