COURSE SYLLABUS
Math 422.01 -- LINEAR ALGEBRA II
Fall 2016

CRN: 10726
CREDIT HOURS: 3
HOUR/DAY: 9:00 – 9:50 a.m. M W F
MEETING ROOM: Wickersham Hall, Room 201

INSTRUCTOR: Dr. Ron Umble
OFFICE: Wickersham Hall, Room 203
OFFICE PHONE: 871-7318
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OFFICE HOURS: 10:00 - 11:00 a.m. M F
11:00 a.m. – noon M R F
and by appointment

REQUIRED TEXTS: H. Anton and C. Rorres, *Elementary Linear Algebra, Applications Version*, 11th Ed., John Wiley & Sons, Inc., New York, 2014. ISBN 978-1-118-43441-3.

L. Johnson, R. Riess and J. Arnold, *Introduction to Linear Algebra*, 5th Ed., Addison Wesley/Pearson Education, Inc. 2002. ISBN 0-201-65859-3.

R. Umble, *Lecture Notes on Linear Algebra: A Second Course,* free download on D2L, 2014.

CALCULATOR: TI-86 or higher (TI-83/84 can't handle some necessary calculations)

FORMAT: Lecture

RATIONALE: Linear algebra is an essential cornerstones of mathematics. Its powerful tools are applied in virtually every area of pure and applied mathematics. A strong foundation in linear algebra is essential for success in every mathematical endeavor.

Throughout this course you will encounter many new theoretical ideas and a wide range of practical applications. Working with applications helps to solidify your theoretical understanding, strengthen your computational skill, and build your self-confidence.

OBJECTIVES: Upon completion of this course, the student will be able to:
1. Apply concepts of Linear Algebra to solve a variety of practical problems
2. Find the matrix of a linear map relative to given bases
3. Find the transition matrix for a change of basis
4. Compare square matrices for similarity
5. Compute eigenvalues and bases for corresponding eigenspaces
6. Diagonalize matrices whenever possible
7. Find the matrix representation of a quadratic form
8. Orthogonally diagonalize a quadratic form
9. Compute the spectral decomposition of a real symmetric matrix
10. Compute the singular value decomposition of any mxn matrix
11. Reduce an nxn matrix to Hessenberg form

12. Compute the characteristic polynomial of a Hessenberg matrix
13. Compute generalized eigenvectors of an unreduced Hessenberg matrix
14. Use Householder transformations to reduce an mxn matrix ($m \geq n$) to trapezoidal form
15. Reduce a singular matrix to Nonsingular-Nilpotent form
16. Compute the Jordan Canonical Form of an nxn matrix

COMMENTS: This course begins with a review of Linear Algebra I. After the fundamentals are well in hand, we move on to the new topics in the course. Lectures during the review period include a brief discussion of the Review Topic (RT) followed by an application (APP). To prepare for class, read the text to be covered carefully, take notes as you read, flag points that seem unclear to you, and bring your questions from the reading to class for discussion. Work out each example in the text BEFORE attempting the homework exercises.

UNDERSTANDINGS: 1. You are expected to attend all classes.

2. You are expected to complete all assigned work on time.

3. You may work together on problem sets, however you must write up your solutions independently.

4. Exams missed for the following reasons can be made up:
   a. Illness documented by campus infirmary or family physician
   b. Death of a family member
   c. Out-of-classroom educational experiences*
   d. University athletic contests*
   e. Religious holidays*
   f. Jury duty*

   *Requires advance notification

EVALUATION:

Course Component	**Weight**
Problem sets* (6 @ 3%)	18%
Hour exams (2 @ 24%)	48%
Individual project	10%
Final examination	24%

*Lowest problem set score is dropped

Grading Scale:

93% - 100%	A*	73% - 76%	C
90% - 92%	A-	70% - 72%	C-
87% - 89%	B+	67% - 69%	D+
83% - 86%	B	63% - 66%	D
80% - 82%	B-	60% - 62%	D-
77% - 79%	C+	Below 60%	F

* At my discretion, Course Honors will be awarded for exceptional scholarship.

COURSE SCHEDULE
Math 422.01 -- LINEAR ALGEBRA II
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Date		Topic	Text Reading		Homework Anton
		Johnson (A=Anton; J=Johnson)			
Aug	29M	RT: Systems of linear equations w/ real coefficients			1 – 34 J59:43,49,61,69
		APP: Network analysis: traffic and current flow	84 – 88		A94:1,3,5,7
		PROBLEM SET #1 ASSIGNED			
	31W	RT: Computing the inverse of a matrix	52 – 58	92 – 102	A59:9a,11a,13,15
		RT: Determinants	105 – 109	447 – 453	J102:11,13,29,48
		APP: Curves and surfaces through specified points		528 – 532 J453:1,9,15,21	A532:1a,2a,3,4a,6a
Sept	2F	Systems of linear equations w/ complex coefficients			320 – 321 J324:1-17(x2),25,26
		APP: Polynomial interpolation	91 – 93	80 – 88	J90:1,5,9,11,13
		APP: Simpson's rule	Lecture notes		
	5M	**LABOR DAY (NO CLASS)**			
	7W	RT: Real vector spaces and linear independence	183 – 210	71 – 78	A200:7,9,19; J78:9,13
		Complex vector spaces	313 – 315	316 – 318	A210:9,15; A324:1,3,5,7,9
	9F	RT: Real inner product spaces	345 – 360	392 – 400	A353:13,17,25,27,31
		Complex inner product spaces	316 – 317		A324:11,13,27,29,30
		PROBLEM SET #1 DUE			J401:1,13
		PROBLEM SET #2 ASSIGNED			
	12M	RT: The Gram-Schmidt process	364 – 373		A376:1,5,7,9,11,15,19,29
		APP: QR decomposition	374 – 375		A377;45,49
	14W	RT: Matrix representation of linear transformations		472 – 478	419 – 429 A479:1,5,9,13
		RT: Dimension Theorem	447 – 455	225 – 239	A456: 7,10,11,12,13,14 J239:3,5,8,11,19-29
	16F	APP: Wronskian determinants	Lecture notes		Exercises in lecture notes
		APP: Least squares and data fitting	378 – 386	243 – 254	A386:3,7,15; J254:1,7,11
	19M	RT: Compositions, inverses, isomorphisms, and inner product space isomorphisms	458 – 470		A464:1,3,11,13,15,22 A471:1,3,5,7,11
	21W	APP: Geometry of matrix operators on $\mathbf{R}^2$	280 – 287		A287:1-4,5-21(x2),22-26
		APP: Translating with homogeneous coordinates	Handout		TBD
		PROBLEM SET #2 DUE			
		PROBLEM SET #3 ASSIGNED			
	23F	RT: Change of basis	229 – 234	431 – 438	A235:1,2a,3,4a,5,7,11
	26M	RT: Real eigenvalues and eigenspaces	291 – 299	298 – 315	A300:1,3a,5a,13,15,19,21
		APP: Reflections in R2; rotations in R3	Lecture notes		TBD
	28W	RT: Diagonalization	302 – 311	327 – 330	A311: 5-25(x4) RT:
		Orthogonal matrices	401 – 407	330 – 333	A407:3,5,7,11,13,15,21
		Complex eigenvalues and eigenspaces	317 – 324	319 – 324	A324:21,23; J324:19

	30F	Hermitian, unitary, and normal matrices	437 – 442		A443:1,3,7,9,19,21,23,25	
		APP: Geometry of space-time & special relativity I		Lecture notes		
Exercises 1-7 in notes						
Oct	3M	APP: Geometry of space-time & special relativity II		Lecture notes		
Exercises 8,9 in notes						
		APP: Systems of linear differential equations	326 – 330		A330:1,3,7,9	
		PROBLEM SET #3 DUE				
		PROBLEM SET #4 ASSIGNED				
Date		**Topic**	**Text Reading**			
Homework						
			Anton	**Johnson**	**(A=Anton; J=Johnson)**	
Oct	5W	APP: The Fibonacci sequence and the Golden Ratio		Lecture notes		
	7F	**HOUR TEST I**				
	8-11	**FALL BREAK**				
	12W	Orthogonal diagonalization of symmetric matrices		409 – 412	333 – 336	A416:7,11,13
		Unitary diagonalization of normal matrices	441 – 442		A443:1,3,11,13,15,17,29	
	14F	Spectral decomposition of a real symmetric matrices		413 – 415		A416:15-18
	17M	Quadratic forms and the Principal Axis Theorem	417 – 422	484 – 492	A427:1,3,5,9,11-21(odd)	
		PROBLEM SET #4 DUE				
		PROBLEM SET #5 ASSIGNED				
	19W	APP: Identifying conics and quadrics	422 – 427		A428:11,13,15; J492:7,19	
	21F	APP: Optimizing quadratic forms	429 – 435		A436:3,5,7,9,11,19	
		PROJECT OPTIONS				
	24M	The singular value decomposition	514 – 520		A520:1-11(odd)	
	26W	APP: Data compression	521 – 523		A524:1-9(odd)	
		Similarity invariants	481 – 485	325 – 327	A311:1-4; A486:1,2,23,24,T-F	
	28F	Reduction to Hesenberg form (Algorithm 1)		502 – 509	J509:1-9(odd)	
		PROBLEM SET #5 DUE				
		PROBLEM SET #6 ASSIGNED				
	31M	Krylov's Method – Computing characteristic polynomials		510 – 518	J518:1-13(x4)	
		PROJECT SELECTIONS DUE				
Nov	2W	Householder transformations		519 – 529	J529:1-15(odd)	
		PROJECTS ASSIGNED				
	4F	Reduction to Hessenberg form (Algorithm 2)			J529:21,22	
		APP: Least-squares revisited		531 – 536	J539:1-17(x4)	
	7M	APP: Computing eigenvalues -- The QR Algorithm		536 – 539		
	9W	The Cayley-Hamilton Theorem		540 – 545	J545:1-4	
	11F	Generalized eigenvectors		546 – 553	J553:1-5	
		PROBLEM SET #6 DUE				
		PROBLEM SET #7 ASSIGNED				
	14M	APP: Systems of differential equations	Lecture notes			Exercise
155						
	16W	Schur Triangularization Theorem	Lecture notes			S-T

Exercises

	18F	Another proof of the Cayley-Hamilton Theorem	Lecture notes	C-H Exercises
		Intro to Range-Nullspace decomposition of $\mathbf{C}^n$	Lecture notes	R-N Exercises
	21M	**HOUR TEST 2**		
	23-27	**THANKSGIVING BREAK**		
	28M	Proof of Range-Nullspace decomposition theorem		
		Intro to Nonsingular-Nilpotent form	Lecture notes	N-N Exercises
		PROBLEM SET #7 DUE		

Date		**Topic**	**Text Reading**	**Homework**
Nov	30W	Proof of Nonsingular-Nilpotent theorem	Lecture notes	
		Intro to Jordan form of a nilpotent matrix	Lecture notes	JF-Nil Ex 252,254,255
Dec	2F	Jordan form of a nilpotent matrix (continued)	Lecture notes	JF-Nil Ex 260-262
		PROJECT PROBLEM SET DUE		
	5M	Jordan Canonical Form of a general nxn matrix	Lecture notes	JF-Gen Exercise 273
	7W	JCF of a general nxn matrix (continued)	Lecture notes	JF-Gen Exercises 274-276
		APP: Powers of a general nxn matrix	Lecture notes	Exercise 279
		TAKE-HOME FINAL EXAM DISTRIBUTED		
	9F	APP: General systems of linear differential eq's	Lecture notes	Exercises 280-281
	12M	Project presentations (3)		
	14W	Project presentations (5)		
		TAKE-HOME F**INAL DUE AT 9:00 a.m.**		

Millersville University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to meet this commitment, comply with Title IX of the Education Amendments of 1972, 20 U.S.C. §1681, et seq., and act in accordance with guidance from the Office for Civil Rights, the University requires faculty members to report to the University's Title IX Coordinator incidents of sexual violence shared by students. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project. Faculty members are obligated to report to the person designated in the University Protection of Minors policy incidents of sexual violence or any other abuse of a student who was, or is, a child (a person under 18 years of age) when the abuse allegedly occurred.

Information regarding the reporting of sexual violence, and the resources that are available to victims of sexual violence, is available at http://www.millersville.edu/titleix/title-ix-policies-and-procedures.php

11-23-2016