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FORMAT 1

Submit original with signatures + 1 copy + electronic copy to Faculty Senate (Box 7500).

See http://www.uaf.edu/uafgov/faculty-senate/curriculum/course-degree-procedures-/ for a complete description of the rules governing curriculum & course changes.

TRIAL COURSE OR NEW COURSE PROPOSAL

SUBMITTED BY:

Department	**DMS**	**College/School**	**CNSM**
Prepared by	**Ed Bueler**	**Phone**	**x7693**
Email Contact	**elbueler@alaska.edu**	**Faculty Contact**	**Ed Bueler**

1. ACTION DESIRED (CHECK ONE): Trial Course [ ] New Course [X]

2. COURSE IDENTIFICATION: Dept **MATH** Course # **614** No. of Credits **3.0**

Justify upper/lower division status & number of credits: **Three lecture hours per week justifies 3.0 credits.**

3. PROPOSED COURSE TITLE: **Numerical Linear Algebra**

4. To be CROSS LISTED? *YES/NO* **NO** If yes, Dept: [ ] Course # [ ]

(Requires approval of both departments and deans involved. Add lines at end of form for additional required signatures.)

5. To be STACKED? *YES/NO* **NO** If yes, Dept. [ ] Course # [ ]

Stacked course applications are reviewed by the (Undergraduate) Curricular Review Committee and by the Graduate Academic and Advising Committee. Creating two different syllabi—undergraduate and graduate versions—will help emphasize the different qualities of what are supposed to be two different courses. The committees will determine: 1) whether the two versions are sufficiently different (i.e. is there undergraduate and graduate level content being offered); 2) are undergraduates being overtaxed?; 3) are graduate students being undertaxed? In this context, the committees are looking out for the interests of the students taking the course. Typically, if either committee has qualms, they both do. More info online – see URL at top of this page.

6. FREQUENCY OF OFFERING: **Alternate Falls**

Fall, Spring, Summer (Every, or Even-numbered Years, or Odd-numbered Years) — or As Demand Warrants

7. SEMESTER & YEAR OF FIRST OFFERING (AY2013-14 if approved by 3/1/2013; otherwise AY2014-15) **Fall 2015**

(Note: It is being offered in current semester, Spring 2013, as a Topics course.)

8. COURSE FORMAT:

NOTE: Course hours may not be compressed into fewer than three days per credit. Any course compressed into fewer than six weeks must be approved by the college or school's curriculum council. Furthermore, any core course compressed to less than six weeks must be approved by the core review committee.

COURSE FORMAT: (check all that apply) [ ] *1* [ ] *2* [ ] *3* [ ] *4* [ ] *5* [X] *6 weeks to full semester*

OTHER FORMAT (specify)

Mode of delivery (specify lecture, field trips, labs, etc) **Lecture.**

9. CONTACT HOURS PER WEEK: **3** LECTURE hours/weeks **0** LAB hours /week **0** PRACTICUM hours /week

Note: # of credits are based on contact hours. 800 minutes of lecture=1 credit. 2400 minutes of lab in a science course=1 credit. 1600 minutes in non-science lab=1 credit. 2400-4800 minutes of practicum=1 credit. 2400-8000 minutes [illegible] 1 credit.

This must match with the syllabus. See http://www.uaf.edu/uafgov/faculty-senate/curriculum/course-degree-procedures-/guidelines-for-computing-/ for more information on number of credits.

OTHER HOURS (specify type)

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College of Natural Science & Mathematics

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Governance
2/27/13 TLP

10. COMPLETE CATALOG DESCRIPTION including dept., number, title, credits, credit distribution, cross-listings and/or stacking (50 words or less if possible):

Example of a complete description:

FISH F487 W, O Fisheries Management
3 Credits Offered Spring
Theory and practice of fisheries management, with an emphasis on strategies utilized for the management of freshwater and marine fisheries. *Prerequisites: COMM F131X or COMM F141X; ENGL F111X; ENGL F211X or ENGL F213X; ENGL F414; FISH F425; or permission of instructor.* Cross-listed with NRM F487. (3+0)

MATH 614 Numerical Linear Algebra

3 Credits

Algorithms and theory for stable and accurate computation using matrices and vectors on computers. Matrix factorizations, direct and iterative methods for solving linear systems, least squares, eigenvalue and singular value decompositions. Practical implementation and application of algorithms. Prerequisites: MATH F314X Linear Algebra or equivalent or permission of instructor. Recommended: MATH F421 Applied Analysis OR MATH F401 Introduction to Real Analysis. (3+0)

11. COURSE CLASSIFICATIONS: Undergraduate courses only. Consult with CLA Curriculum Council to apply S or H classification appropriately; otherwise leave fields blank.

H = Humanities [ ] S = Social Sciences [ ]

Will this course be used to fulfill a requirement for the baccalaureate core? **If YES, attach form.**	**YES:**		**NO:**	**X**

IF YES, check which core requirements it could be used to fulfill:

O = Oral Intensive, **Format 6**		W = Writing Intensive, **Format 7**		Natural Science,("X" for Core) **Format 8**	

11.A Is course content related to northern, arctic or circumpolar studies? If yes, a "snowflake" symbol will be added in the printed Catalog, and flagged in Banner.

YES [ ] NO [ ]

12. COURSE REPEATABILITY:

Is this course repeatable for credit? **YES** [ ] **NO** [X]

Justification: Indicate why the course can be repeated (for example, the course follows a different theme each time).

How many times may the course be repeated for credit?		**TIMES**
If the course can be repeated for credit, what is the maximum number of credit hours that may be earned for this course?		**CREDITS**
If the course can be repeated with variable credit, what is the maximum number of credit hours that may be earned for this course?		**CREDITS**

13. GRADING SYSTEM: Specify only one. Note: Later changing the grading system for a course constitutes a Major Course Change.

LETTER: [X] **PASS/FAIL:** [ ]

RESTRICTIONS ON ENROLLMENT (if any)

14. PREREQUISITES	**MATH F314X Linear Algebra or equivalent or permission of instructor**

These will be *required* before the student is allowed to enroll in the course.

15. SPECIAL RESTRICTIONS, CONDITIONS	**None**
16. PROPOSED COURSE FEES	**$ 0**

Has a memo been submitted through your dean to the Provost for fee approval? **Yes/No**	

17. PREVIOUS HISTORY

Has the course been offered as special topics or trial course previously? **Yes/No**	**Yes**

If yes, give semester, year, course #, etc.: **As MATH 630 in Fall 2003. As MATH 694 in Spring 2009. As MATH 694 in Spring 2011. As MATH 665 in Spring 2013 (current).**

18. ESTIMATED IMPACT

WHAT IMPACT, IF ANY, WILL THIS HAVE ON BUDGET, FACILITIES/SPACE, FACULTY, ETC.

Only a lecture classroom needed. Based on previous/current enrollment (10, 5, 7, 9 in offerings), a small lecture room is fine.

19. LIBRARY COLLECTIONS

Have you contacted the library collection development officer (kljensen@alaska.edu, 474-6695) with regard to the adequacy of library/media collections, equipment, and services available for the proposed course? If so, give date of contact and resolution. If not, explain why not.

No	X	Yes		**Holdings are already adequate. Current textbook and many alternative texts already present. (Key texts include Golub&vanLoan, Saad, Higham; all are in the library.)**

20. IMPACTS ON PROGRAMS/DEPTS

What programs/departments will be affected by this proposed action?
Include information on the Programs/Departments contacted (e.g., email, memo)

In previous offerings a fraction of the class (~20%) has been from outside of MATH, esp. from engineering, geology & geophysics, physics. These students have taken this course as an elective. That should continue to happen.

21. POSITIVE AND NEGATIVE IMPACTS

*Please specify **positive and negative** impacts on other courses, programs and departments resulting from the proposed action.*

No known negative impacts; the course content is not offered in other UAF courses.

Positive impacts are many; MATH 614 would appeal to graduate students from multiple disciplines, expands the graduate mathematics curriculum for graduate mathematics students, may serve as a course that can be used as a source of material for graduate master's comprehensive exams in mathematics, MATH 614 may also be used as a elective in other graduate programs (also see Justification below).

JUSTIFICATION FOR ACTION REQUESTED

The purpose of the department and campus-wide curriculum committees is to scrutinize course change and new course applications to make sure that the quality of UAF education is not lowered as a result of the proposed change. Please address this in your response. This section needs to be self-explanatory. Use as much space as needed to fully justify the proposed course.

This is an applied mathematics course at the graduate level. The primary, but not at all exclusive, audience is graduate students in mathematics. Graduate students in physics, engineering, geophysics, computer science, statistics, and bioinformatics are able to take this course if they come with a background of undergraduate linear algebra and some mathematical maturity. The course has been, and will be, advertised to these other departments as an

appropriate technical elective.

This material it covers is central to modern technology including search, geophysical inversion, image and signal processing, computational finance, bioinformatics, and fluid dynamics.

APPROVALS: Add additional signature lines as needed.

Signature, Chair, Program/Department of: Mathematics and Statistics. Date 2/21/2013

Signature, Chair, College/School Curriculum Council for: CNSM Date 2/21/2013

Signature, Dean, College/School of: CNSM Date Feb 27, 2013

Offerings above the level of approved programs must be approved in advance by the Provost.

Signature of Provost (if above level of approved programs) Date

ALL SIGNATURES MUST BE OBTAINED PRIOR TO SUBMISSION TO THE GOVERNANCE OFFICE

Signature, Chair Date

Faculty Senate Review Committee: ___Curriculum Review ___GAAC

___Core Review ___SADAC

ADDITIONAL SIGNATURES: (As needed for cross-listing and/or stacking)

Signature, Chair, Program/Department of: Date

Signature, Chair, College/School Curriculum Council for: Date

Signature, Dean, College/School of: Date

ATTACH COMPLETE SYLLABUS (as part of this application). The guidelines are online:
http://www.uaf.edu/uafgov/faculty-senate/curriculum/course-degree-procedures-/uaf-syllabus-requirements/
The Faculty Senate curriculum committees will review the syllabus to ensure that each of the items listed below are included. If items are missing or unclear, the proposed course (or changes to it) may be denied.

SYLLABUS CHECKLIST FOR ALL UAF COURSES

During the first week of class, instructors will distribute a course syllabus. Although modifications may be made throughout the semester, this document will contain the following information (as applicable to the discipline):

1. **Course information:**
   ❑Title, ❑ number, ❑credits, ❑prerequisites, ❑ location, ❑ meeting time
   (make sure that contact hours are in line with credits).
2. **Instructor (and if applicable, Teaching Assistant) information:**
   ❑ Name, ❑ office location, ❑ office hours, ❑ telephone, ❑ email address.
3. **Course readings/materials:**
   ❑ Course textbook title, ❑ author, ❑ edition/publisher.
   ❑ Supplementary readings (indicate whether ❑ required or ❑ recommended) and
   ❑ any supplies required.
4. **Course description:**
   ❑ Content of the course and how it fits into the broader curriculum;
   ❑ Expected proficiencies required to undertake the course, if applicable.
   ❑ Inclusion of catalog description is *strongly* recommended, and
   ❑ Description in syllabus must be consistent with catalog course description.
5. ❑ **Course Goals (general), and (see #6)**
6. ❑ **Student Learning Outcomes (more specific)**
7. **Instructional methods:**
   ❑ Describe the teaching techniques (eg: lecture, case study, small group discussion, private instruction, studio instruction, values clarification, games, journal writing, use of Blackboard, audio/video conferencing, etc.).
8. **Course calendar:**
   ❑ A schedule of class topics and assignments must be included. Be specific so that it is clear that the instructor has thought this through and will not be making it up on the fly (e.g. it is not adequate to say "lab". Instead, give each lab a title that describes its content). You may call the outline Tentative or Work in Progress to allow for modifications during the semester.
9. **Course policies:**
   ❑ Specify course rules, including your policies on attendance, tardiness, class participation, make-up exams, and plagiarism/academic integrity.
10. **Evaluation:**
    ❑ Specify how students will be evaluated, ❑ what factors will be included, ❑ their relative value, and ❑ how they will be tabulated into grades (on a curve, absolute scores, etc.) ❑ Publicize UAF regulations with regard to the grades of "C" and below as applicable to this course. (Not required in the syllabus, but may be a convenient way to publicize this.) Faculty Senate Meeting #171:
    http://www.uaf.edu/uafgov/faculty-senate/meetings/2010-2011-meetings/#171
11. **Support Services:**
    ❑ Describe the student support services such as tutoring (local and/or regional) appropriate for the course.
12. **Disabilities Services:** Note that the phone# and location have been **updated.**
    The Office of Disability Services implements the Americans with Disabilities Act (ADA), and ensures that UAF students have equal access to the campus and course materials.
    ❑ State that you will work with the Office of Disabilities Services (208 WHITAKER BLDG, 474-5655)to provide reasonable accommodation to students with disabilities.

Math 694 Numerical Linear Algebra

CRN 37025

Spring 2011, UAF

Instructor: Ed Bueler
Office: Chapman 301C. Office hours online.
Phone: 474-7693
eMail: elbueler@alaska.edu

Class Time: MWF 1:00 - 2:00pm, Chapman 104
CRN: 37025
Text: Trefethen & Bau, *Numerical Linear Algebra*

Course Web Site: www.dms.uaf.edu/~bueler/Math694S11.htm

Course Content and Goals: This course will describe how actual matrices and vectors can be handled in a stable, fast, and accurate manner. This is key technology for scientific and engineering computation. We will place these topics in the correct framework, emphasizing the geometry of the action of matrices. We will cover the famous matrix decompositions, theorems, and algorithms: singular value decomposition (SVD), LU decomposition, spectral theorem, Schur decomposition, the QR method for eigenvalues, and Krylov methods. Applications of these ideas include solving large linear systems, solving systems of ordinary differential equations, statistical methods, inverse methods in geophysics, and Markov processes. Numerical linear algebra is perhaps in greatest need, perhaps, when working with discretized partial differential equations and with network problems.

Examples in class will often use Matlab/Octave. (Or python---scipy/pylab---for students who are already comfortable with python.) I will help students learn how to use one of these tools, all of which are well-suited to numerical linear algebra. Student competence with one of these languags, for the purpose of scientific computing though not necessarily general programming, is a goal of the course.

Topic list, in probable order:

- matrix/vector mechanics
- geometric view of linear algebra
- singular value decomposition
- QR factorization and least squares
- conditioning and stability
- operation count and problem size
- systems of equations
- computing eigenvalues
- iterative methods

Outcomes: At the end of this course you will be able to understand and apply the ideas and algorithms of numerical linear algebra.

Assigned Work and Evaluation and Grade: Weekly homework will include by-hand computations, proofs, and Matlab/Octave computations. There will be a short project in which you are asked to find and explain/explore an application of numerical linear algebra. There will be a **one hour in-class midterm exam**, emphasizing definitions and basic manipulations, and a **take-home final exam** emphasizing proofs and nontrivial calculations/applications.

Exams/Homework	**Percent of Grade**	**Dates**
In class Midterm Exam	15%	Monday FIXME!!
Take home Final Exam	25%	Due in my box 5:00 p.m., Wednesday, May 11.
Homework	55%	(nearly) weekly
Short Project	5%	due about one week before final; will be announced

Based on your raw homework and exam scores, I guarantee grades according to the following schedule: 90 - 100 % = **A**, 79 - 89 % = **B**, 68 - 78 % = **C**, 57 - 67 % = **D**, 0 - 56 % = **F** . I reserve the right to increase your grade above this schedule based on the actual difficulty of the work and on average class performance.

Policies: The Dept of Mathematics and Statistics has reasonable policies on incompletes, late withdrawals, early final examinations, etc.; see www.dms.uaf.edu/dms/Policies.html. You are covered by the UAF Student Code of Conduct. I will work with the Office of Disabilities Services (208 WHIT, 474-5655) to provide reasonable accommodation to student with disabilities.

Prerequisites: Undergraduate linear algebra and mathematical maturity. Concretely, *MATH 314 Linear Algebra or equivalent. Recommended: MATH 421 Applied Analysis OR MATH 401 Introduction to Real Analysis OR equivalent post-calculus course in analysis.*

Math 694 Numerical Linear Algebra

Spring 2011, Ed Bueler

Ed Bueler
elbueler@alaska.edu x7693
Office: Chapman 301C (hours here)
Class time: MWF 1:00--2:00pm
Classroom: Chapman 104
Text: Trefethen and Bau, *Numerical Linear Algebra*, SIAM Press 1997.

Syllabus and **Advertisement**

PARTS OF COURSE:

A	abstract linear algebra
B	matrix/vector manipulations
C	geometric linear algebra
D	QR and least squares
E	conditioning and stability
F	systems of equations
G	computing eigenvalues
H	iterative methods

MATLAB/Octave/pylab:

Schedule: *(final version Monday, 16 May 2011)*

Thanks for a great semester. I hope you tell me about future contact with numerical linear algebra, if that occurs. I have handed out solutions to the final exam on paper, and I have returned short projects. Codes listed on the solutions to the final are listed at the bottom>

Part	**Day**	**Lecture** (in text)	**Topic** (some take more than one day)	**Assigned or Due** (links are PDF)
A	Fri 1/21		introduction, vector spaces and examples, linear operators	A #1 (includes proof advice) (PDF)
A	Mon 1/24		bases, matrices	
B	Wed 1/26	1	matrix-vector multiplication, matrix product; "view (ii)"	
B	Fri 1/28		cont.	
C	Mon 1/31	2	inner product, adjoint, hermitian, orthogonal, unitary	**A # 1 Due** A #2 (PDF)
C	Wed 2/2	2	cont.	
C	Fri 2/4	2	cont.; + intro to Matlab/Octave class4feb.m	
C	Mon 2/7	3	norms of vectors and matrices	~~**A # 2 Due**~~
C	Wed 2/9	3	cont. what to know about matrix norms (PDF)	**A # 2 Due** A #3 (PDF)
C	Fri 2/11	3	cont.	
C	Mon 2/14	4	the singular value decomposition (SVD)	

- *comparison handout* (PDF)
- ortho.m ortho.py
- hello.m hello.py
- mgs.m mgs.py
- exer1pt1.m
- baddet.m
- class4feb.m
- fourballs.m
- solnA2probP4.m
- class14feb.m
- svdframes.m
- solnA3probP8.m
- class23feb.m
- detail.mat (needed by above)
- epsrank.m
- chebgs.m
- showchebpolys.m
- class9mar.m
- P12ortho.m
- class21mar.m
- house.m
- esgfit.m
- polycos.m
- polyinterpnorms.m
- class11april.m
- class13april.m
- class18april.m
- getmydrift.m
- mylu.m
- myslash.m
- doqreigs.m
- expnorms.m
- forwardgmd.m
- matrixfordrift.m
- invertgmd.m

			class14feb.m	
C	Wed 2/16	4	cont.	**A # 3 Due** A #4 (PDF)
C	Fri 2/18	5	cont. svdframes.m	
C	Mon 2/21	5		
C	Wed 2/23	5,6	compression of images class23feb.m detail.mat (needed by above) projectors	
C	Fri 2/25	6	cont.	**A # 4 Due** A #5 (PDF)
D	Mon 2/28	7	Gram-Schmidt process and QR factorization	
D	Wed 3/2	7	cont. chebgs.m showchebpolys.m	
D	Fri 3/4	8	modified Gram-Schmidt/operation count	
D	Mon 3/7	10	orthogonal triangulation; Householder reflections	**A # 5 Due** A #6 (PDF)
D	Wed 3/9	10	cont.; algorithmic issues class9mar.m	
D	Fri 3/11	11	least squares (by QR, SVD and normal eqns)	
D	3/14-18		SPRING BREAK	
D	Mon 3/21	11	cont. class21mar.m	**A # 6 Due**
E	Wed 3/23	12	conditioning *of problems*	
E	Fri 3/25	12	cont.	
	Mon 3/28		MIDTERM QUIZ: in class	review for quiz

LINKS:

- Matlab: great but not free. Available at UAF through OIT-maintained site license.
- old Matlab/Octave help page
- Octave: (http://www.gnu.org/software/octave/) is a reliable free alternative to Matlab. Octave should work exactly the same as Matlab for this class. Linux: use package manager. Windows and MacOSX: see http://octave.sourceforge.net for binaries.
- pylab = python + ipython + scipy + matplotlib: Packages scipy and matplotlib, and the ipython shell, allow the powerful language Python can do everything needed for this class. Recommended if you already use Python.
- Cleve Moler, *The World's Largest Matrix Computation*
- I find the PBS NOVA episode *Why the Towers Fell* very interesting for what it says about computer modeling in the 1970s and 1980s. At that time, models of the combined effect of fast moving fluid and fire, and the effects on fireproofing of steel

			covers Lectures: 1,2,3,4,5,6,7,8,10,11 focus on: definitions, statements of theorems, basic geometrical ideas, basic applications of theorems	(PDF)
E	Wed 3/30	12	cont.	A #7 (PDF)
E	Fri 4/1	13	floating point arithmetic	
E	Mon 4/4	14	stability and backward stability *of algorithms* about your Short Project (PDF)	
	Wed 4/6	14	cont	
E	Fri 4/8	15	cont related to solutions: house.m esgfit.m polycos.m polyinterpnorms.m	**A # 7 Due**
E	Mon 4/11	16	backward stability of Householder class11april.m	A #8 (PDF)
F	Wed 4/13	17	backward stability of back-substitution class13april.m	
F	Fri 4/15	20	Gauss elimination (=GE)	
F	Mon 4/18	21, 22	GE with w. partial pivoting; stability of GE class18april.m	**A # 8 Due** A #9 (PDF)
F	Wed 4/20	23	Cholesky	
G	Fri 4/22	24	eigenvalues, Schur decomposition, spectral theorem	
G	Mon 4/25		cont	
G	Wed 4/27	25	eigenvalue algorithms TAKE HOME FINAL *(REVISED)* (PDF) getmydrift.m	**A # 9 Due**

structures, was beyond the abilities of numerical simulations available to engineers. (See the transcript of this NOVA episode and search for "mathematical models".)

Texts for related courses:

- Golub & van Loan, *Matrix Computations*
- Higham, *Accuracy and Stability of Numerical Algorithms*

Background books:

- Strang, *Linear Algebra and Its Applications*
- Moler, *Numerical Computing with MATLAB*
- Burden & Faires, *Numerical Analysis*
- Press et al, *Numerical Recipes*

			mylu.m myslash.m	
G	Fri 4/29		springfest, no class	
G	Mon 5/2	26	reduction to Hessenberg/tridiagonal	**SHORT PROJECT due at 5pm in my box**
H	Wed 5/4	28	inverse and Rayleigh iteration for eigenvalues of matrices doqreigs.m	
H	Fri 5/6		*last day of instruction* Krylov ideas: how to solve *large* systems Ax=b	
	Wed 5/11		TAKE HOME FINAL *(REVISED)* **DUE** in my box 5:00 p.m. Wednesday, May 11 codes from solutions to Final: expnorms.m forwardgmd.m matrixfordrift.m invertgmd.m	

Download Adobe's Acrobat Reader for free to view **PDF** files.

doc info