TRIAL COURSE OR NEW COURSE PROPOSAL

SUBMITTED BY:

<table>
<thead>
<tr>
<th>Department</th>
<th>Mathematics and Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepared by</td>
<td>Elizabeth Allman</td>
</tr>
<tr>
<td>Email Contact</td>
<td><a href="mailto:e.allman@uaf.edu">e.allman@uaf.edu</a></td>
</tr>
<tr>
<td>College/School</td>
<td>CNSM</td>
</tr>
<tr>
<td>Phone</td>
<td>474-2479</td>
</tr>
<tr>
<td>Faculty Contact</td>
<td>Elizabeth Allman</td>
</tr>
</tbody>
</table>

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

2. COURSE IDENTIFICATION:
   - Dept: MATH
   - Course #: F665
   - No. of Credits: 3
   - This course is an elective for majors; three credits is appropriate for the content and depth of material.

3. PROPOSED COURSE TITLE:
   - Topics in graduate mathematics

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

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

5. STACKED?
   - [ ] YES/NO
   - If yes, Dept: 
   - Course #:

6. FREQUENCY OF OFFERING:
   - As demands warrants
   - (Every or Alternate) Fall, Spring, Summer — or As Demand Warrants

7. SEMESTER & YEAR OF FIRST OFFERING (if approved)
   - As demand warrants; possibly spring 2010

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 one)
   - [ ] 1
   - [x] 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 LEARNING hours/weeks
   - [ ] LAB hours/week
   - [ ] 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 of internship=1 credit. This must match with the syllabus. See http://www.uaf.edu/uafgov/faculty/cd/credits.html for more information on number of credits.

   OTHER HOURS (specify type)

10. COMPLETE CATALOG DESCRIPTION including dept., number, title and credits (50 words or less, if possible):
    MATH F665 Topics in graduate mathematics 3 credits Offered as Demand Warrants
    Elective courses in graduate mathematics offered by faculty on a rotating basis. Topics may include, but are not limited to, graph theory, glaciology modeling, general relativity, mathematical biology, Galois theory, and numerical linear algebra.
    May be repeated for credit, with permission of instructor.

Received
FEB 25 2009
Dean’s Office
College of Natural Science & Mathematics
11. **COURSE CLASSIFICATIONS:** (undergraduate courses only. Use approved criteria found on Page 10 & 17 of the manual. If justification is needed, attach on separate sheet.)

H = Humanities □  N = Natural Science □  S = Social Sciences □

Will this course be used to fulfill a requirement for the baccalaureate core? □ YES □ NO

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

O = Oral Intensive, Format 6 □  W = Writing Intensive, Format 7 □  Natural Science, Format 8 □

12. **COURSE REPEATABILITY:**

Is this course repeatable for credit? □ YES □ NO

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

This course is an elective, with changing focus and topics depending on the instructor.

How many times may the course be repeated for credit? □ 3 TIMES

If the course can be repeated with variable credit, what is the maximum number of credit hours that may be earned for this course? □

13. **GRADING SYSTEM:**

LETTER: □ X  PASS/FAIL:

**RESTRICTIONS ON ENROLLMENT (if any)**

14. **PREREQUISITES**

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

**RECOMMENDED**

Classes, etc. that student is strongly encouraged to complete prior to this course.

15. **SPECIAL RESTRICTIONS, CONDITIONS**

16. **PROPOSED COURSE FEES**

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

17. **PREVIOUS HISTORY**

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

If yes, give semester, year, course #, etc.: 

18. **ESTIMATED IMPACT**

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

None.

19. **LIBRARY COLLECTIONS**

Have you contacted the library collection development officer (flkj@uaf.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 □ UAF resources for this course are already adequate

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)

N/A

21. **POSITIVE AND NEGATIVE IMPACTS**

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

Positive: The Mathematics graduate has very few elective offerings for its Master's students. This will strengthen the graduate curriculum and allow faculty to teach graduate courses in their areas of expertise. Additionally, this should help students find advisors for theses and projects. As two new
faculty members will join the Department in fall 2009, there will be no negative impact on the
Department's service responsibilities or need for reallocation of faculty resources.

Negative: N/A

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.

The addition of new courses to the graduate program will permit students to learn of faculty research
interests and expertise. This should aid graduate students in finding an advisor who does mathematics in a
field of interest to the student. This will also enrich a sparse curriculum.

APPROVALS:

Signature, Chair, Program/Department of: Mathematics & Statistics
Date 2/24/2007

Signature, Chair, College/School Curriculum Council for: CNSM
Date 3/21/07

Signature, Dean, College/Department of: CNSM
Date

Signature of Provost (if applicable)
Offerings above the level of approved programs must be approved in advance by the Provost.

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

Signature, Chair, UAF Faculty Senate Curriculum Review Committee
Date

ADDITIONAL SIGNATURES: (If required)

Signature, Chair, Program/Department of: 
Date

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

Signature, Dean, College/School of: 
Date
Math 694 Numerical Linear Algebra

CRN 50330

Spring 2009, UAF

Instructor: Ed Bueler
Office: Chapman 301C. Office hours online.
Phone: 474-7693, eMail: ffeisb@uaf.edu

Class Time: MWF 2:15 - 3:15pm, Chapman 107
Text: Trefethen & Bau, Numerical Linear Algebra
Web Site: www.dms.uaf.edu/~bueler

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

Examples in class will often use Matlab/Octavelpylab. I will help students choose and learn how to use one of these tools, all of which are well-suited to numerical linear algebra. Student competence with one of these tools, for the purpose of scientific computing though not necessarily general programming, is a goal of the course.

Assigned Work and Grade: Weekly (nearly so ...) homework will include paper computations, proofs, and Matlab/Octavelpylab computations.

There will be a one hour in-class midterm exam, emphasizing definitions and basic manipulations. There will be a take home final.

Exams/Homework | Percent of Grade | Dates
---|---|---
In class Midterm Exam | 15% | Wednesday March 25.
Take home Final Exam | 30% | Due in my box 5:00 p.m., Thursday, May 7.
Homework | 55% | nearly weekly

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.

Topic list:

- 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

Policies: The Dept of Mathematics and Statistics has reasonable policies on in completes, 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 (203 WHIT, 474-7043) 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 2009, Ed Bueler

Ed Bueler: felb@uaf.edu, x7693
Office: Chapman 301C
(Classroom: Chapman 107

Syllabus and Advertisement

PARTS OF COURSE:

<table>
<thead>
<tr>
<th>Part</th>
<th>Day</th>
<th>Lecture (in text)</th>
<th>Topic</th>
<th>Assigned or Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1/23 Fri</td>
<td></td>
<td>introduction, matrices, vector spaces and examples</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>1/26 Mon</td>
<td>1</td>
<td>bases, linear maps, matrices</td>
<td></td>
</tr>
<tr>
<td>C, A</td>
<td>1/28 Wed</td>
<td>1</td>
<td>matrix-vector multiplication, matrix product</td>
<td></td>
</tr>
<tr>
<td>C, A</td>
<td>1/30 Fri</td>
<td>2</td>
<td>inner product, adjoint, hermitian, orthogonal, unitary</td>
<td>(PDF)</td>
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<tr>
<td>A</td>
<td>2/2 Mon</td>
<td>2</td>
<td>cont.</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>2/4 Wed</td>
<td>2</td>
<td>cont.</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>2/6 Fri</td>
<td>3</td>
<td>norms of vectors and matrices</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>2/9 Mon</td>
<td>3</td>
<td>cont.</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>2/11 Wed</td>
<td>4</td>
<td>the singular value decomposition</td>
<td></td>
</tr>
</tbody>
</table>

Matlab/Octave/Python Codes:
- comparison handout (PDF)
- legendre.m
- legendre.py

Schedule: (version 2/11/09)

A #1 (includes proof advice) (PDF)
Matlab/Octave
/Pylab comparison
handout (PDF)
A # 1 Due
A #1 solutions
(PDF)
A #2 (PDF)
A # 2 Due
A #3 (PDF)
<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Topic</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>2/13 Fri</td>
<td>4 cont</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>2/16 Mon</td>
<td>5 cont</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>2/18 Wed</td>
<td>5 compression of images</td>
<td>A # 3 Due</td>
</tr>
<tr>
<td>B</td>
<td>2/20 Fri</td>
<td>6 projectors</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>2/23 Mon</td>
<td>6 cont</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>2/25 Wed</td>
<td>7 Gram-Schmidt process and QR factorization</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>2/27 Fri</td>
<td>7 cont</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>3/2 Mon</td>
<td>8 TOPICS NOT DETERMINED from here</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>3/4 Wed</td>
<td>9 modified Gram-Schmidt/operation count</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>3/6 Fri</td>
<td>10 SPRING BREAK</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>3/9-3/13</td>
<td>10 Householder triangularization</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>3/16 Mon</td>
<td>10 cont</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>3/18 Wed</td>
<td>11 Least squares (by QR, QVD and Cholesky)</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>3/20 Fri</td>
<td>11 cont</td>
<td></td>
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<tr>
<td>D</td>
<td>3/23 Mon</td>
<td>11 MIDTERM QUIZ: Wednesday in class</td>
<td></td>
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<tr>
<td>D</td>
<td>3/25 Wed</td>
<td>11 Least squares cont</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>3/30 Mon</td>
<td>12 Conditioning</td>
<td></td>
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<tr>
<td>E</td>
<td>4/1 Wed</td>
<td>12 Conditioning, cont</td>
<td></td>
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<tr>
<td>E</td>
<td>4/3</td>
<td>13 Floating point arithmetic</td>
<td>Stability</td>
</tr>
<tr>
<td>E</td>
<td>4/6 Mon</td>
<td>14, 15</td>
<td></td>
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<tr>
<td>E</td>
<td>4/8</td>
<td>14, 15 cont</td>
<td></td>
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**LINKS:**

- **Matlab:** great but not free. Available at UAF through OIT-maintained site license in theory; anyone know a link?
- **My old Matlab help page.**
- **Octave:** (http://www.gnu.org/software/octave/) is a supported and reliable free alternative to Matlab. Octave should work exactly the same as Matlab for the purposes of this class. It is available as source code, Windows binaries, MacOSX binaries, and some Linux binaries (including Debian/Ubuntu). See http://octave.sourceforge.net for Windows and MacOSX binaries.
- **Python/SciPy/PyLab:** With packages `scipy` and `matplotlib`, and the `ipython` shell, the powerful language Python can do everything needed for this class. But
programs are different from those in Matlab/Octave.

- Cleve Moler, *The World's Largest Matrix Computation*

Other important books:

- Golub & van Loan, *Matrix Computations*
- Demmel, *Applied Numerical Linear Algebra*
- Higham, *Accuracy and Stability of Numerical Algorithms*
- Strang, *Linear Algebra and Its Applications*
- Roman, *Advanced Linear Algebra*
- Moler, *Numerical Computing with MATLAB*
- Cheney & Kincaid, *Numerical Mathematics and Computing*
- Press et al, *Numerical Recipes in C/Fortran*

<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Page(s)</th>
<th>Topic</th>
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<tbody>
<tr>
<td>E</td>
<td>4/10</td>
<td>16,17,19</td>
<td>Stability of: Householder, back sub, least squares</td>
</tr>
<tr>
<td>F</td>
<td>4/13 Mon</td>
<td>20</td>
<td>Gauss elimination</td>
</tr>
<tr>
<td>F</td>
<td></td>
<td>20, 21</td>
<td>w. partial pivoting</td>
</tr>
<tr>
<td>F</td>
<td></td>
<td>22, 23</td>
<td>stability of Gauss elimination, Cholesky</td>
</tr>
<tr>
<td>B/C</td>
<td>4/20 Mon</td>
<td>24</td>
<td>Eigenvectors, Schur decomposition, spectral theorem</td>
</tr>
<tr>
<td>G</td>
<td></td>
<td>24</td>
<td>cont</td>
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<tr>
<td>G</td>
<td></td>
<td>24</td>
<td>cont</td>
</tr>
<tr>
<td>G</td>
<td>4/27 Mon</td>
<td>24, 25</td>
<td>eigenvalue algorithms and power method</td>
</tr>
<tr>
<td>G</td>
<td></td>
<td>25</td>
<td>cont</td>
</tr>
<tr>
<td>G</td>
<td></td>
<td>26</td>
<td>reduction to Hessenberg/tridiagonal;</td>
</tr>
<tr>
<td>G</td>
<td>5/4 Mon</td>
<td>28</td>
<td>QR for symmetric matrices</td>
</tr>
</tbody>
</table>

|       |       |       | FINAL EXAM: take home; due Thursday May 7, 5pm at my office box |

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