

**Math 107.01: Linear Algebra and Differential Equations**

TTh 10:05am – 11:20pm, Room 116, Old Chemistry Building

<http://www.math.duke.edu/~alayton/math107/>

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This course will discuss:

- *Linear algebra*: Systems of linear equations, matrix operations, vector spaces, linear transformations, orthogonality, determinants, eigenvalues and eigenvectors, diagonalization.
  - *Differential equations*: Linear differential equations and systems with constant coefficients and applications, computer simulations.
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**Office Hours:** (tentative)

Layton: TTh 11:20–11:40pm (Old Chem 116), Th 1:05–2:00pm (Physics 213).

Mela: M: 10:00–11:00am, W: 1:30pm–2:30pm, F: 11:30am–12:30pm (Physics 029B).

**Textbooks:** *Linear Algebra and Differential Equations*, by Gary L. Peterson and James S. Sochacki**Prerequisites:** Math 102, 103, or 105, some knowledge of matlab.**Homework:** Problem sets are collected weekly at your recitations. Normally, you will submit problem sets for topics covered by the preceding Tuesday lecture and the Thursday lecture before that. (E.g., On the 9/4 Friday or 9/7 Monday recitations, you will turn in problem sets for lectures on 8/27 and 9/1, i.e., Sections 1.2 and 1.3; see “Course Outline and Homework Syllabus.”)Homeworks are to be turned in at the *beginning* of your recitations. Late assignments will *not* be accepted.

Your homework score is the average of all but the two worst assignment grades.

You are encouraged to discuss the homework problems with each other, but your final submission (written hard-copies and electronically submitted codes) must be entirely your own independent work. The Duke Community Standard will be assumed in full effect throughout this course.

**Tests and final examination:** There will be two tests and a final exam.**Grading:** Course grades will be based on the problem sets (20%), the two tests (40%), and the final exam (40%).

Needless to say, you are required to attend all lectures and recitations. Excessive absence or poor participation may adversely affect your final grade.

Test grade revision requested may be accepted only in writing and within *one* week of the return of your graded test. Late requests will not be accepted.

**Computing Environment:** MATLAB

## Course Outline and Homework Syllabus

Week	Date	Topic(s)	Reading	Problems
1	8/25	systems of linear equations	1.1	2,8,15,18,19,22,23,26,28 30 (intro to Matlab) Additional Problem 1
	8/27	matrices and matrix operations	1.2	5,9,11,12,14,18,20,21,23,28–30,37
2	9/1	inverses of matrices	1.3	1,6,7,10,11(b),13,14,16,26
	9/3	special matrices	1.4	4,12,17,20,22(c),24(d),26,32,33
		determinants	1.5	5,8,12,15,16
3	9/8	proofs and applications	1.6	4,6,10,11,13,15(c),16,17
	9/10	proofs and applications	1.7	5–7
4	9/15	linear independence in $\mathbb{R}^n$	2.3	1–3,6
	9/17	vector spaces	2.1	2,3,9
		subspaces	2.2	1(c,d),2(b,d),3(c),5,11–13,21,22
5	9/22	linear independence	2.3	7,10,14,17,21,24,25,27,28,32
		dimension	2.4	2,3(a,b),4(c,d),7,10,14,18,21,26
	9/24	Wronskians	2.5	5–8,12,14,16
6	9/29	modeling with DE	3.6	1,2,4,11,13,15,16
<b>First test Tuesday 10/1. Covers material through Section 2.5</b>				
7	10/6	Fall break; no class		
	10/8	intro differential eqns	4.1 3.1	2,3,6,10,11,15,17,24 1,4,7
8	10/8	homogeneous CCLDE (i)	4.2	2,5,23 Additional Problems 2 and 3
	10/15	CCLDE (ii) undeterm coeff	4.2 4.3	7,10–13,20,22,24,29,30,37,40–42 1,4,9,11,18,36
9	10/20	applications (i)	4.5	5–8,11,13
	10/22	applications (ii)	4.5	1,3,15,16,18
10	10/27	linear transformations	5.1	3,4,7,12,13,18,20,33,35,36
	10/29	algebra of LT	5.2	6,11,14,18,20,23
11	11/3	matrices	5.3	1,5,7,9,17
		eigenvalues	5.4	5,8,9,16,17,20,26,32
	11/5	similar matrices, Jordan	5.5	5,8,9,16,17,21,24,30,31,36 32 (is A diagonalizable?)
12	11/10	inner product spaces	9.1	6–8,12,16,18,20–22
	11/12	orthonormal bases	9.2	2,6,9,13
		Schur's thm, symmetric matrices	9.3	
13	11/17	systems of LDE	6.1	1,4,5,9,17,27,28
<b>Second test Tuesday 11/19. Covers material through Section 9.3</b>				
14	11/24	constant coeffs diag	6.2	3,5,11,15,22,25,28,30
		nondiag	6.3	3,17
	11/26	Thanksgiving; no class		
15	12/1	nonhomogeneous systems	6.4	1,5,11,13,15
	12/3	converting eqns	6.5	4,5,13

## Additional Problems

1. In parts (a) and (b) assume that the given system is consistent. For each system determine all possibilities for the numbers  $r$  and  $n - r$  where  $r$  is the number of nonzero rows of the (reduced) row echelon form of the augmented matrix and  $n$  is the number of the unknowns of the given system.
- (a)  $Ax = b$  where  $A = [a_{ij}]_{3 \times 2}$ .
- (b)  $Ax = b$  where  $A = [a_{ij}]_{3 \times 4}$ .

2. In each of the following write the given expression in the form  $a + ib$ :

(a)  $\frac{3+i}{4-5i}$ , (b)  $\exp(2 - 3i)$ , (c)  $e^{i\pi}$ ,  
(d)  $e^{2-i\pi/2}$ , (e)  $2^{1-i}$ , (f)  $\pi^{1+2i}$ .

3. Solve each of the following equations:

(a)  $x^4 + 2x^2 + 1 = 0$ , (b)  $x^5 + 1 = 0$ .