New Course Request

Indiana University Indianapolis Campus

Check Appropriate Boxes:
- Undergraduate credit [X]
- Graduate credit [ ]
- Professional credit [ ]

1. School/Division: Science
2. Academic Subject Code: MATH
3. Course Number: 35300 (must be cleared with University Enrollment Services)
4. Instructor: Cowen
5. Course Title: Linear Algebra II, with Applications

Recommended Abbreviation (Optional): (Limited to 32 Characters including spaces)

6. First time this course is to be offered (Semester/Year): Fall 2010
7. Credit Hours: Fixed at 3 or Variable from ( ) to ( )
8. Is this course to be graded S-F (only)? Yes [ ] No [X]
9. Is variable title approval being requested? Yes [ ] No [X]
10. Course description (not to exceed 50 words) for Bulletin publication: P: MATH 35100 or MATH 51100

This course involves the development of mathematics with theorems and their proofs. This course also includes several important applications, which will be used to create a mathematical model, prove theorems that lead to the solution of problems in the model, and interpret the results in terms of the original problem.

11. Lecture Contact Hours: Fixed at 3 or Variable from ( ) to ( )
12. Non-Lecture Contact Hours: Fixed at N/A or Variable from ( ) to ( )
13. Estimated enrollment: 25 of which _________ percent are expected to be graduate students.
14. Frequency of scheduling: every semester

15. This course be required for majors? [ ] No
16. Justification for new course: Creating new option for a sequential course

17. Are the necessary reading materials currently available in the appropriate library? [ ] Yes
18. Please append a complete outline of the proposed course, and indicate instructor (if known), textbooks, and other materials.
19. If this course overlaps with existing courses, please explain with which courses it overlaps and whether this overlap is necessary, desirable, or unimportant.

A copy of every new course proposal must be submitted to departments, schools, or divisions in which there may be overlap of the new course with existing courses or areas of strong concern, with instructions that they send comments directly to the originating Curriculum Committee. Please append a list of departments, schools, or divisions thus consulted.

Submitted by: ____________________________ Date: 10-8-2009
Department Chairman/Division Director

Approved by: ____________________________ Date: 11-12-09
Dean

Dean of Graduate School (when required) Date
Chancellor/Vice-President Date
University Enrollment Services Date

After School/Division approval, forward the last copy (without attachments) to University Enrollment Services for initial processing, and the remaining four copies and attachments to the Campus Chancellor or Vice-President.
**PURDUE UNIVERSITY**
REQUEST FOR ADDITION, EXPIRATION,
OR REVISION OF AN UNDERGRADUATE COURSE
(10000-40000 LEVEL)

**DEPARTMENT** Mathematical Sciences  
**EFFECTIVE SESSION** Spring 2010

**INSTRUCTIONS:** Please check the items below which describe the purpose of this request.

- [X] New course with supporting documents
- [ ] Add existing course offered at another campus
- [ ] Expiration of a course
- [ ] Change in course number
- [ ] Change in course title
- [ ] Change in course credit/type
- [ ] Change in course attributes (department head signature only)
- [ ] Change in Instructional hours
- [ ] Change in course description
- [ ] Change in course requisites
- [ ] Change in semesters offered (department head signature only)
- [ ] Transfer from one department to another

**PROPOSED:**

<table>
<thead>
<tr>
<th>Subject Abbreviation</th>
<th>MATH</th>
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<tbody>
<tr>
<td>Course Number</td>
<td>35300</td>
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<tr>
<td>Long Title</td>
<td>Linear Algebra II, with Applications</td>
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**EXISTING:**

<table>
<thead>
<tr>
<th>Subject Abbreviation</th>
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</thead>
</table>

**TERMS OFFERED**

- [ ] Summer
- [ ] Fall
- [X] Spring

**CAMPUS(ES) INVOLVED**

- [ ] Calumet
- [ ] Cont Ed
- [ ] Ft. Wayne
- [X] Indianapolis
- [ ] N. Central
- [ ] Tech Statewide
- [ ] W. Lafayette

**CREDIT TYPE**

<table>
<thead>
<tr>
<th>Schedule Type</th>
<th>Minutes Per Mtg</th>
<th>Meetings Per Week</th>
<th>Weeks Offered</th>
<th>% of Credit Allocated</th>
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<td>Recitation</td>
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<td>Presentation</td>
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<td>Laboratory</td>
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<td>Lab Prep</td>
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<td>Ind. Study</td>
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<tr>
<td>Pred/Observ</td>
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**COURSE ATTRIBUTES:** Check All That Apply

- [ ] 1. Pass/Not Pass Only
- [ ] 2. Satisfactory/Unsatisfactory Only
- [ ] 3. Repeatable
- [ ] 4. Credit by Examination
- [ ] 5. Special Fees
- [ ] 6. Registration Approval Type
- [ ] Department
- [ ] Instructor
- [ ] 7. Variable Title
- [ ] 8. Honors
- [ ] 9. Full Time Privilege
- [ ] 10. Off Campus Experience

**COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS):**

P: MATH 35100 or MATH 51100
This course involves the development of mathematics with theorems and their proofs. This course also includes several important applications, which will be used to create a mathematical model, prove theorems that lead to the solution of problems in the model, and interpret the results in terms of the original problem.

**Calumet Department Head**

**Fort Wayne Department Head**

**Indianapolis Department Head**

**North Central Department Head**

**West Lafayette Department Head**

**Calumet School Dean**

**Fort Wayne School Dean**

**Indianapolis School Dean**

**North Central Chancellor**

**West Lafayette College/School Dean**

**West Lafayette Registrar**

**OFFICE OF THE REGISTRAR**
Proposed course Math 35300: Linear Algebra II, with applications

Linear algebra is second only to calculus in terms of importance for applications. In many applications, the problem is formulated mathematically, it is then converted to a linear algebra problem (possibly without the user knowing it), the linear algebra problem is solved using a computer, and, finally, the results are interpreted. For example, many numerical routines for solving differential equations change the problem into a linear algebra problem first.

In this course, we will develop the mathematics with theorems and their proofs. The course also includes several important applications in which we will create a mathematical model, prove theorems that lead to the solution of problems in the model, and interpret the results in terms of the original problem. Throughout the course, we will remain conscious of the reliance on computers for real world computation and there will be a formal computer component to the course. Most homework and test questions will be designed for paper and pencil computation, but students will be permitted (encouraged!) to do their homework using machines. Students will be able to use Matlab software, capable of doing all the numerical computations required for the course, on many of the UIAA machines on the IUPUI campus, including the lab on the second floor of LD. It is planned that the second mid-term test, and possibly the first mid-term test and some or all of the final exam, will be held in a computer laboratory so that students will be able to use Matlab software if they wish. The importance of computer computation will affect the development of some of the topics for the course. In many situations in linear algebra, the obvious method is not the one used in practice because it is too prone to error or too time consuming. We will always try to indicate the practical algorithms for solving linear algebra problems, and one of the goals of the course is to make it possible for students to understand the techniques used in linear algebra software, and read the documentation for such software.

The official text will be

Text: *Linear Algebra for Engineering and Science*, by Carl Cowen (ISBN 0-9650717-4-X) with supplemental material for the application to cost accounting and possibly other topics. Books on reserve in the library that cover some topics of the course include the text and:

*Linear Algebra and Its Applications*, by Gilbert Strang.


Math 351 (or Math 511) is a prerequisite for this course and I will assume students know material in that course. Some of the important ideas from that course include linear independence, basis, and rank; the (half dozen or so) equivalent conditions for invertibility of a matrix; inner products and the Gram–Schmidt algorithm; and linear transformations and their relation to matrices. (Although eigenvalues and eigenvectors are usually introduced in Math 351 and Math 511, we will begin at the beginning of this topic.)

There will be two one-hour tests, each counting about 20–25% of the grade, and about 40% of the grade will come from the two-hour final exam given during Final Exam week. Weekly homework and occasional quizzes will make up the remaining 10–15% of the grade.

The goals for the students in this course are

**Short term goal:** That students become proficient in the language of linear algebra, as it is used both formally and informally in theoretical discussions and applications to problems from other disciplines.
**Short term goal:** That students develop their ability to read mathematics and learn from what is read.

**Short term goal:** That students develop the ability to write mathematics, especially the ability to create and clearly write proofs, which are the explanations of why things in mathematics are true.

**Long term goal:** That students develop and sustain an excitement about mathematics and its connections to problems in the 'real world' generally, especially the math they need in their professional and personal lives, and that they can communicate that excitement to others.

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**Approximate Course Outline**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Lectures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partitioning Matrices</td>
<td>1</td>
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<tr>
<td>Gaussian Elimination Revisited: LU Factorization</td>
<td>2</td>
</tr>
<tr>
<td>Norms of Matrices</td>
<td>2</td>
</tr>
<tr>
<td>Efficiency &amp; Accuracy of Algorithms</td>
<td>1</td>
</tr>
<tr>
<td>Application: Internal Cost Allocation</td>
<td>1</td>
</tr>
<tr>
<td>Geometry of Subspaces, Orthogonal Projections</td>
<td>4</td>
</tr>
<tr>
<td>Application: Least Squares Estimation</td>
<td>2</td>
</tr>
</tbody>
</table>

**Midterm Test I** (possibly in computer lab, week 6 or 7)

<table>
<thead>
<tr>
<th>Topic</th>
<th>Lectures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eigenvalues, Eigenvectors, and Diagonalization</td>
<td>2</td>
</tr>
<tr>
<td>Application: Markov Chains</td>
<td>2</td>
</tr>
<tr>
<td>Hermitian and Normal Matrices</td>
<td>1</td>
</tr>
<tr>
<td>Nilpotent Matrices</td>
<td>1</td>
</tr>
<tr>
<td>Jordan Canonical Form</td>
<td>2</td>
</tr>
<tr>
<td>Application: Systems of Differential Equations</td>
<td>1</td>
</tr>
<tr>
<td>Gerschgorin's Theorem, Computation of Eigenvalues, Rayleigh Quotients</td>
<td>2</td>
</tr>
</tbody>
</table>

**Midterm Test II** (probably in computer lab, week 12 or 13)

<table>
<thead>
<tr>
<th>Topic</th>
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<tbody>
<tr>
<td>Convexity</td>
<td>1</td>
</tr>
<tr>
<td>Application: Introduction to Linear Programming</td>
<td>2</td>
</tr>
</tbody>
</table>

**Final Exam** (possibly part or all in computer lab)