TO: Michael Auerbach  
Dean of the School of Science and Mathematics

FROM: Robert Mignone  
Chair, Department of Mathematics  
Annalisa Calini and Martin Jones  
Mathematics Graduate Program Co-Directors

DATE: February 1, 2016

SUBJECT: Cross-listed (Undergraduate/Graduate) Mathematics Courses

In response to a request by Academic Affairs, we are submitting changes to our currently cross-listed undergraduate/graduate-level courses in order to make these courses compliant with the new Course Number Policy.

None of the changes are substantial. Changes include:

1. Aligning the course descriptions to match, if not already the same.

2. Clarifying the wording of the prerequisites for undergraduate courses.

3. Removing references to specific undergraduate courses from the prerequisites for graduate courses, while requiring equivalent content.

3. Making the course rotations consistent, or adding course rotation when absent.

4. Changing graduate course number from 600 to 500 in two cases. (460/560, 461/561)

5. Slightly changing course titles to match in two cases. (423/523, 415/515)

6. Removing one of the prerequisites for MATH 452/552. (See form for justification)

Respectfully,

Bob, Anna, and Martin

APPROVAL AND SIGNATURES.

1. Signature of Department Chair or Program Director:

   [Signature] Date: 2/1/2016

2. Signature of Academic Dean:

   [Signature] Date: 2/1/2016

3. Signature of Provost:

   [Signature] Date: 2/18/16

4. Signature of Business Affairs (only for course fees):

   [Signature] Date: ________________

   □ fee approved on ________________
   □ BOT approval pending

5. Signature of Curriculum Committee Chair:

   [Signature] Date: ________________

6. Signature of Faculty Senate Secretary:

   [Signature] Date: ________________

Date Approved by Faculty Senate: ________________
Contact Name__Robert Mignone (Chair), Annalisa Calini and Martin Jones (Graduate Program Co-directors)________

Email__mignoner@cofc.edu, calinia@cofc.edu, jonesm@cofc.edu

Phone__3-5730________

Department/Program__Mathematics______ School__SSM____

Catalog Year in Which Change Will Take Effect__Fall 2016________

Does this proposal include:  □ Course title change*
□ Course number change*
X□ Course description change*
X□ Undergraduate/Graduate cross-listing
*complete Existing Course/New Course Information

A. If you are proposing to cross-list two existing courses at the same level, list the courses (acronym, title, number, course description) and provide a reason for cross-listing.

B. If you are proposing to cross-list an existing undergraduate course with an existing graduate course, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.

C. If you are proposing to cross-list an existing course with a new course at the same level, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach the appropriate new course proposal form.

D. If you are proposing to cross-list an existing course with a new course at a different level, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach the appropriate new course proposal form(s). Also attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.
Proposed Cross-listed Courses
(course acronyms, numbers, titles, and descriptions)

MATH 402, Advanced Linear Algebra (3)

This course provides the linear algebra background necessary for a variety of applied fields as well as advanced work in algebra and analysis. Topics include vector spaces, linear transformations, dual spaces, matrices, matrix factorizations, matrix norms, determinants, eigenvalues and diagonalization, bilinear forms, projections, orthogonal and unitary transformations, Jordan canonical form, and infinite dimensional linear spaces. Applications such as approximation theory, positive matrices, computation, multilinear algebra, and spectral theory will be selected by the instructor. F

Prerequisites: MATH 203 (Linear Algebra) and at least one of MATH 303 (Abstract Algebra I) and MATH 311 (Advanced Calculus I).

MATH 502, Advanced Linear Algebra (3)

This course provides the linear algebra background necessary for a variety of applied fields as well as advanced work in algebra and analysis. Topics include vector spaces, linear transformations, dual spaces, matrices, matrix factorizations, matrix norms, determinants, eigenvalues and diagonalization, bilinear forms, projections, orthogonal and unitary transformations, Jordan canonical form, and infinite dimensional linear spaces. Applications such as approximation theory, positive matrices, computation, multilinear algebra, and spectral theory will be selected by the instructor. F

Prerequisites: Students must have a working knowledge of undergraduate Linear Algebra and proof techniques of Abstract Algebra and Analysis.
Reason for Cross-listing

This pair of courses has previously been approved for cross-level listing, and we propose that this be continued for the following reasons:

1. The core material taught at both the 400-level and 500-level is very similar.

2. On the other hand, the course objectives and student learning outcomes are distinguished, in that graduate students do additional, more independent work on projects and in wider reading, and do additional homework and test exercises which address the more advanced theoretical aspects of the material.

3. The cross-level listing allows some of our strongest undergraduate students to take courses that they would otherwise not see at the undergraduate level, thus better preparing them for graduate school and/or the employment marketplace.

4. In a typical semester, it would be difficult to justify the use of resources to teach this pair as two independent courses, since enrollments in higher level mathematics courses are often small; thus cross-listing expands opportunities for both undergraduate and graduate students.

We do not find that having undergraduate and graduate students in the same classes to be problematic. In fact, it seems to have a very positive effect on both groups through a greater degree of peer interaction and discussion.

Changes to Existing Course Numbers/Titles/Descriptions

Existing Course:

**MATH 402 Advanced Linear Algebra (3)**
A one-semester course that provides the linear algebra background necessary for a variety of applied fields. Topics include vector spaces, linear transformations, matrices, matrix factorizations, matrix norms, determinants, eigenvalues and diagonalization, bilinear forms, orthogonal and unitary transformations, Jordan canonical form. Application topics will be selected by the instructor.

*Prerequisites:* MATH 203 and at least one of MATH 303 and MATH 311.

**MATH 502 Advanced Linear Algebra (3)**
This course provides the background in linear algebra needed for advanced work in algebra, analysis, and applications. Topics include vector spaces over a field, dual spaces, bilinear functions, linear transformations, determinants, eigenvalues, projections, diagonalization, Jordan canonical form and infinite dimensional spaces. Special topics such as applications to approximation theory, positive matrices, computation, multilinear algebra and spectral theory will be selected by the instructor.

*Prerequisite:* MATH 203 (Linear Algebra).
Proposed Course Change:

1. Slightly change BOTH descriptions to the common description shown in the **Proposed Cross-listed Courses** box.

2. Clarify the prerequisites for Math 402 to:

   *Prerequisites:* MATH 203 (Linear Algebra) and at least one of MATH 303 (Abstract Algebra I) and MATH 311 (Advanced Calculus I).

3. Modify the Prerequisites for Math 502 to:

   *Prerequisites:* Students must have a working knowledge of undergraduate linear algebra and proof techniques of abstract algebra and analysis.

4. Add course rotation specifications to both courses: F.
Math 402 Advanced Linear Algebra  
College of Charleston  
Department of Mathematics  
Sample Syllabus

<table>
<thead>
<tr>
<th>Instructor Information</th>
<th>XXX</th>
<th>Office Hours: T.B.A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office: RSS XXX</td>
<td></td>
<td>E-mail: <a href="mailto:xxx@cofc.edu">xxx@cofc.edu</a></td>
</tr>
</tbody>
</table>

| Course Meetings        | Mondays and Wednesdays in Maybank 112 from 4:00 - 5:15 PM. |

| Course Description     | This course provides the linear algebra background necessary for a variety of applied fields as well as advanced work in algebra and analysis. Topics include vector spaces, linear transformations, dual spaces, matrices, matrix factorizations, matrix norms, determinants, eigenvalues and diagonalization, bilinear forms, projections, orthogonal and unitary transformations, Jordan canonical form, and infinite dimensional linear spaces. Applications such as approximation theory, positive matrices, computation, multilinear algebra, and spectral theory will be selected by the instructor. |

| Prerequisites          | MATH 203 (Linear Algebra) and at least one of MATH 303 (Abstract Algebra I) and MATH 311 (Advanced Calculus I). |


<table>
<thead>
<tr>
<th>Undergraduate Mathematics Program Student Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>This course can be used to satisfy some requirements of the undergraduate mathematics degree program, for which there are also some standard goals. Students are expected to display a thorough understanding of the topics covered. In particular, upon completion of the course, students will be able to</td>
</tr>
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</table>

1. use algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics to model phenomena in mathematical terms

2. use algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics to derive correct answers to challenging questions by applying the models from the previous Learning Outcome; and

3. write complete, grammatically and logically correct arguments to prove their conclusions.

These outcomes will be assessed on the tests and projects.
After completing this course, students will be able to:

1. Solve problems in the advanced areas of Linear Algebra using the appropriate terminology, concepts, and methods developed in this course.

2. Reproduce important theoretical results and concepts underpinning the development of Linear Algebra.

3. Employ the main tools of Linear Algebra to describe the properties of linear transformations and the underlying linear spaces.

These outcomes will be assessed by means of homework assignments and in-class exams.

In this course, we will have two midterm exams, a final examination, and weekly homework.

<table>
<thead>
<tr>
<th></th>
<th>Percentage</th>
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<td>Midterms:</td>
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<tr>
<td>Final Exam:</td>
<td>30%</td>
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<tr>
<td>Homework:</td>
<td>30%</td>
</tr>
</tbody>
</table>

Midterm I: Monday, September 21
Midterm II: Wednesday, October 28
Final Exam: Friday, December 11

Midterms and Final Exam. Two midterm exams will each account for 20% of the course grade. The Final Exam is comprehensive and is worth 30% of the final grade.

Homework. I will assign homework problems for each topic, and you should complete and understand all the assigned problems. I will grade selected homework problems and give unannounced quizzes. Feel free to work in groups on the homework. However: Copying someone's writeup without participating in the solution and allowing your solution to be so copied are both considered a violation of the Honor Code. The best way to learn to think mathematically is to do lots of practice problems. Homework is worth 30% of the class grade.

Grading Scale. Grades will be based on the percentage of points earned in the categories listed above according to the following:

A (93-100), A- (90-92), B+ (87-89), B (84-86), B- (80-83), C+ (77-79), C (74-76), C- (70-73), D+ (67-69), D (64-66), D- (60-63), F (below 60).

You are expected to attend class every day. If you miss class, you will need to obtain notes from one of your classmates and talk with me about material that you do not understand. If for some reason you are not able to attend class the day that an assignment is due, you should email me your assignment that day. Make-up exams are only possible with proper documentation from the Absence Memo Office.

If there is a student in this class who has a documented disability and has been approved to receive accommodations through the Center for Disability Services/ SNAP (Students Needing Access Parity), please come and discuss this with me during my office hours. See also http://disabilityservices.cofc.edu/accommodations/

Any violation of the College's Honor Code will be reported to the Honor Board. For more details, see http://studentaffairs.cofc.edu/honor-system/ and the Student Handbook at http://studentaffairs.cofc.edu/honor-system/studenthandbook/
ADDITIONAL HELP  When you have questions and you are unable to come to the instructor's office for help during his office hours, you should (1) discuss with and get help from your peers (but no copying each other's homework), or (2) make an appointment with the instructor.

SUPPLEMENTARY MATERIALS  Homework assignments, solutions to homework problems, and solutions to practice exams and exams will be posted on OAKS regularly.

TOPICS  The following topics will be discussed:

1. Fundamentals: linear spaces, subspaces, linear independence, basis, dimension.
2. Quotient spaces and Duality. (Applications: quadrature formula.)
3. Linear Mappings: range and nullspace, transposition, similarity, projections. (Applications: interpolation, difference equations.)
4. Matrix Representation of Linear Transformations.
5. Determinant and Trace. (Application/Motivation: computing volumes in n-dimensions.)
7. Euclidean Structure: scalar product, Gram-Schmidt orthogonalization, matrix adjoint, isometries. (Application: the QR matrix factorization.)
Math 502 Advanced Linear Algebra
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION
Office Hours: T.B.A.
Office: RSS XXX
E-mail: xxx@cofc.edu

Course Meetings
Mondays and Wednesdays in Maybank 112 from 4:00 - 5:15 PM.

Course Description
This course provides the linear algebra background necessary for a variety of applied fields as well as advanced work in algebra and analysis. Topics include vector spaces, linear transformations, dual spaces, matrices, matrix factorizations, matrix norms, determinants, eigenvalues and diagonalization, bilinear forms, projections, orthogonal and unitary transformations, Jordan canonical form, and infinite dimensional linear spaces. Applications such as approximation theory, positive matrices, computation, multilinear algebra, and spectral theory will be selected by the instructor.

Prerequisites
Students must have a working knowledge of undergraduate Linear Algebra and proof techniques of Abstract Algebra and Analysis.

Textbook

Student Learning Outcomes:
After completing this course, students will be able to:

1. Analyze and solve theoretical and applied problems in the advanced areas of Linear Algebra using appropriate terminology, concepts, and methods developed in this course.

2. Prove and explain important theoretical results and concepts underpinning the development of Linear Algebra.

3. Use results and tools from Advanced Linear Algebra to discuss the properties of linear transformations and the underlying linear spaces in both finite- and infinite-dimensional settings.

4. Present theorems and results in reports that include a precise statement of hypotheses and thesis, employment of appropriate proof methods, and a discussion and interpretation of the results.

These outcomes will be assessed by means of homework assignments, a project, and in-class exams.

Graded Assignments
In this course, we will have two midterm exams, a final examination, and weekly homework. Graduate students will also be expected to complete a project. Graduate students are expected to have a deeper understanding of the material, assessed by means of extra work of a more theoretical nature and requiring a higher-level of proof skills, and a project, culminating in a report synthesizing material learned from the course. The project will involve reading and understanding literature in the field.
Midterms: 40%
Final Exam: 30%
Homework: 20%
Project: 10%

**Important Dates**

- **Midterm I:** Monday, September 21
- **Midterm II:** Wednesday, October 28
- **Final Exam:** Friday, December 11

**Course Grades**

**Midterms and Final Exam.** Two midterm exams will each account for 20% of the course grade. The Final Exam is comprehensive and is worth 30% of the final grade.

**Homework.** I will assign homework problems for each topic, and you should complete and understand all the assigned problems. I will grade selected homework problems and give unannounced quizzes. Feel free to work in groups on the homework. However, copying someone's writeup without participating in the solution and allowing your solution to be so copied are both considered a violation of the Honor Code. The best way to learn to think mathematically is to do lots of practice problems. Homework is worth 20% of the class grade.

**Project.** Graduate students will be given a project to work on that will involve learning a topic at a greater degree of depth (e.g. working through proofs of major theoretical results). These projects will demonstrate and synthesize the tools learned in the course and the chosen topic can be one of interest to the student provided it is approved by the instructor. The project is worth 10% of the final grade.

**Grading Scale.** Grades will be based on the percentage of points earned in the categories listed above according to the following:

A (90-100), B+ (87-89), B (80-86), C+ (77-79), C (70-76), D (60-69), F (below 60).

**Attendance Policy**

You are expected to attend class every day. If you miss class, you will need to obtain notes from one of your classmates and talk with me about material that you do not understand. If for some reason you are not able to attend class the day that an assignment is due, you should email me your assignment that day. Make-up exams are only possible with proper documentation from the Absence Memo Office.

**Disability Policy**

If there is a student in this class who has a documented disability and has been approved to receive accommodations through the Center for Disability Services/SNAP (Students Needing Access Parity), please come and discuss this with me during my office hours. See also [http://disabilityservices.cofc.edu/accommodations/](http://disabilityservices.cofc.edu/accommodations/)

**Honor Code**

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**Additional Help**

When you have questions and you are unable come to the instructor’s office for help during his office hours, you should (1) discuss with and get help from your peers (but no copying each other’s homework), or (2) make an appointment with the instructor.

**Supplementary Materials**

Homework assignments, solutions to homework problems, and solutions to practice exams and exams will be posted on OAKS regularly.
The following topics will be discussed:

1. Fundamentals: linear spaces, subspaces, linear independence, basis, dimension.
2. Quotient spaces and Duality. (Applications: quadrature formula.)
3. Linear Mappings: range and nullspace, transposition, similarity, projections. (Applications: interpolation, difference equations.)
4. Matrix Representation of Linear Transformations.
5. Determinant and Trace. (Application/Motivation: computing volumes in n-dimensions.)
7. Euclidean Structure: scalar product, Gram-Schmidt orthogonalization, matrix adjoint, isometries. (Application: the QR matrix factorization.)
Contact Name, Robert Mignone (Chair), Annalisa Calini and Martin Jones (Graduate Program Co-directors)

Email: migner@cofc.edu, calinia@cofc.edu, jonesm@cofc.edu

Phone: 3-5730

Department/Program: Mathematics School: SSM

Catalog Year in Which Change Will Take Effect: Fall 2016

Does this proposal include: X Course title change*
   □ Course number change*
   X□ Course description change*
   □ Undergraduate/Graduate cross-listing
   *complete Existing Course/New Course Information

A. If you are proposing to cross-list two existing courses at the same level, list the courses (acronym, title, number, course description) and provide a reason for cross-listing.

B. If you are proposing to cross-list an existing undergraduate course with an existing graduate course, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.

C. If you are proposing to cross-list an existing course with a new course at the same level, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach the appropriate new course proposal form.

D. If you are proposing to cross-list an existing course with a new course at a different level, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach the appropriate new course proposal form(s). Also attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.
Proposed Cross-listed Courses
(courses acronyms, numbers, titles, and descriptions)

MATH 415, Complex Analysis (3)
This course provides a proof-based introduction to Complex Analysis. Topics include the complex number system, analytic and harmonic functions, power series, integration, residue theory, analytic continuation, conformal mapping, and applications. S

Prerequisites: Math 311 (Advanced Calculus I).

MATH 515, Complex Analysis (3)
This course provides a proof-based introduction to Complex Analysis. Topics include the complex number system, analytic and harmonic functions, power series, integration, residue theory, analytic continuation, conformal mapping, and applications. S

Prerequisites: Students must have a working knowledge of proof techniques of analysis.

Reason for Cross-listing
This pair of courses has previously been approved for cross-level listing, and we propose that this be continued for the following reasons:

1. The core material taught at both the 400-level and 500-level is very similar.

2. On the other hand, the course objectives and student learning outcomes are distinguished, in that graduate students do additional, more independent work on projects and in wider reading, and do additional homework and test exercises which address the more advanced theoretical aspects of the material.

3. The cross-level listing allows some of our strongest undergraduate students to take courses that they would otherwise not see at the undergraduate level, thus better preparing them for graduate school and/or the employment marketplace.

4. In a typical semester, it would be difficult to justify the use of resources to teach this pair as two independent courses, since enrollments in higher level mathematics courses are often small; thus cross-listing expands opportunities for both undergraduate and graduate students.

We do not find that having undergraduate and graduate students in the same classes to be problematic. In fact, it seems to have a very positive effect on both groups through a greater degree of peer interaction and discussion.
Changes to Existing Course Numbers/Titles/Descriptions

Existing Course:

**MATH 415 Complex Analysis (3)**
The complex number system, analytic functions, integration, power series, residue theory, analytic continuation and conformal mapping.  
*Prerequisite:* MATH 311.

**MATH 515 Complex Variables (3)**
Topics to be covered include the complex number system, analytic and harmonic functions, power series, integration, residue theory, analytic continuation, conformal mapping and applications.

*Prerequisites:* MATH 311 (Advanced Calculus I), MATH 411 (Advanced Calculus II) recommended. S

Proposed Course Change:

1. Change Math 515 title to: **Complex Analysis** (matching the Math 415 title)

2. Slightly change BOTH descriptions to the common description shown in the Proposed Cross-listed Courses box.

3. Clarify the Prerequisites for Math 415:
   *Prerequisites:* MATH 311 (Advanced Calculus I)

4. Modify the Prerequisites for Math 515 to:
   *Prerequisites:* Students must have a working knowledge of proof techniques of analysis.

5. Add course rotation specification for both courses: S
Math 415 Complex Analysis  
College of Charleston  
Department of Mathematics  
Sample Syllabus

<table>
<thead>
<tr>
<th>INSTRUCTOR INFORMATION</th>
<th>XXX</th>
<th>Office Hours: T.B.A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office: Rss XXX</td>
<td>E-mail: <a href="mailto:xxx@cofc.edu">xxx@cofc.edu</a></td>
<td></td>
</tr>
</tbody>
</table>

| COURSE MEETINGS | Mondays and Wednesdays in Maybank 112 from 5:30 - 5:45 PM. |

| COURSE DESCRIPTION | This course provides a proof-based introduction to Complex Analysis. Topics include the complex number system, analytic and harmonic functions, power series, integration, residue theory, analytic continuation, conformal mapping, and applications. |

| PREREQUISITES | MATH 311 (Advanced Calculus I). |


<table>
<thead>
<tr>
<th>UNDERGRADUATE MATHEMATICS PROGRAM STUDENT LEARNING OUTCOMES</th>
<th>This course can be used to satisfy some requirements of the undergraduate mathematics degree program, for which there are also some standard goals. Students are expected to display a thorough understanding of the topics covered. In particular, upon completion of the course, students will be able to</th>
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<tbody>
<tr>
<td>1. use algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics to model phenomena in mathematical terms</td>
<td></td>
</tr>
<tr>
<td>2. use algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics to derive correct answers to challenging questions by applying the models from the previous Learning Outcome; and</td>
<td></td>
</tr>
<tr>
<td>3. write complete, grammatically and logically correct arguments to prove their conclusions.</td>
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These outcomes will be assessed on the tests and projects.
After completing this course, students will be able to:

1. Solve problems involving complex numbers and using the geometry of the complex plane.

2. Reproduce key theoretical results underpinning the development of Complex Analysis.

3. Apply the classical results of Complex Analysis.

4. Apply complex residue theory to the integration of real-valued functions.

These outcomes will be assessed by means of homework assignments and in-class exams.

In this course, we will have two midterm exams, a final examination, and weekly homework.

<table>
<thead>
<tr>
<th>Midterms: 40%</th>
<th>Final Exam: 30%</th>
<th>Homework: 30%</th>
</tr>
</thead>
</table>

Midterm I: 02/15
Midterm II: 03/28
Final Exam: 04/27

Midterms and Final Exam. Two midterm exams will each account for 20% of the course grade. The Final Exam is comprehensive and is worth 30% of the final grade.

Homework. Homework exercises will be assigned in each lecture. They will be collected in the following days:

HW#1: 01/25;
HW#2: 02/08;
HW#3: 02/29;
HW#4: 03/21;
HW#5: 04/11;
HW#6: 04/20.

The instructor will grade the exercises and give points accordingly. Homework turned in late may suffer an up-to 50% reduction of the original points. Students are encouraged to discuss with the instructor the unassigned exercises from the textbook. Homework is worth 30% of the class grade.

Grading Scale. Grades will be based on the percentage of points earned in the categories listed above according to the following:

A (93-100), A- (90-92), B+ (87-89), B (84-86), B- (80-83), C+ (77-79), C (74-76), C- (70-73), D+ (67-69), D (64-66), D- (60-63), F (below 60).

Please note that NO extra work will be offered in order to lift one's grade and NO special consideration will be given for changing an individual's weight distribution of the tests, homework, and final exam. In order to earn a good grade, one needs to perform well through entire semester.
You are expected to attend class every day. If you miss class, you will need to obtain notes from one of your classmates and talk with me about material that you do not understand. If for some reason you are not able to attend class the day that an assignment is due, you should email me your assignment that day. Make-up exams are only possible with proper documentation from the Absence Memo Office.

If there is a student in this class who has a documented disability and has been approved to receive accommodations through the Center for Disability Services/SNAP (Students Needing Access Parity), please come and discuss this with me during my office hours. See also http://disabilityservices.cofc.edu/accommodations/

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When you have questions and you are unable to come to the instructor’s office for help during his office hours, you should (1) discuss with and get help from your peers (but no copying each other’s homework), or (2) make an appointment with the instructor on Monday, Wednesday, or Friday.

Course lecture notes and other materials, including homework sets, solution keys, and occasional handouts, will be posted on OAKS.

The following topics will be discussed:

1. **Complex Numbers and Elementary Functions**: Complex numbers and their properties, elementary functions, stereographic projection, limits, continuity, and differentiation.

2. **Analytic Functions and Integration**: Cauchy-Riemann equations, multivalued functions, Riemann surfaces, complex integration, Cauchy’s theorem, Cauchy’s integral formula and its generalizations, Liouville’s theorem, Morera’s theorem.

3. **Sequences, Series and Singularities**: Basic properties, Taylor series, Laurent series, singularities of complex functions, analytic continuation, infinite products.

4. **Residue Calculus and Contour Integration**: Cauchy Residue Theorem, evaluation of definite integrals, principal value integrals, integrals with branch points, the Argument Principle, Fourier and Laplace transforms.

If time allows, we will discuss Conformal Mapping or Asymptotic Evaluations of Integrals, depending on class interest.
Math 515 Complex Analysis
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION

XXX
Office Hours: T.B.A.
Office: RSS XXX
E-mail: xxx@cofc.edu

COURSE MEETINGS

Mondays and Wednesdays in Maybank 112 from 5:30 - 5:45 PM.

COURSE DESCRIPTION

This course provides a proof-based introduction to Complex Analysis. Topics include the complex number system, analytic and harmonic functions, power series, integration, residue theory, analytic continuation, conformal mapping, and applications.

PREREQUISITES

Students must have a working knowledge of proof techniques of analysis.

TEXTBOOK


STUDENT LEARNING OUTCOMES:

After completing this course, students will be able to:

1. Extend the theory of real-valued analysis to the complex domain.

2. Apply mathematical reasoning involving complex numbers and the geometry of the complex plane to solve theoretical and applied problems.

3. Prove and apply the classical results of Complex Analysis.

4. Derive the key results of complex residue theory and apply them to the integration of real-valued functions.

5. Present theorems and results in reports that include a precise statement of hypotheses and thesis, employment of appropriate proof methods, and a discussion and interpretation of the results.

These outcomes will be assessed by means of homework assignments, a project, and in-class exams.

GRADED ASSIGNMENTS

In this course, we will have two midterm exams, a final examination, and weekly homework. Graduate students will also be expected to complete a project. Graduate students are expected to have a deeper understanding of the material, assessed by means of extra work of a more theoretical nature and requiring a higher-level of proof skills, and a project, culminating in a report synthesizing material learned from the course. The project will involve reading and understanding literature in the field.

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<tr>
<td>Homework</td>
<td>20%</td>
</tr>
<tr>
<td>Project</td>
<td>10%</td>
</tr>
</tbody>
</table>
Important Dates

| Midterm I: | 02/15 |
| Midterm II: | 03/28 |
| Final Exam: | 04/27 |

Course Grades

Midterms and Final Exam. Two midterm exams will each account for 20% of the course grade. The Final Exam is comprehensive and is worth 30% of the final grade.

Homework. Homework exercises will be assigned in each lecture. They will be collected in the following days:

HW#1: 01/25;
HW#2: 02/08;
HW#3: 02/29;
HW#4: 03/21;
HW#5: 04/11;
HW#6: 04/20.

The instructor will grade the exercises and give points accordingly. Homework turned in late may suffer an up-to 50% reduction of the original points. Students are encouraged to discuss with the instructor the unassigned exercises from the textbook. Homework is worth 20% of the class grade.

Project. Graduate students will be given a project to work on that will involve learning a topic at a greater degree of depth (e.g. working through proofs of major theoretical results). These projects will demonstrate and synthesize the tools learned in the course and the chosen topic can be one of interest to the student provided it is approved by the instructor. The project is worth 10% of the final grade.

Grading Scale. Grades will be based on the percentage of points earned in the categories listed above according to the following:

A (90-100), B+ (87-89), B (80-86), C+ (77-79), C (70-76), D (60-69), F (below 60).

Please note that NO extra work will be offered in order to lift one's grade and NO special consideration will be given for changing an individual's weight distribution of the tests, homework and project, and final exam. In order to earn a good grade, one needs to perform well through entire semester.

Attendance Policy

You are expected to attend class every day. If you miss class, you will need to obtain notes from one of your classmates and talk with me about material that you do not understand. If for some reason you are not able to attend class the day that an assignment is due, you should email me your assignment that day. Make-up exams are only possible with proper documentation from the Absence Memo Office.

Disability Policy

If there is a student in this class who has a documented disability and has been approved to receive accommodations through the Center for Disability Services/ SNAP (Students Needing Access Parity), please come and discuss this with me during my office hours. See also http://disabilityservices.cofc.edu/accommodations/.

Honor Code

Any violation of the College's Honor Code will be reported to the Honor Board. For more details, see http://studentaffairs.cofc.edu/honor-system/ and the Student Handbook at http://studentaffairs.cofc.edu/honor-system/studenthandbook/
ADDITIONAL HELP: When you have questions and you are unable to come to the instructor's office for help during his office hours, you should (1) discuss with and get help from your peers (but no copying each other's homework), or (2) make an appointment with the instructor on Monday, Wednesday, or Friday.

SUPPLEMENTARY MATERIALS: Course lecture notes and other materials, including homework sets, solution keys, and occasional handouts, will be posted on OAKS.

TOPICS: The following topics will be discussed:

1. Complex Numbers and Elementary Functions: Complex numbers and their properties, elementary functions, stereographic projection, limits, continuity, and differentiation.


4. Residue Calculus and Contour Integration: Cauchy Residue Theorem, evaluation of definite integrals, principal value integrals, integrals with branch points, the Argument Principle, Fourier and Laplace transforms.

If time allows, we will discuss Conformal Mapping or Asymptotic Evaluations of Integrals, depending on class interest.
Contact Name: Robert Mignone (Chair), Annalisa Calini and Martin Jones (Graduate Program Co-directors)

Email: mignoner@cofc.edu, calinia@cofc.edu, jonesm@cofc.edu

Phone: 3-5730

Department/Program: Mathematics  School: SSM

Catalog Year in Which Change Will Take Effect: Fall 2016

Does this proposal include:  X☐ Course title change*
☐ Course number change*
☐ Course description change*
☐ Undergraduate/Graduate cross-listing
*complete Existing Course/New Course Information

A. If you are proposing to cross-list two existing courses at the same level, list the courses (acronym, title, number, course description) and provide a reason for cross-listing.

B. If you are proposing to cross-list an existing undergraduate course with an existing graduate course, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.

C. If you are proposing to cross-list an existing course with a new course at the same level, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach the appropriate new course proposal form.

D. If you are proposing to cross-list an existing course with a new course at a different level, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach the appropriate new course proposal form(s). Also attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.
**Proposed Cross-listed Courses**
*(course acronyms, numbers, titles, and descriptions)*

**MATH 423, Partial Differential Equations (3)**
This course provides an introduction to the three main classes of partial differential equations (hyperbolic, parabolic, and elliptic) that arise in the description of wave motion, diffusion processes, and potential theory. Topics include the study of initial and boundary value problems, and solution methods such as fundamental solutions and separation of variables. Additional topics may include the method of characteristics, Sturm-Liouville theory, Green's functions, integral transforms, and nonlinear partial differential equations.

*Prerequisites:* MATH 221 (Calculus III) and MATH 323 (Differential Equations).

**MATH 523, Partial Differential Equations I (3)**
This course provides an introduction to the three main classes of partial differential equations (hyperbolic, parabolic, and elliptic) that arise in the description of wave motion, diffusion processes, and potential theory. Topics include the study of initial and boundary value problems, and solution methods such as fundamental solutions and separation of variables. Additional topics may include the method of characteristics, Sturm-Liouville theory, Green's functions, integral transforms, and nonlinear partial differential equations.

*Prerequisites:* Students must have a working knowledge of Vector Calculus and Ordinary Differential Equations.
**Reason for Cross-listing**

This pair of courses has previously been approved for cross-level listing, and we propose that this be continued for the following reasons:

1. The core material taught at both the 400-level and 500-level is very similar.

2. On the other hand, the course objectives and student learning outcomes are distinguished, in that graduate students do additional, more independent work on projects and in wider reading, and do additional homework and test exercises which address the more advanced theoretical aspects of the material.

3. The cross-level listing allows some of our strongest undergraduate students to take courses that they would otherwise not see at the undergraduate level, thus better preparing them for graduate school and/or the employment marketplace.

4. In a typical semester, it would be difficult to justify the use of resources to teach this pair as two independent courses, since enrollments in higher level mathematics courses are often small; thus cross-listing expands opportunities for both undergraduate and graduate students.

We do not find that having undergraduate and graduate students in the same classes to be problematic. In fact, it seems to have a very positive effect on both groups through a greater degree of peer interaction and discussion.

---

**Changes to Existing Course Numbers/Titles/Descriptions**

**Existing Course:**

**Math 423, Introduction to Partial Differential Equations**

Study of heat, potential, and wave equations in rectangular, polar and cylindrical coordinate systems. Separation of variables and eigenfunction expansion techniques. Sturm-Liouville theory. F

*Prerequisites:* MATH 221 and 323

**Math 523** This course is designed to provide senior first-year graduate students with an understanding of and the ability to solve some of the partial differential equations arising in science and engineering.

*Prerequisite:* MATH 221 (Calculus III) and MATH 323 (Differential Equations). eF
Proposed Course Change:

1. Change Math 423 title to: Partial Differential Equations

2. Change BOTH descriptions to the common description shown in the Proposed Cross-listed Courses box.

3. Clarify the Prerequisites for Math 423:
   Prerequisites: MATH 221 (Calculus III) and MATH 323 (Differential Equations).

4. Modify the Prerequisites for Math 523 to:
   Prerequisites: Students must have a working knowledge of Vector Calculus and Ordinary Differential Equations.

5. Change course rotation for Math 523 from eF to F.
Math 423 Partial Differential Equations
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION
XXX
Office: RSS XXX
E-mail: xxx@cofc.edu

Office Hours: T.B.A.

Course Meetings
Mondays and Wednesdays in Maybank 223 from 7:00 - 8:15 PM.

Course Description
This course provides an introduction to the three main classes of partial differential equations (hyperbolic, parabolic, and elliptic) that arise in the description of wave motion, diffusion processes, and potential theory. Topics include the study of initial and boundary value problems, and solution methods such as fundamental solutions and separation of variables. Additional topics may include the method of characteristics, Sturm-Liouville theory, Green's functions, integral transforms, and nonlinear partial differential equations.

Prerequisites
MATH 221 (Calculus III) and MATH 323 (Differential Equations).

Textbook
The principal reference for this course will be a self-contained set of Lecture Notes, which will be distributed regularly during the semester. The following additional references are on reserve at the Addiestone Library:


Undergraduate Mathematics Program Student Learning Outcomes
This course can be used to satisfy some requirements of the undergraduate mathematics degree program, for which there are also some standard goals. Students are expected to display a thorough understanding of the topics covered. In particular, upon completion of the course, students will be able to

1. use algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics to model phenomena in mathematical terms

2. use algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics to derive correct answers to challenging questions by applying the models from the previous Learning Outcome; and

3. write complete, grammatically and logically correct arguments to prove their conclusions.

These outcomes will be assessed on the tests and projects.
After completing this course, students will be able to:

1. Apply solution methods for the three main classes of partial differential equations, including the method of characteristics, separation of variables, and fundamental solutions.

2. Choose the appropriate methods to derive solutions of models of wave motion, diffusion, and potential theory in both initial-value and boundary value problems.

3. Reproduce key theoretical results underpinning both models and solution methods.

4. Write complete and correct derivations of mathematical models and their solutions, and a description of results supported by logical arguments or computational proofs.

These outcomes will be assessed by means of homework assignments and in-class exams.

In this course, we will have two midterm exams, a final examination, and weekly homework.

| Midterms | 40% |
| Final Exam | 30% |
| Homework | 30% |

Midterm I: Monday, September 24
Midterm II: Monday, October 29
Final Exam: Friday, December 7

Midterms and Final Exam. Two midterm exams will account for 40% of the course grade. The Final Exam is comprehensive and is worth 30% of the final grade.

Homework. The weekly assignments are due on Wednesday by the beginning of class. No late homework will be accepted. Homework must be taken very seriously in order not to fall behind with the material. I encourage discussions with me and with one another; however, the work you turn in for grading must be your own work, well-thought and carefully written.

Important: I do not answer homework questions on the day the homework is due. Homework problems in any upper level class are non-trivial, and require time and dedication. Begin the homework as soon as it is assigned and allow time to produce several drafts. Homework is worth 30% of the final grade. Solutions will be provided weekly, and email questions about an assignment will be replied to promptly.

Grading Scale. Grades will be based on the percentage of points earned in the categories listed above according to the following:

A (93-100), A- (90-92), B+ (87-89), B (84-86), B- (80-83), C+ (77-79), C (74-76), C- (70-73), D+ (67-69), D (64-66), D- (60-63), F (below 60).

You are expected to attend class every day. If you miss class, you will need to obtain notes from one of your classmates and talk with me about material that you do not understand. If for some reason you are not able to attend class the day that an assignment is due, you should email me your assignment that day. Late assignments will not be accepted. Make-up exams are only possible with proper documentation from the Absence Memo Office.
DISABILITY POLICY
If there is a student in this class who has a documented disability and has been approved to receive accommodations through the Center for Disability Services/SNAP (Students Needing Access Parity), please come and discuss this with me during my office hours. See also http://disabilityservices.cofc.edu/accommodations/

HONOR CODE
Any violation of the College’s Honor Code will be reported to the Honor Board. For more details, see http://studentaffairs.cofc.edu/honor-system/ and the Student Handbook at http://studentaffairs.cofc.edu/honor-system/studenthandbook/

SUPPLEMENTARY MATERIALS
Course lecture notes and other materials, including homework sets, solution keys, and occasional handouts, will be posted on OAKS.

E-MAIL
The best way to contact me is by e-mail. Please always include your name, the course name, and the section number in your e-mails. In general, you should expect a response within the next school day.

TOPICS
The following topics will be discussed, with the warning that we may not manage to cover the entire list.

First Order Equations
-The Cauchy Problem: the Transport Equation, the Method of Characteristics, Semilinear and Quasilinear Equations.

The Wave Equation
-Higher Dimension: Spherical Means, the Three-Dimensional Wave Equation, the Two-Dimensional Wave Equation. Huygens Principle.
-Applications: Electromagnetism, Acoustics.

The Heat Equation
-Application: Brownian Motion.

The Laplace Equation
-Separation of Variables for Special 2-Dimensional Geometries.
-The Dirichlet Problem on the Circle. Poisson’s Formula and its Consequences: The Mean Value Property, the Maximum Principle, Differentiability.
-Some Properties in Higher Dimensions: Green’s Identities and Green’s Functions. Dirichlet Problem on the Half Space and on the Ball.
Math 523 Partial Differential Equations I
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION
XXX
Office: RSS XXX
E-mail: xxxx@ofc.edu
Office Hours: T.B.A.

MEETINGS
Mondays and Wednesdays in Maybank 223 from 7:00 - 8:15 PM.

DESCRIPTION
This course provides an introduction to the three main classes of partial differential equations (hyperbolic, parabolic, and elliptic) that arise in the description of wave motion, diffusion processes, and potential theory. Topics include the study of initial and boundary value problems, and solution methods such as fundamental solutions and separation of variables. Additional topics may include the method of characteristics, Sturm-Liouville theory, Green's functions, integral transforms, and nonlinear partial differential equations.

PREREQUISITES
Students must have a working knowledge of Vector Calculus and Ordinary Differential Equations.

TEXTBOOK
The principal reference for this course will be a self-contained set of Lecture Notes, which will be distributed regularly during the semester. The following additional references are on reserve at the Addlestone Library:


STUDENT LEARNING OUTCOMES:
After completing this course, students will be able to:

1. Apply solution methods for the three main classes of partial differential equations, including the method of characteristics, separation of variables, and fundamental solutions.

2. Employ the appropriate analytical tools developed in the course to derive and interpret solutions of models of wave motion, diffusion, and potential theory in both initial-value and boundary value problems; integrating these tools to produce a comprehensive description of their properties and behavior.

3. Demonstrate a sound understanding of the theoretical aspects underpinning both models and solution methods.

4. Present theorems and results in reports that include description of the problem, implementation of appropriate methods, and a discussion and interpretation of the results.

These outcomes will be assessed by means of homework assignments, a project, and in-class exams.
Honor Code

Any violation of the College's Honor Code will be reported to the Honor Board. For more details, see http://studentaffairs.cofc.edu/honor-system/ and the Student Handbook at http://studentaffairs.cofc.edu/honor-system/studenthandbook/.

Supplementary Materials

Course lecture notes and other materials, including homework sets, solution keys, and occasional handouts, will be posted on OAKS.

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Topics

The following topics will be discussed, with the warning that we may not manage to cover the entire list.

First Order Equations

- The Cauchy Problem: the Transport Equation, the Method of Characteristics, Semilinear and Quasilinear Equations.

The Wave Equation

- Higher Dimension: Spherical Means, the Three-Dimensional Wave Equation, the Two-Dimensional Wave Equation. Huygens Principle.
- Applications: Electromagnetism, Acoustics.

The Heat Equation

- Application: Brownian Motion.

The Laplace Equation

- Separation of Variables for Special 2-Dimensional Geometries.
- The Dirichlet Problem on the Circle. Poisson's Formula and its Consequences: The Mean Value Property, the Maximum Principle, Differentiability.
- Some Properties in Higher Dimensions: Green's Identities and Green's Functions. Dirichlet Problem on the Half Space and on the Ball.
In this course, we will have two **midterm exams**, a **final examination**, and **weekly homework**. Graduate students will also be expected to complete a **project**. Graduate students are expected to have a deeper understanding of the material, assessed by means of extra work of a more theoretical nature and requiring a higher-level of proof skills, and a project, culminating in a report synthesizing material learned from the course. The project will involve reading and understanding literature in the field.

<table>
<thead>
<tr>
<th>Graded Assignments</th>
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<tbody>
<tr>
<td><strong>Midterms:</strong> 40%</td>
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<td><strong>Midterms and Final Exam.</strong> Two midterm exams will account for 40% of the course grade. The Final Exam is comprehensive and is worth 30% of the final grade.</td>
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**Homework.** The weekly assignments are due on Wednesday by the beginning of class. No late homework will be accepted. Homework must be taken very seriously in order not to fall behind with the material. I encourage discussions with me and with one another; however, the work you turn in for grading must be your own work, well-thought and carefully written.

**Important:** I do not answer homework questions on the day the homework is due. Homework problems in any upper level class are non-trivial, and require time and dedication. Begin the homework as soon as it is assigned and allow time to produce several drafts. Homework is worth 20% of the final grade. Solutions will be provided weekly, and email questions about an assignment will be replied to promptly.

**Project.** Graduate students will be given a project to work on that will involve learning a topic at a greater degree of depth (e.g. working through proofs of major theoretical results). These projects will demonstrate and synthesize the tools learned in the course and the application can be one of interest to the student provided that the topic is approved by the instructor. The project is worth 10% of the final grade.

**Grading Scale.** Grades will be based on the percentage of points earned in the categories listed above according to the following:

A (90-100), B+ (87-89), B (80-86), C+ (77-79), C (70-76), D (60-69), F (below 60).

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</tr>
</tbody>
</table>
Contact Name__Robert Mignone (Chair), Annalisa Callai and Martin Jones (Graduate Program Co-directors)__________

Email__mignoner@cofc.edu, calinia@cofc.edu, jonesm@cofc.edu

Phone__3-5730__________

Department/Program_Mathematics_____ School____SSM_____  
Catalog Year in Which Change Will Take Effect__Fall 2016_______

Does this proposal include:  □ Course title change*
□ Course number change*
X□ Course description change*
X□ Undergraduate/Graduate cross-listing
*complete Existing Course/New Course Information

A. If you are proposing to cross-list two existing courses at the same level, list the courses (acronym, title, number, course description) and provide a reason for cross-listing.

B. If you are proposing to cross-list an existing undergraduate course with an existing graduate course, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.

C. If you are proposing to cross-list an existing course with a new course at the same level, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach the appropriate new course proposal form.

D. If you are proposing to cross-list an existing course with a new course at a different level, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach the appropriate new course proposal form(s). Also attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.
Proposed Cross-listed Courses
(courset acronyms, numbers, titles, and descriptions)

MATH 430, Mathematical Statistics I (3)

This is a calculus based probability and statistics course. Topics include probability, probability functions, probability densities, mathematical expectation, sums of random variables and sampling distributions. F

Prerequisites: MATH 221 (Calculus III).

MATH 530, Mathematical Statistics I (3)

This is a calculus based probability and statistics course. Topics include probability, probability functions, probability densities, mathematical expectation, sums of random variables and sampling distributions. F

Prerequisites: Students must have a working knowledge of Vector Calculus.

Reason for Cross-listing

This pair of courses has previously been approved for cross-level listing, and we propose that this be continued for the following reasons:

1. The core material taught at both the 400-level and 500-level is very similar.

2. On the other hand, the course objectives and student learning outcomes are distinguished, in that graduate students do additional, more independent work on projects and in wider reading, and do additional homework and test exercises which address the more advanced theoretical aspects of the material.

3. The cross-level listing allows some of our strongest undergraduate students to take courses that they would otherwise not see at the undergraduate level, thus better preparing them for graduate school and/or the employment marketplace.

4. In a typical semester, it would be difficult to justify the use of resources to teach this pair as two independent courses, since enrollments in higher level mathematics courses are often small; thus cross-listing expands opportunities for both undergraduate and graduate students.

We do not find that having undergraduate and graduate students in the same classes to be problematic. In fact, it seems to have a very positive effect on both groups through a greater degree of peer interaction and discussion.
Changes to Existing Course Numbers/Titles/Descriptions

Existing Course:

**MATH 430, Mathematical Statistics I (3)**
This is a calculus based probability and statistics course. Topics will include probability functions and densities, mathematical expectations, sums of random variables, and sampling distributions. F.

*Prerequisite:* MATH 221

**MATH 530, Mathematical Statistics I (3)**
Topics include probability, probability functions, probability densities, mathematical expectation, sums of random variables and sampling distributions.

*Prerequisite:* MATH 221 (Calculus III). F

Proposed Course Change:

1. Slightly change BOTH descriptions to the common description shown in the **Proposed Cross-listed Courses** box.

2. Clarify the Prerequisites for Math 430:
   *Prerequisites:* MATH 221 (Calculus III).

3. Modify the Prerequisites for Math 530 to:
   *Prerequisites:* Students must have a working knowledge of Vector Calculus.
Math 430 Mathematical Statistics I
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION
XXX
Office: RSS XXX
Office Hours: T.B.A.
E-mail: xxx@cofc.edu

COURSE MEETINGS
Mondays and Wednesdays in Maybank 112 from 7:00 - 8:15 PM.

PREREQUISITES
Math 221 Calculus III.

TEXTBOOK
Mathematical Statistics with Applications by Wackerly, Mendenhall and Sheaffer, Seventh Edition.

COURSE DESCRIPTION
This is a calculus-based probability and statistics course. Topics include probability, probability functions, probability densities, mathematical expectation, sums of random variables and sampling distributions.

STUDENT LEARNING OUTCOMES:
After completing this course, students will be able to

1. Explain the importance of the statistical theory in the development of the tools of statistical inference.

2. Recognize the connection between classical and non-classical statistical theory for inference.

3. Demonstrate an understanding of mathematical proofs in the development of mathematical statistical theory.

4. Implement the statistical package R to work with statistical models.

These outcomes will be assessed in homework and on in class exams.

UNDERGRADUATE MATHEMATICS PROGRAM LEARNING OUTCOMES
Students are expected to display a thorough understanding of the topics covered. In particular, upon completion of the course, students will be able to

1. Using algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics, students model phenomena in mathematical terms.

2. Using algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics, students derive correct answers to challenging questions by applying the models from Student Learning Outcome 1.

3. Write complete, grammatically and logically correct arguments to prove their conclusions.

These outcomes will be assessed in homework and on in class exams.

GRADED ASSIGNMENTS
In this course, we will have one midterm exam, a final examination, and bi-weekly homework. Graduate students will also be expected to complete a project. Graduate students will be expected to show mastery of the more theoretical aspects of the
course. This will involve extra homework exercises, additional problems on exams, and a project, culminating in a report synthesizing material learned from the course. This additional work will be optional for undergraduates.

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<tr>
<td>Midterm:</td>
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<td>Final Exam:</td>
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<tr>
<td>Homework:</td>
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**Important Dates**

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<tr>
<td>Midterm:</td>
<td>Wednesday, October 14</td>
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<tr>
<td>Final Exam:</td>
<td>Wednesday, December 16</td>
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**Course Grades**

**Midterm and Final Exams (25% each):** These two in class exams will assess your understanding of the mathematical theory in the development of statistical inference. You will be expected to reproduce short proofs, show facility with the statistical tools, and perform calculations and predictions using the models.

**Homework (50%):** Every other week you will be expected to turn in assigned problems from the text. These problems may be a combination of theory and the application of statistical inference to real data. Some exercises will require the statistical software package R.

**Grading Scale:** Final grades will be based on the percentage of points earned. Letter grades will be determined from the following scale: Grading Scale: A 93-100, A- 90-92, B+ 87-89, B 83-86, B- 80-82, C+ 77-79, C 73-76, C- 70-72, D+ 67-69, D 63-66, D- 60-62, F below 60. If your final exam grade is better than your pre-exam average, I will weight your final exam more heavily.

**Attendance Policy**

You are expected to attend class every day. If you miss class, you will need to obtain notes from one of your classmates and talk with me about material that you do not understand. If for some reason you are not able to attend class the day that an assignment is due, you should email me your assignment that day. Late assignments will not be awarded full credit. Late assignments will not be accepted after graded papers are returned or problem solutions have been distributed. Make-up exams are only possible with proper documentation from the Absence Memo Office.

**Accommodations for Students with Disabilities**

If there is a student in this class who has a documented disability and has been approved to receive accommodations through the Center for Disability Services/SNAP (Students Needing Access Parity), please come and discuss this with me during my office hours.

**Honor Code**

Any violation of the College's Honor Code will be reported to the Honor Board. For more details, see http://studentaffairs.cofc.edu/honor-system/ and the Student Handbook at http://studentaffairs.cofc.edu/honor-system/studenthandbook/

**Supplementary Material**

Supplementary materials for our course will be posted on OAKS.

**E-MAIL**

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Week 6-7: Some Important Statistical Distributions.

Week 8: Moment Generating Functions.


Week 11: Limits of Random Variables.


Week 13: Characteristic Functions and related Limit Theorems


Week 15: Review for Final Exam.
Math 530 Mathematical Statistics I
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION
XX
Office: RSS XXX
Office Hours: T.B.A.
E-mail: xxx@cofc.edu

COURSE MEETINGS
Mondays and Wednesdays in Maybank 112 from 7:00 - 8:15 PM.

PREREQUISITES
Students must have a working knowledge of Vector Calculus.

TEXTBOOK

COURSE DESCRIPTION
This is a calculus-based probability and statistics course. Topics include probability, probability functions, probability densities, mathematical expectation, sums of random variables and sampling distributions.

STUDENT LEARNING OUTCOMES:
After completing this course, students will be able to

1. Critique and investigate the importance of the statistical theory in the development of the tools of statistical inference.

2. Compare and contrast classical and non-classical approaches to statistical inference.

3. Develop and construct mathematical proofs in the development of mathematical statistical theory.

4. Develop models using the statistical package R to make statistical inferences.

These outcomes will be assessed in homework and on in class exams.

GRADED ASSIGNMENTS
In this course, we will have one midterm exam, a final examination, and bi-weekly homework. Graduate students will also be expected to complete a project. Graduate students will be expected to show mastery of the more theoretical aspects of the course. This will involve extra homework exercises, additional problems on exams, and a project, culminating in a report synthesizing material learned from the course. This additional work will be optional for undergraduates.

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Course Grades

Midterm and Final Exams (25% each): These two in class exams will assess your understanding of the mathematical theory in the development of statistical inference. You will be expected to reproduce short proofs, show facility with the statistical tools, and perform calculations and predictions using the models.

Homework (50%): Every other week you will be expected to turn in assigned problems from the text. These problems may be a combination of theory and the application of statistical inference to real data. Some exercises will require the statistical software package R.

Project (20%): Graduate students will be given a project to work on that will involve learning a more specialized topic in the area of linear models. These projects will demonstrate and synthesize the tools learned in the course and the application can be one of interest to the student provided that the topic is approved by the instructor. Students will be required to read and understand literature in the field.

Grading Scale: Grades will be based on the percentage of points earned in the categories listed above. A (90-100%), B+ (87-89%), B (80-86%), C+ (77-79%), C (70-76%), D (60-69%), F (below 60%).

Attendance Policy

You are expected to attend class every day. If you miss class, you will need to obtain notes from one of your classmates and talk with me about material that you do not understand. If for some reason you are not able to attend class the day that an assignment is due, you should email me your assignment that day. Late assignments will not be awarded full credit. Late assignments will not be accepted after graded papers are returned or problem solutions have been distributed. Make-up exams are only possible with proper documentation from the Absence Memo Office.

Accommodations for Students with Disabilities

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Week 15: Review for Final Exam.
Contact Name__Robert Mignone (Chair), Annalisa Calini and Martin Jones (Graduate Program Co-directors)

Email__mignoner@cofc.edu, calinia@cofc.edu, jonesm@cofc.edu

Phone__3-5730

Department/Program__Mathematics____ School__SSM_

Catalog Year in Which Change Will Take Effect__Fall 2016____

Does this proposal include: □ Course title change*
□ Course number change*
□ Course description change*
□ Undergraduate/Graduate cross-listing
*complete Existing Course/New Course Information

A. If you are proposing to cross-list two existing courses at the same level, list the courses (acronym, title, number, course description) and provide a reason for cross-listing.

B. If you are proposing to cross-list an existing undergraduate course with an existing graduate course, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.

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D. If you are proposing to cross-list an existing course with a new course at a different level, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach the appropriate new course proposal form(s). Also attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.
Proposed Cross-listed Courses
(course acronyms, numbers, titles, and descriptions)

MATH 431, Mathematical Statistics II (3)
This is the second course in a two-semester course on Mathematical Statistics. Topics include decision theory, estimation, hypothesis testing, regression, correlation, and analysis of variance. S

Prerequisites: MATH 430 (Mathematical Statistics I).

MATH 531, Mathematical Statistics II (3)
This is the second course in a two-semester course on Mathematical Statistics. Topics include decision theory, estimation, hypothesis testing, regression, correlation and analysis of variance. S

MATH 530 (Mathematical Statistics I) or equivalent.

Reason for Cross-listing

This pair of courses has previously been approved for cross-level listing, and we propose that this be continued for the following reasons:

1. The core material taught at both the 400-level and 500-level is very similar.

2. On the other hand, the course objectives and student learning outcomes are distinguished, in that graduate students do additional, more independent work on projects and in wider reading, and do additional homework and test exercises which address the more advanced theoretical aspects of the material.

3. The cross-level listing allows some of our strongest undergraduate students to take courses that they would otherwise not see at the undergraduate level, thus better preparing them for graduate school and/or the employment marketplace.

4. In a typical semester, it would be difficult to justify the use of resources to teach this pair as two independent courses, since enrollments in higher level mathematics courses are often small; thus cross-listing expands opportunities for both undergraduate and graduate students.

We do not find that having undergraduate and graduate students in the same classes to be problematic. In fact, it seems to have a very positive effect on both groups through a greater degree of peer interaction and discussion.
Changes to Existing Course Numbers/Titles/Descriptions

Existing Course:

**MATH 431, Mathematical Statistics I (3)**
This course is the sequel to MATH 430. Topics will include estimation, decision theory, regression, correlation, hypothesis testing and ANOVA. S.
*Prerequisite:* MATH 430.

**MATH 531, Mathematical Statistics I (3)**
Topics include decision theory, estimation, hypothesis testing, regression, correlation and analysis of variance.
*Prerequisite:* MATH 530. S

Proposed Course Change:

1. Slightly change BOTH descriptions to the common description shown in the **Proposed Cross-listed Courses** box.

2. Clarify the Prerequisites for Math 431:
   *Prerequisites:* MATH 430 (Mathematical Statistics I).

3. Modify the Prerequisites for Math 530 to:
   *Prerequisites:* MATH 530 (Mathematical Statistics I) or equivalent.
Math 431 Mathematical Statistics II
College of Charleston
Department of Mathematics
Sample Syllabus

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**COURSE MEETINGS**
Mondays and Wednesdays in Maybank 112 from 7:00 - 8:15 PM.

**PREREQUISITES**
Math 430 Mathematical Statistics I.

**TEXTBOOK**

**COURSE DESCRIPTION**
This is a second course in a two-semester course on Mathematical Statistics. Topics include decision theory, estimation, hypothesis testing, regression, correlation, and analysis of variance.

**STUDENT LEARNING OUTCOMES:**
After completing this course, students will be able to

1. Explain the importance of the statistical theory in the development of the tools of statistical inference.

2. Recognize the connection between classical and non-classical statistical theory for inference.

3. Demonstrate an understanding of mathematical proofs in the development of mathematical statistical theory.

4. Implement the statistical package R to analyze new data sets.

These outcomes will be assessed in homework and on in class exams.

**UNDERGRADUATE MATHEMATICS PROGRAM LEARNING OUTCOMES**

Students are expected to display a thorough understanding of the topics covered. In particular, upon completion of the course, students will be able to

1. Using algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics, students model phenomena in mathematical terms.

2. Using algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics, students derive correct answers to challenging questions by applying the models from Student Learning Outcome 1.

3. Write complete, grammatically and logically correct arguments to prove their conclusions.

These outcomes will be assessed in homework and on in class exams.

**GRADED ASSIGNMENTS**
In this course, we will have one midterm exam, a final examination, and bi-weekly homework. Graduate students will also be expected to complete a project. Graduate students will be expected to show mastery of the more theoretical aspects of the
course. This will involve extra homework exercises, additional problems on exams, and a project, culminating in a report synthesizing material learned from the course. This additional work will be optional for undergraduates.

| Midterm: 25% | Final Exam: 25% | Homework: 50% |

**IMPORTANT DATES**

| Midterm: Wednesday, October 14 | Final Exam: Wednesday, December 16 |

**Course Grades**

*Midterm and Final Exams (25% each):* These two in-class exams will assess your understanding of the mathematical theory in the development of statistical inference. You will be expected to reproduce short proofs, show facility with the statistical tools, and perform calculations and predictions using the models.

*Homework (50%):* Every other week you will be expected to turn in assigned problems from the text. These problems may be a combination of theory and the application of statistical inference to real data. Some exercises will require the statistical software package R.

**Grading Scale:** Final grades will be based on the percentage of points earned. Letter grades will be determined from the following scale: Grading Scale: A 93-100, A- 90-92, B+ 87-89, B 83-86, B- 80-82, C+ 77-79, C 73-76, C- 70-72, D+ 67-69, D 63-66, D- 60-62, F below 60. If your final exam grade is better than your pre-exam average, I will weight your final exam more heavily.

**Attendance Policy**

You are expected to attend class every day. If you miss class, you will need to obtain notes from one of your classmates and talk with me about material that you do not understand. If for some reason you are not able to attend class the day that an assignment is due, you should email me your assignment that day. Late assignments will not be awarded full credit. Late assignments will not be accepted after graded papers are returned or problem solutions have been distributed. Make-up exams are only possible with proper documentation from the Absence Memo Office.

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Week 6-7: Maximum Likelihood Methods.

Week 8: Sufficiency.

Week 9-10: Optimal Tests of Hypotheses.

Week 11: Inferences about Normal models.

Week 12: Nonparametric Statistics.

Week 13: Bayesian Statistics.

Week 14-15: Linear Models.

Week 15: Review for Final Exam.
Math 531 Mathematical Statistics II
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION
XXX
Office: RSS XXX
Office Hours: T.B.A.
E-mail: xxx@cofc.edu

MEETINGS
Mondays and Wednesdays in Maybank 112 from 7:00 - 8:15 PM.

PREREQUISITES
Math 530 Mathematical Statistics I or equivalent.

TEXTBOOK
Mathematical Statistics with Applications by Wackerly, Mendenhall and Sheaffer, Seventh Edition.

COURSE DESCRIPTION
This is a second course in a two-semester course on Mathematical Statistics. Topics include decision theory, estimation, hypothesis testing, regression, correlation, and analysis of variance.

STUDENT LEARNING OUTCOMES:
After completing this course, students will be able to

1. Critique and investigate the importance of the statistical theory in the development of the tools of statistical inference.

2. Compare and contrast classical and non-classical approaches to statistical inference.

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Week 15: Review for Final Exam.
Contact Name: Robert Mignone (Chair), Annalisa Calini and Martin Jones (Graduate Program Co-directors)

Email: mignonr@cofc.edu, calinj@cofc.edu, jonesm@cofc.edu

Phone: 3-5730

Department/Program: Mathematics  School: SSM

Catalog Year in Which Change Will Take Effect: Fall 2016

Does this proposal include:
□ Course title change*
□ Course number change*
X□ Course description change*
X□ Undergraduate/Graduate cross-listing

*complete Existing Course/New Course Information

A. If you are proposing to cross-list **two existing courses at the same level**, list the courses (acronym, title, number, course description) and provide a reason for cross-listing.

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Proposed Cross-listed Courses
(course acronyms, numbers, titles, and descriptions)

**MATH 440, Statistical Learning I (3)**

This course provides an introduction to various approaches to statistical learning including empirical processes, classification and clustering, nonparametric density estimation and regression, model selection and adaptive procedures, bootstrapping and cross-validation.

*Prerequisites: MATH 203 (Linear Algebra), 220 (Calculus II), and 350 (Statistical Methods II)*

**MATH 540, Statistical Learning I (3)**

This course provides an introduction to various approaches to statistical learning including empirical processes, classification and clustering, nonparametric density estimation and regression, model selection and adaptive procedures, bootstrapping and cross-validation.

*Prerequisites: Students must have a working knowledge of undergraduate Linear Algebra, Multivariable Calculus, and Statistics.*

**Reason for Cross-listing**

This pair of courses has previously been approved for cross-level listing, and we propose that this be continued for the following reasons:

1. The core material taught at both the 400-level and 500-level is very similar.
2. On the other hand, the course objectives and student learning outcomes are distinguished, in that graduate students do additional, more independent work on projects and in wider reading, and do additional homework and test exercises which address the more advanced theoretical aspects of the material.
3. The cross-level listing allows some of our strongest undergraduate students to take courses that they would otherwise not see at the undergraduate level, thus better preparing them for graduate school and/or the employment marketplace.
4. In a typical semester, it would be difficult to justify the use of resources to teach this pair as two independent courses, since enrollments in higher level mathematics courses are often small; thus cross-listing expands opportunities for both undergraduate and graduate students.

We do not find that having undergraduate and graduate students in the same classes to be problematic. In fact, it seems to have a very positive effect on both groups through a greater degree of peer interaction and discussion.
Changes to Existing Course Numbers/Titles/Descriptions

Existing Course:

**MATH 440, Statistical Learning I (3)**
Introduction to various approaches to statistical learning including empirical processes, classification and clustering, nonparametric density estimation and regression, model selection and adaptive procedures, bootstrapping and cross-validation. F.
*Prerequisites:* MATH 203, 220, and 350.

**MATH 540, Statistical Learning I (3)**
Introduction to various approaches to statistical learning including empirical processes, classification and clustering, nonparametric density estimation and regression, model selection and adaptive procedures, bootstrapping and cross-validation.
*Prerequisite:* Permission of the instructor

Proposed Course Change:

1. Slightly change the already common description to the common description shown in the **Proposed Cross-listed Courses** box.

2. Clarify the Prerequisites for Math 440:
*Prerequisites:* MATH 203 (Linear Algebra), 220 (Calculus II), and 350 (Statistical Methods II)

3. Modify the Prerequisites for Math 540 to:

*Prerequisites:* Students must have a working knowledge of undergraduate Linear Algebra, Multivariable Calculus, and Statistics.

4. Specify course rotation for Math 540: F
Math 440 Statistical Learning I
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION
XXX
Office: RSS XXX
E-mail: xxx@cofc.edu

Office Hours: T.B.A.

Course Meetings
Mondays and Wednesdays in Maybank 112 from 7:00 - 8:15 PM.

Prerequisites
Math 203 Linear Algebra, 220 Calculus II, and 350 Statistical Methods II.

Textbook
The Elements of Statistical Learning by Hastie, Tibshirani, and Friedman, Second Edition.

Course Description
This course provides an introduction to various approaches to statistical learning including empirical processes, classification and clustering, nonparametric density estimation and regression, model selection and adaptive procedures, bootstrapping and cross-validation.

Student Learning Outcomes:
After completing this course, students will be able to

1. Explain the importance of the statistical theory in the development of the tools of statistical learning theory.

2. Recognize situations that require the use of statistical theory tools and the advantages of these methods.

3. Demonstrate an understanding of mathematical proofs in the development of statistical learning theory.

4. Implement the statistical package R to work with statistical learning models.

These outcomes will be assessed in homework and on in class exams.

Undergraduate Mathematics Program Learning Outcomes
Students are expected to display a thorough understanding of the topics covered. In particular, upon completion of the course, students will be able to

1. Using algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics, students model phenomena in mathematical terms.

2. Using algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics, students derive correct answers to challenging questions by applying the models from Student Learning Outcome 1.

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In this course, we will have one midterm exam, a final examination, and bi-weekly homework. Graduate students will also be expected to complete a project. Graduate students will be expected to show mastery of the more theoretical aspects of the course. This will involve extra homework exercises, additional problems on exams, and a project, culminating in a report synthesizing material learned from the course. This additional work will be optional for undergraduates.

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within two school days.

**Coverage of Topics**

**Week 1**: Overview of Supervised Learning.

**Week 2-5**: Linear Methods for Regression.

**Week 6-10**: Linear Methods for Classification.

**Week 10-11**: Basic Expansions and Regularization.

**Week 12-13**: Kernel Smoothing Methods.

**Week 14**: Model Assessment and Selection.

**Week 15**: Review for Final Exam.
Math 540 Statistical Learning I
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION

XXX
Office: RSS XXX
Office Hours: T.B.A.
E-mail: xxx@cofc.edu

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Mondays and Wednesdays in Maybank 112 from 7:00 - 8:15 PM.

Prerequisites

Students must have a working knowledge of undergraduate Linear Algebra, Multivariate Calculus, and Statistics.

Textbook

The Elements of Statistical Learning by Hastie, Tibshirani, and Friedman, Second Edition.

Course Description

This course provides an introduction to various approaches to statistical learning including empirical processes, classification and clustering, nonparametric density estimation and regression, model selection and adaptive procedures, bootstrapping and cross-validation.

Student Learning Outcomes:

After completing this course, students will be able to

1. Critique and investigate the importance of the statistical theory in the development of the tools of statistical learning theory.

2. Compare and contrast situations that require the use of statistical theory tools with those that do not and the advantages of these methods in the situations that require them.

3. Develop and construct mathematical proofs in the development of statistical learning theory.

4. Develop statistical learning models using the statistical package R.

These outcomes will be assessed in homework and on in class exams.

Graded Assignments

In this course, we will have one midterm exam, a final examination, and bi-weekly homework. Graduate students will also be expected to complete a project. Graduate students will be expected to show mastery of the more theoretical aspects of the course. This will involve extra homework exercises, additional problems on exams, and a project, culminating in a report synthesizing material learned from the course. This additional work will be optional for undergraduates.

<table>
<thead>
<tr>
<th>Assignment</th>
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<tr>
<td>Homework</td>
<td>40%</td>
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<tr>
<td>Project</td>
<td>20%</td>
</tr>
</tbody>
</table>
Midterm: Wednesday, October 14
Final Exam: Wednesday, December 16

**Course Grades**

Midterm and Final Exams (25% each): These two in class exams will assess your understanding of the mathematical theory in the development of statistical learning theory. You will be expected to reproduce short proofs, show facility with the statistical tools, and perform calculations and predictions using the models.

Homework (50%): Every other week you will be expected to turn in assigned problems from the text. These problems may be a combination of theory and the application of statistical learning models to real data. Some exercises will require the statistical software package R.

Project (20%): Graduate students will be given a project to work on that will involve learning a more specialized topic in the area of statistical learning. These projects will demonstrate and synthesize the tools learned in the course and the application can be one of interest to the student provided that the topic is approved by the instructor. Students will be required to read and understand literature in the field.

Grading Scale: Grades will be based on the percentage of points earned in the categories listed above. A (90-100%), B+ (87-89%), B (80-86%), C+ (77-79%), C (70-76%), D (60-69%), F (below 60%).

**Attendance Policy**

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**Accommodations for Students with Disabilities**

If there is a student in this class who has a documented disability and has been approved to receive accommodations through the Center for Disability Services/SNAP (Students Needing Access Parity), please come and discuss this with me during my office hours.

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**Supplementary Material**

Supplementary materials for our course will be posted on OAKS.

**E-Mail**

The best way to contact me is by e-mail. Please always include your name, the course name, and the section number in your e-mails. In general, you should expect a response within two school days.

**Coverage of Topics**

Week 1: Overview of Supervised Learning.

Week 2-5: Linear Methods for Regression.

Week 6-10: Linear Methods for Classification.
Week 10-11: Basic Expansions and Regularization.


Week 14: Model Assessment and Selection.

Week 15: Review for Final Exam.
Contact Name__Robert Mignone (Chair), Annalisa Calini and Martin Jones (Graduate Program Co-directors)__________

Email__mignonr@cofc.edu, calinia@cofc.edu, jonesm@cofc.edu

Phone__3-5730________

Department/Program__Mathematics_____ School__SSM_

Catalog Year in Which Change Will Take Effect__Fall 2016_____

Does this proposal include:  □  Course title change*
     □  Course number change*
     X□  Course description change*
     X□  Undergraduate/Graduate cross-listing
*complete Existing Course/New Course Information

A. If you are proposing to cross-list two existing courses at the same level, list the courses (acronym, title, number, course description) and provide a reason for cross-listing.

B. If you are proposing to cross-list an existing undergraduate course with an existing graduate course, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.

C. If you are proposing to cross-list an existing course with a new course at the same level, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach the appropriate new course proposal form.

D. If you are proposing to cross-list an existing course with a new course at a different level, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach the appropriate new course proposal form(s). Also attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.
Proposed Cross-listed Courses
(course acronyms, numbers, titles, and descriptions)

MATH 441, Statistical Learning II (3)

Neural networks, nearest neighbor procedures, Vapnik Chervonenkis dimension, support vector machines, structural risk minimization induction, regularization methods and boosting and bagging in classification and regression. S.

Prerequisites: MATH 440 (Statistical Learning I)

MATH 541, Statistical Learning II (3)

Neural networks, nearest neighbor procedures, Vapnik Chervonenkis dimension, support vector machines, structural risk minimization induction, regularization methods and boosting and bagging in classification and regression. S.

Prerequisites: MATH 540 (Statistical Learning I) or equivalent.

Reason for Cross-listing

This pair of courses has previously been approved for cross-level listing, and we propose that this be continued for the following reasons:

1. The core material taught at both the 400-level and 500-level is very similar.

2. On the other hand, the course objectives and student learning outcomes are distinguished, in that graduate students do additional, more independent work on projects and in wider reading, and do additional homework and test exercises which address the more advanced theoretical aspects of the material.

3. The cross-level listing allows some of our strongest undergraduate students to take courses that they would otherwise not see at the undergraduate level, thus better preparing them for graduate school and/or the employment marketplace.

4. In a typical semester, it would be difficult to justify the use of resources to teach this pair as two independent courses, since enrollments in higher level mathematics courses are often small; thus cross-listing expands opportunities for both undergraduate and graduate students.

We do not find that having undergraduate and graduate students in the same classes to be problematic. In fact, it seems to have a very positive effect on both groups through a greater degree of peer interaction and discussion.
Changes to Existing Course Numbers/Titles/Descriptions

Existing Course:

**MATH 441 Statistical Learning II (3)**
Neural networks, nearest neighbor procedures, Vapnik Chervonenkis dimension, support vector machines, structural risk minimization induction, regularization methods and boosting and bagging in classification and regression. S.
*Prerequisite:* MATH 440.

**MATH 541 Statistical Learning II (3)**
Neural networks, nearest neighbor procedures, Vapnik Chervonenkis dimension, support vector machines, structural risk minimization induction, regularization methods and boosting, and bagging in classification and regression.
*Prerequisite:* MATH 540

Proposed Course Change:

1. Clarify the Prerequisites for Math 441:

   *Prerequisites:* MATH 440 (Statistical Learning I)

2. Modify the Prerequisites for Math 541 to:

   *Prerequisites:* MATH 540 (Statistical Learning I) or equivalent.

3. Specify course rotation for Math 540: F
## Math 441 Statistical Learning II

College of Charleston  
Department of Mathematics  
Sample Syllabus

| Instructor Information | Office Hours: T.B.A.  
Office: RSS XXX  
E-mail: xxx@cofc.edu |
<table>
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<tbody>
<tr>
<td>Course Meetings</td>
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<tr>
<td>Prerequisites</td>
<td>Math 440 Statistical Learning I</td>
</tr>
<tr>
<td>Textbook</td>
<td><em>The Elements of Statistical Learning</em> by Hastie, Tibshirani, and Friedman, Second Edition.</td>
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**Course Description**  
Neural networks, nearest neighbor procedures, Vapnik Chervonenkis dimension, support vector machines, structural risk minimization induction, regularization methods and boosting and bagging in classification and regression.

**Student Learning Outcomes:**  
After completing this course, students will be able to:

1. Explain the importance of the statistical theory in the development of the tools of statistical learning theory.

2. Recognize situations that require the use of statistical theory tools and the advantages of these methods.

3. Demonstrate an understanding of mathematical proofs in the development of statistical learning theory.

4. Implement the statistical package R to work with statistical learning models.

These outcomes will be assessed in homework and on in class exams.

**Undergraduate Mathematics Program Learning Outcomes**  
Students are expected to display a thorough understanding of the topics covered. In particular, upon completion of the course, students will be able to:

1. Using algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics, students model phenomena in mathematical terms.

2. Using algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics, students derive correct answers to challenging questions by applying the models from Student Learning Outcome 1.

3. Write complete, grammatically and logically correct arguments to prove their conclusions.

These outcomes will be assessed in homework and on in class exams.

**Graded Assignments**  
In this course, we will have one midterm exam, a final examination, and bi-weekly homework. Graduate students will also be expected to complete a project. Graduate students will be expected to show mastery of the more theoretical aspects of the
course. This will involve extra homework exercises, additional problems on exams, and a project, culminating in a report synthesizing material learned from the course. This additional work will be optional for undergraduates.

| Midterm: 25% |
| Final Exam: 25% |
| Homework: 50% |

**IMPORTANT DATES**

| Midterm: Wednesday, October 14 |
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**COURSE GRADES**

Midterm and Final Exams (25% each): These two in class exams will assess your understanding of the mathematical theory in the development of statistical learning theory. You will be expected to reproduce short proofs, show facility with the statistical tools, and perform calculations and predictions using the models.

Homework (50%): Every other week you will be expected to turn in assigned problems from the text. These problems may be a combination of theory and the application of statistical learning models to real data. Some exercises will require the statistical software package R.

Grading Scale: Final grades will be based on the percentage of points earned. Letter grades will be determined from the following scale: Grading Scale: A 93-100, A- 90-92, B+ 87-89, B 83-86, B- 80-82, C+ 77-79, C 73-76, C- 70-72, D+ 67-69, D 63-66, D- 60-62, F below 60. If your final exam grade is better than your pre-exam average, I will weight your final exam more heavily.

**ATTENDANCE POLICY**

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Week 10-11: Support Vector Machines.

Week 12: Nearest Neighbor Methods.

Week 13-14: Unsupervised Learning.

Week 15: Review for Final Exam.
Math 541 Statistical Learning II
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION

XXX
Office: RSS XXX
E-mail: xxx@cofc.edu

Office Hours: T.B.A.

COURSE MEETINGS

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PREREQUISITES

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TEXTBOOK

The Elements of Statistical Learning by Hastie, Tibshirani, and Friedman, Second Edition.

COURSE DESCRIPTION

Neural networks, nearest neighbor procedures, Vapnik Chervonenkis dimension, support vector machines, structural risk minimization induction, regularization methods and boosting and bagging in classification and regression.

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IMPORTANT DATES

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Week 12: Nearest Neighbor Methods.

Week 13-14: Unsupervised Learning.

Week 15: Review for Final Exam.
Contact Name: Robert Mignone (Chair), Annalisa Calini and Martin Jones (Graduate Program Co-directors)

Email: mignoner@cofc.edu, calinia@cofc.edu, jonesm@cofc.edu

Phone: 3-5730

Department/Program: Mathematics School: SSM

Catalog Year in Which Change Will Take Effect: Fall 2016

Does this proposal include:  
- Course title change*  
- Course number change*  
- X Course description change*  
- X Undergraduate/Graduate cross-listing  
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# Proposed Cross-listed Courses

(course acronyms, numbers, titles, and descriptions)

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<tr>
<td><strong>MATH 445</strong></td>
<td>Numerical Analysis (3)</td>
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This course is a study of numerical methods and analysis of their accuracy, robustness, and speed. Topics include numerical solution of ordinary differential equations, approximation of functions, solving simultaneous linear equations by direct and iterative methods, computing eigenvalues and eigenvectors, and solving systems of non-linear equations. Standard computer software will be used. eS

*Prerequisites:* MATH 203 (Linear Algebra), MATH 323 (Differential Equations), and CSCI 220 (Computer Programming I), or permission of the instructor.

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<tbody>
<tr>
<td><strong>MATH 545</strong></td>
<td>Numerical Analysis I (3)</td>
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</tbody>
</table>

This course is a study of numerical methods and analysis of their accuracy, robustness, and speed. Topics include numerical solution of ordinary differential equations, approximation of functions, solving simultaneous linear equations by direct and iterative methods, computing eigenvalues and eigenvectors, and solving systems of non-linear equations. Standard computer software will be used. eS

*Prerequisites:* Students must have a working knowledge of Linear Algebra, Ordinary Differential Equations, and some computer programming skills.
Reason for Cross-listing

This pair of courses has previously been approved for cross-level listing, and we propose that this be continued for the following reasons:

1. The core material taught at both the 400-level and 500-level is very similar.

2. On the other hand, the course objectives and student learning outcomes are distinguished, in that graduate students do additional, more independent work on projects and in wider reading, and do additional homework and test exercises which address the more advanced theoretical aspects of the material.

3. The cross-level listing allows some of our strongest undergraduate students to take courses that they would otherwise not see at the undergraduate level, thus better preparing them for graduate school and/or the employment marketplace.

4. In a typical semester, it would be difficult to justify the use of resources to teach this pair as two independent courses, since enrollments in higher level mathematics courses are often small; thus cross-listing expands opportunities for both undergraduate and graduate students.

We do not find that having undergraduate and graduate students in the same classes to be problematic. In fact, it seems to have a very positive effect on both groups through a greater degree of peer interaction and discussion.

Changes to Existing Course Numbers/Titles/Descriptions

Existing Course:

**MATH 445 Numerical Analysis (3)**
Topics include numerical methods for solving ordinary differential equations, direct methods and iterative methods in numerical linear algebra and selected topics in functions of several variables. S.
*Prerequisites: MATH 203, 245, and 323.*

**MATH 545 Numerical Analysis I (3)**
This course is a study of numerical methods and analysis of the associated errors. Topics include both direct and iterative methods of numerical linear algebra, computation of eigenvalues and singular values, approximation of functions and numerical solution of ordinary differential equations. Standard computer software libraries will be used.
*Prerequisite: MATH 203 (Linear Algebra), MATH 323 (Differential Equations), and CSCI 220 (Computer Programming I) or permission of the instructor. oS*
Proposed Course Change:

1. Change BOTH descriptions to the common description shown in the Proposed Cross-listed Courses box.

2. Modify the Prerequisites for Math 445 to:

   *Prerequisites:* MATH 203 (Linear Algebra), MATH 323 (Differential Equations), and CSCI 220 (Computer Programming I), or permission of the instructor.

4. Modify the Prerequisites for Math 545 to:

   *Prerequisites:* Students must have a working knowledge of Linear Algebra, Ordinary Differential Equations, and some computer programming skills.

5. Change course rotation for both courses to eS.
Mathematics 445: Numerical Analysis

Class Meetings: Tuesday and Thursday 4:00-5:15 pm, in Maybank 200

Text: Numerical Mathematics and Computing,
by Ward Cheney and David Kincaid

Instructor: Brenton LeMesurier
Office: Robert Scott Small Building, room 200
Phone: 953-5917, messages 953-5730
Email: lemesurierb@cofc.edu
Web Site: http://blogs.cofc.edu/lemesurierb/

Course objectives, structure, and student learning outcomes

This course is a study of numerical methods and analysis of their accuracy, robustness, and speed. Topics include numerical solution of ordinary differential equations, approximation of functions, solving simultaneous linear equations by direct and iterative methods, computing eigenvalues and eigenvectors, and solving systems of non-linear equations.

The numerical solution of differential equations will be used as an organizing theme for the study of other topics.

Upon completion of the course, students will be able to:

- apply numerical methods for the solution of differential equations, systems of linear and nonlinear equations, eigenvalue problems, and for the approximation of functions by polynomials and sinusoidal functions;

- choose between several possible methods based on criteria such as accuracy and efficiency;

- present results in reports that include a statement of the problem to be solved, a description of the numerical methods used, implementation of those methods in a suitable programming language, numerical results, and a discussion of the results.

Undergraduate Mathematics Program student learning outcomes

This course can be used to satisfy some requirements of the undergraduate mathematics degree program, for which there are also some standard goals. Students are expected to display a thorough understanding of the topics covered. In particular, upon completion of the course, students will be able to

1. use algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics to model phenomena in mathematical terms

2. use algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics to derive correct answers to challenging questions by applying the models from the previous Learning Outcome; and
3. write complete, grammatically and logically correct arguments to prove their conclusions.

These outcomes will be assessed on the tests and projects.

Computational work and tools

Computational work will typically be done with Python, but if you are experienced with an alternative like Matlab you may use that if you prefer to do so. (I do not recommend it though!) I will use Python version 3.5, with the packages NumPy, SciPy, and Matplotlib for examples in class, and recommend it for advantages like being free and easy to install on your own computer. All this can be accessed most easily by installing Spyder from https://github.com/spyder-ide/spyder/releases/ All needed software is available on the computers in MYBK 200, along with Matlab, R and Mathematica.

Assessment

Assignments There will be assignments about every two weeks. As these assignments are intended largely as educational experiences, I will be happy to give help with both mathematical and programming problems. What is more, I expect some exercises to be challenging enough that they need to be discussed in class, so you definitely should start work on them at least a week in advance!

Tests There will be two tests: a mid-semester with an in-class part on Thursday February 25 and a take-home part due on Tuesday March 1; and a final at the scheduled exam time of noon to 3 pm, Thursday April 28.

Projects Computer based work will be done mostly in several projects rather than numerous shorter tasks.

I will emphasize that the first step of any computational work is a careful written discussion of the mathematical background and numerical algorithms to be used, and the final step is a presentation and discussion of any computed results, not just a collection of computer output files full of numerical values and graphs.

Attendance and participation

Regular, punctual attendance is important, especially due to the "hands-on" computational work that will be done at times. Students will be dropped [WA] for missing more than two assessment tasks without explanation.

You are responsible for knowing what happens in each class such as handouts and announcements of assignment details and deadlines, so if you miss one, get notes and find out about such details; either from me or a classmate.
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or a total of 30%.

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<th>D^+</th>
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ions for students with disabilities

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This course is a study of numerical methods and analysis of their accuracy, robustness, and speed. Topics include numerical solution of ordinary differential equations, approximation of functions, solving simultaneous linear equations by direct and iterative methods, computing eigenvalues and eigenvectors, and solving systems of non-linear equations.

The numerical solution of differential equations will be used as an organizing theme for the study of other topics.

Upon completion of the course, students will be able to:

- apply numerical methods for the solution of differential equations, systems of linear and nonlinear equations, eigenvalue problems, and for the approximation of functions by polynomials and sinusoidal functions;

- develop numerical methods for solving complex computational problems by analysing them into component problems, devising or choosing solution methods for these components on the basis of criteria such as accuracy and efficiency, and integrating these into a method of solution for the problem as a whole; and

- present results in reports that include descriptions of the problems to be solved, the methods used, implementation of those methods in a suitable programming language, numerical results, a discussion of the results, and evaluation of the methods used.

Computational work and tools

Computational work will typically be done with Python, but if you are experienced with an alternative like Matlab you may use that if you prefer to do so. (I do not recommend it though!) I will use Python version 3.5, with the packages NumPy, SciPy, and Matplotlib for examples in class, and recommend it for advantages like being free and easy to install on your own computer. All this can be accessed most easily by installing Spyder from https://github.com/spyder-ide/spyder/releases/ All needed software is available on the computers in MYBK 200, along with Matlab, R and Mathematica.
Assessment

Assignments  There will be assignments about every two weeks. As these assignments are intended largely as educational experiences, I will be happy to give help with both mathematical and programming problems. What is more, I expect some exercises to be challenging enough that they need to be discussed in class, so you definitely should start work on them at least a week in advance!

Tests  There will be two tests: a mid-semester with an in-class part on Thursday February 25 and a take-home part due on Tuesday March 1; and a final at the scheduled exam time of noon to 3 pm, Thursday April 28.

On both assignments and tests, graduate students will answer some additional questions that test mastery of the more theoretical aspects of the course.

Projects  Computer based work will be done mostly in several projects rather than numerous shorter tasks. Graduate students will do an individually chosen final project that involves analysis of a problem into several simpler parts, choosing solution methods for each of these on the basis of criteria such as accuracy and efficiency, integrating these into a method of solution for the problem as a whole, and explaining the decisions made in this process.

I will emphasize that the first step of any computational work is a careful written discussion of the mathematical background and numerical algorithms to be used, and the final step is a presentation and discussion of any computed results, not just a collection of computer output files full of numerical values and graphs.

Attendance and participation

Regular, punctual attendance is important, especially due to the “hands-on” computational work that will be done at times. Students will be dropped [WA] for missing more than two assessment tasks without explanation.

You are responsible for knowing what happens in each class such as handouts and announcements of assignment details and deadlines, so if you miss one, get notes and find out about such details; either from me or a classmate.

Grading system

- The assignments will count a total of 30%,
- the projects will count a total of 40%, and
- each test will count 15% for a total of 30%.

Final course grades will be determined by the scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>91-100</td>
</tr>
<tr>
<td>B+</td>
<td>86-90</td>
</tr>
<tr>
<td>B</td>
<td>80-85</td>
</tr>
<tr>
<td>C+</td>
<td>76-79</td>
</tr>
<tr>
<td>C</td>
<td>70-75</td>
</tr>
</tbody>
</table>
Accommodations for students with disabilities

If there is a student in this class who has a documented disability and has been approved to receive accommodations through the Center for Disability Services/SNAP (Students Needing Access Parity), please come and discuss this with me during my office hours.

See also http://disabilityservices.cofc.edu/accommodations/

Honor Code

Any violation of the College's Honor Code will be reported to the Honor Board. For more details, see http://studentaffairs.cofc.edu/honor-system/ and the Student Handbook at http://studentaffairs.cofc.edu/honor-system/studenthandbook/
Contact Name__Robert Mignone (Chair), Annalisa Calini and Martin Jones (Graduate Program Co-directors)__________

Email__mignoner@cofc.edu, calinia@cofc.edu, jonesm@cofc.edu

Phone__3-5730________

Department/Program__Mathematics______ School__SSM__

Catalog Year in Which Change Will Take Effect__Fall 2016________

Does this proposal include:  □ Course title change*
□ Course number change*
☐ Course description change*
☐ Undergraduate/Graduate cross-listing
*complete Existing Course/New Course Information

A. If you are proposing to cross-list two existing courses at the same level, list the courses (acronym, title, number, course description) and provide a reason for cross-listing.

B. If you are proposing to cross-list an existing undergraduate course with an existing graduate course, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.

C. If you are proposing to cross-list an existing course with a new course at the same level, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach the appropriate new course proposal form.

D. If you are proposing to cross-list an existing course with a new course at a different level, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach the appropriate new course proposal form(s). Also attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.
Proposed Cross-listed Courses
(courses, acronyms, numbers, titles, and descriptions)

MATH 449 Linear Models (3)
This course provides an introduction to the theory of linear models for analyzing data. Topics include analysis of variance and regression models, as well as Bayesian estimation, hypothesis testing, multiple comparisons, and experimental design models. Additional topics such as balanced incomplete block designs, testing for lack of fit, testing for independence, and variance component estimation are also treated. The approach taken is based on projections, orthogonality, and other vector space concepts. F

Prerequisites: MATH 203 (Linear Algebra) and 350 (Statistical Methods II)

MATH 550 Linear Models (3)
This course provides an introduction to the theory of linear models for analyzing data. Topics include analysis of variance and regression models, as well as Bayesian estimation, hypothesis testing, multiple comparisons, and experimental design models. Additional topics such as balanced incomplete block designs, testing for lack of fit, testing for independence, and variance component estimation are also treated. The approach taken is based on projections, orthogonality, and other vector space concepts. F

Prerequisites: Students must have a working knowledge of undergraduate Linear Algebra and Statistics.
Reason for Cross-listing

This pair of courses has previously been approved for cross-level listing, and we propose that this be continued for the following reasons:

1. The core material taught at both the 400-level and 500-level is very similar.

2. On the other hand, the course objectives and student learning outcomes are distinguished, in that graduate students do additional, more independent work on projects and in wider reading, and do additional homework and test exercises which address the more advanced theoretical aspects of the material.

3. The cross-level listing allows some of our strongest undergraduate students to take courses that they would otherwise not see at the undergraduate level, thus better preparing them for graduate school and/or the employment marketplace.

4. In a typical semester, it would be difficult to justify the use of resources to teach this pair as two independent courses, since enrollments in higher level mathematics courses are often small; thus cross-listing expands opportunities for both undergraduate and graduate students.

We do not find that having undergraduate and graduate students in the same classes to be problematic. In fact, it seems to have a very positive effect on both groups through a greater degree of peer interaction and discussion.

Changes to Existing Course Numbers/Titles/Descriptions

Existing Course:

MATH 449 Linear Models (3)
This course is an introduction to linear models for analyzing data. Topics covered include analysis of variance and regression models, Bayesian estimation, hypothesis testing, multiple comparison, experimental design models, balanced incomplete block designs, testing for lack of fit, testing for independence, and variance component estimation.
Prerequisites: MATH 203, MATH 350

MATH 550 Linear Models (3)
This course provides an introduction to the theory of linear models for analyzing data. Topics include analysis of variance and regression models, as well as Bayesian estimation, hypothesis testing, multiple comparisons, and experimental design models. Additional topics such as balanced incomplete block designs, testing for lack of fit, testing for independence, and variance component estimation are also treated. The approach taken is based on projections, orthogonality, and other vector space concepts.
Prerequisites: Linear Algebra (MATH 203) and Statistical Methods (MATH 350) eF
Proposed Course Change:

1. Slightly change the MATH 449 description to match the MATH 550 description. The common descriptions are shown in the Proposed Cross-listed Courses box.

2. Clarify the Prerequisites for Math 449:
   *Prerequisites:* MATH 203 (Linear Algebra) and 350 (Statistical Methods II)

3. Modify the Prerequisites for Math 550 to:
   *Prerequisites:* Students must have a working knowledge of undergraduate Linear Algebra and Statistics.

4. Specify course rotation for both courses: F
# Math 449 Linear Models

College of Charleston  
Department of Mathematics  
Sample Syllabus

| INSTRUCTOR INFORMATION | XXX Office Hours: T.B.A.  
Office: RSS XXX E-mail: xxx@cofc.edu |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>COURSE MEETINGS</td>
<td>Mondays and Wednesdays in Maybank 112 from 7:00 - 8:15 PM.</td>
</tr>
<tr>
<td>PREREQUISITES</td>
<td>Math 203 Linear Algebra and Math 350 Statistical Methods II.</td>
</tr>
<tr>
<td>COURSE DESCRIPTION</td>
<td>This course provides an introduction to the theory of linear models for analysing data. Topics include analysis of variance and regression models, as well as Bayesian estimation, hypothesis testing, multiple comparisons, and experimental design models. Additional topics such as balanced incomplete block designs, testing for lack of fit, testing for independence, and variance component estimation are also treated. The approach taken is based on projections, orthogonality, and other vector space concepts.</td>
</tr>
</tbody>
</table>
| STUDENT LEARNING OUTCOMES: | After completing this course, students will be able to  
1. Explain the importance of the statistical theory behind the construction of linear models.  
2. Recognize the connection between geometric and algebraic approaches to linear model theory.  
3. Demonstrate an understanding of mathematical proofs in the development of linear model theory.  
4. Implement the statistical package R to analyze new data sets.  
These outcomes will be assessed in homework and on in class exams. |
| UNDERGRADUATE MATHEMATICS PROGRAM LEARNING OUTCOMES | Students are expected to display a thorough understanding of the topics covered. In particular, upon completion of the course, students will be able to  
1. Using algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics, students model phenomena in mathematical terms.  
2. Using algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics, students derive correct answers to challenging questions by applying the models from Student Learning Outcome 1.  
3. Write complete, grammatically and logically correct arguments to prove their conclusions.  
These outcomes will be assessed in homework and on in class exams. |
In this course, we will have one midterm exam, a final examination, and bi-weekly homework. Graduate students will also be expected to complete a project. Graduate students will be expected to show mastery of the more theoretical aspects of the course. This will involve extra homework exercises, additional problems on exams, and a project, culminating in a report synthesizing material learned from the course. This additional work will be optional for undergraduates.

**Graded Assignments**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midterm</td>
<td>25%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>25%</td>
</tr>
<tr>
<td>Homework</td>
<td>50%</td>
</tr>
</tbody>
</table>

**Important Dates**

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midterm</td>
<td>Wednesday, October 14</td>
</tr>
<tr>
<td>Final Exam</td>
<td>Wednesday, December 16</td>
</tr>
</tbody>
</table>

**Course Grades**

Midterm and Final Exams (25% each): These two in class exams will assess your understanding of the mathematical theory in the development of linear models. You will be expected to reproduce short proofs, show facility with the probabilistic tools, and perform calculations and predictions using the models.

Homework (50%): Every other week you will be expected to turn in assigned problems from the text. These problems may be a combination of theory and the application of linear models to real data. Some exercises will require the statistical software package R.

Grading Scale: Final grades will be based on the percentage of points earned. Letter grades will be determined from the following scale: Grading Scale: A 93-100, A- 90-92, B+ 87-89, B 83-86, B- 80-82, C+ 77-79, C 73-76, C- 70-72, D+ 67-69, D 63-66, D- 60-62, F below 60. If your final exam grade is better than your pre-exam average, I will weight your final exam more heavily.

**Attendance Policy**

You are expected to attend class every day. If you miss class, you will need to obtain notes from one of your classmates and talk with me about material that you do not understand. If for some reason you are not able to attend class the day that an assignment is due, you should email me your assignment that day. Late assignments will not be awarded full credit. Late assignments will not be accepted after graded papers are returned or problem solutions have been distributed. Make-up exams are only possible with proper documentation from the Absence Memo Office.

**Accommodations for Students with Disabilities**

If there is a student in this class who has a documented disability and has been approved to receive accommodations through the Center for Disability Services/SNAP (Students Needing Access Parity), please come and discuss this with me during my office hours.

**Honor Code**

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**Supplementary Material**

Supplementary materials for our course will be posted on OAKS.

**E-Mail**

The best way to contact me is by e-mail. Please always include your name, the course name, and the section number in your e-mails. In general, you should expect a response within two school days.
Coverage of Topics

Week 1: Introduction to the course.

Week 2: Simple linear regression, inferences about parameters, analysis of variance, categorical predictors.

Week 3: Diagnostics and transformations for simple linear regression.

Week 4: Diagnostics, weighted least squares regression.

Week 5: Weighted regression. Introduction to multiple regression.

Week 6: Multiple linear regression, polynomial regression, analysis of covariance, diagnostics.

Week 7: Diagnostics for multiple regression.

Week 8: Review and Midterm Exam.

Week 9: Transformations, multicollinearity for multiple regression.

Week 10: Variable selection for multiple regression models.

Week 11: Logistic Regression.

Week 12: Time Series models.

Week 13: Time Series Models, Mixed models.

Week 14: Mixed Models.

Week 15: Review for Final Exam.
Math 550 Linear Models
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION
XXX
Office: RSS XXX
E-mail: xxx@cofc.edu

COURSE MEETINGS
Mondays and Wednesdays in Maybank 112 from 7:00 - 8:15 PM.

PREREQUISITES
Students must have a working knowledge of Linear Algebra and Statistics.

TEXTBOOK

COURSE DESCRIPTION
This course provides an introduction to the theory of linear models for analyzing data. Topics include analysis of variance and regression models, as well as Bayesian estimation, hypothesis testing, multiple comparisons, and experimental design models. Additional topics such as balanced incomplete block designs, testing for lack of fit, testing for independence, and variance component estimation are also treated. The approach taken is based on projections, orthogonality, and other vector space concepts.

STUDENT LEARNING OUTCOMES:
After completing this course, students will be able to

1. Critique and investigate the statistical theory behind the construction of linear models.

2. Compare and contrast the geometric and algebraic approaches to linear model theory.

3. Develop and construct proofs of aspects of the development of linear model theory.

4. Develop models to analyze real data using the statistical package R.

These outcomes will be assessed in homework and on in class exams.

GRADED ASSIGNMENTS
In this course, we will have one midterm exam, a final examination, and bi-weekly homework. Graduate students will also be expected to complete a project. Graduate students will be expected to show mastery of the more theoretical aspects of the course. This will involve extra homework exercises, additional problems on exams, and a project, culminating in a report synthesizing material learned from the course. The project will involve reading and understanding primary literature in the field.

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<thead>
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Midterm and Final Exams (20% each): These two in class exams will assess your understanding of the mathematical theory in the development of linear models. You will be expected to reproduce short proofs, show facility with the probabilistic tools, and perform calculations and predictions using the models.

Homework (40%): Every other week you will be expected to turn in assigned problems from the text. These problems may be a combination of theory and the application of linear models to real data. Some exercises will require the statistical software package R.

Project (20%): Graduate students will be given a project to work on that will involve learning a more specialized topic in the area of linear models. These projects will demonstrate and synthesize the tools learned in the course and the application can be of interest to the student provided that the topic is approved by the instructor. Students will be required to read and understand literature in the field.

Grading Scale: Grades will be based on the percentage of points earned in the categories listed above. A (90-100%), B+ (87-89%), B (80-86%), C+ (77-79%), C (70-76%), D (60-69%), F (below 60%).

You are expected to attend class every day. If you miss class, you will need to obtain notes from one of your classmates and talk with me about material that you do not understand. If for some reason you are not able to attend class the day that an assignment is due, you should email me your assignment that day. Late assignments will not be awarded full credit. Late assignments will not be accepted after graded papers are returned or problem solutions have been distributed. Make-up exams are only possible with proper documentation from the Absence Memo Office.

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Week 10: Variable selection for multiple regression models.

Week 11: Logistic Regression.

Week 12: Time Series models.

Week 13: Time Series Models, Mixed models.

Week 14: Mixed Models.

Week 15: Review for Final Exam.
Contact Name__Robert Mignone (Chair), Annalisa Calini and Martin Jones (Graduate Program Co-directors)__________

Email__mignoner@cofc.edu, calinia@cofc.edu, jonesm@cofc.edu

Phone__3-5730________

Department/Program__Mathematics______ School__SSM_

Catalog Year in Which Change Will Take Effect__Fall 2016________

Does this proposal include:  □ Course title change*
□ Course number change*
X□ Course description change*
X□ Undergraduate/Graduate cross-listing
*complete Existing Course/New Course Information

A. If you are proposing to cross-list **two existing courses at the same level**, list the courses (acronym, title, number, course description) and provide a reason for cross-listing.

B. If you are proposing to cross-list **an existing undergraduate course with an existing graduate course**, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and **attach a syllabus** (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.

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Proposed Cross-listed Courses
(course acronyms, numbers, titles, and descriptions)

MATH 451 Linear Programming and Optimization (3)

This course provides an introduction to deterministic models in operations research. Topics include linear programming, network analysis, dynamic programming, and game theory.

Prerequisites: MATH 203 (Linear Algebra), MATH 221 (Calculus III), and CSCI 220 (Computer Programming I) or MATH 245 (Numerical Methods and Mathematical Computing), or permission of the instructor.

MATH 551 Linear Programming and Optimization (3)

This course provides an introduction to deterministic models in operations research. Topics include linear programming, network analysis, dynamic programming, and game theory.

Prerequisites: Students must have a working knowledge of Linear Algebra, Vector Calculus, and some computer programming skills.

Reason for Cross-listing

This pair of courses has previously been approved for cross-level listing, and we propose that this be continued for the following reasons:

1. The core material taught at both the 400-level and 500-level is very similar.

2. On the other hand, the course objectives and student learning outcomes are distinguished, in that graduate students do additional, more independent work on projects and in wider reading, and do additional homework and test exercises which address the more advanced theoretical aspects of the material.

3. The cross-level listing allows some of our strongest undergraduate students to take courses that they would otherwise not see at the undergraduate level, thus better preparing them for graduate school and/or the employment marketplace.

4. In a typical semester, it would be difficult to justify the use of resources to teach this pair as two independent courses, since enrollments in higher level mathematics courses are often small; thus cross-listing expands opportunities for both undergraduate and graduate students.

We do not find that having undergraduate and graduate students in the same classes to be problematic. In fact, it seems to have a very positive effect on both groups through a greater degree of peer interaction and discussion.
Changes to Existing Course Numbers/Titles/Descriptions

Existing Course:

**MATH 451 Linear Programming and Optimization (3)**
An introduction to deterministic models in operations research. Topics include linear programming, network analysis, dynamic programming, and game theory.

*Prerequisites:* MATH 203, 221, and CSCI 220 or MATH 245, or permission of the instructor.

**MATH 551 Linear Programming and Optimization (3)**
This course is designed to provide first-year graduate students with an introduction to deterministic models in operations research. Topics include linear programming, network analysis, dynamic programming, and game theory.

*Prerequisite:* MATH 221 (Calculus III), MATH 203 (Linear Algebra), and CSCI 220, or permission of the instructor.

Proposed Course Change:

1. Slightly change BOTH descriptions to the common description shown in the **Proposed Cross-listed Courses** box.

2. Clarify the Prerequisites for Math 451:

*Prerequisites:* MATH 203 (Linear Algebra), MATH 221 (Calculus III), and CSCI 220 (Computer Programming I) or MATH 245 (Numerical Methods and Mathematical Computing), or permission of the instructor.

3. Modify the Prerequisites for Math 551 to:

*Prerequisites:* Students must have a working knowledge of Linear Algebra, Vector Calculus, and some computer programming skills.

4. Specify course rotation for Math 451: oF
Math 451 Linear Programming and Optimization
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION
XXX
Office: RSS XXX
Office Hours: T.B.A.
E-mail: xxx@cofc.edu

COURSE MEETINGS
Mondays and Wednesdays in Maybank 112 from 7:00 - 8:15 PM.

PREREQUISITES
Math 203 Linear Algebra, Math 221 Calculus III, and CSCI 220 Computer Programming I or Math 245 Numerical Methods and Mathematical Computing, or permission of the instructor.

TEXTBOOK

COURSE DESCRIPTION
This course provides an introduction to deterministic models in operations research. Topics include linear programming, network analysis, dynamic programming, and game theory.

STUDENT LEARNING OUTCOMES:
After completing this course, students will be able to

1. Explain the importance of the mathematical theory in the development of the tools of linear programming and optimization methods.

2. Recognize the mathematical tools for use in specific situations that require linear programming and optimization techniques.

3. Demonstrate an understanding of mathematical proofs in the development of linear programming and optimization.

4. Implement computer packages to work with linear programming and optimization models.

These outcomes will be assessed in homework and on in class exams.

UNDERGRADUATE MATHEMATICS PROGRAM LEARNING OUTCOMES
Students are expected to display a thorough understanding of the topics covered. In particular, upon completion of the course, students will be able to

1. Using algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics, students model phenomena in mathematical terms.

2. Using algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics, students derive correct answers to challenging questions by applying the models from Student Learning Outcome 1.

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In this course, we will have one midterm exam, a final examination, and bi-weekly homework. Graduate students will also be expected to complete a project. Graduate students will be expected to show mastery of the more theoretical aspects of the course. This will involve extra homework exercises, additional problems on exams, and a project, culminating in a report synthesizing material learned from the course. This additional work will be optional for undergraduates.

**Midterm:** 25%
**Final Exam:** 25%
**Homework:** 50%

**Important Dates**

| Midterm | Wednesday, October 14 |
| Final Exam | Wednesday, December 16 |

**Course Grades**

Midterm and Final Exams (25% each): These two in class exams will assess your understanding of the mathematical theory in the development of linear programming and optimization. You will be expected to reproduce short proofs, show facility with the mathematical tools, and perform calculations and predictions using the models.

**Homework (50%)**: Every other week you will be expected to turn in assigned problems from the text. These problems may be a combination of theory and the application of models to real data. Some exercises will require the use of computer software packages.

**Grading Scale**: Final grades will be based on the percentage of points earned. Letter grades will be determined from the following scale: Grading Scale: A 93-100, A- 90-92, B+ 87-89, B 83-86, B- 80-82, C+ 77-79, C 73-76, C- 70-72, D+ 67-69, D 63-66, D- 60-62, F below 60. If your final exam grade is better than your pre-exam average, I will weight your final exam more heavily.

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The best way to contact me is by e-mail. Please always include your name, the course name, and the section number in your e-mails. In general, you should expect a response within two school days.
Week 1-2: Introduction to Linear Programming.

Week 3-4: Solving Linear Programming Problems.

Week 5-6: Simplex Method and Duality Theory.

Week 7-8: Linear Programming under Uncertainty.

Week 9-10: Assignment Problems.

Week 11-12: Game Theory.

Week 13-14: Dynamic Programming.

Week 15: Review for Final Exam.
Math 551 Linear Programming and Optimization
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION

XXX
Office: RSS XXX
Office Hours: T.B.A.
E-mail: xxx@cofc.edu

Course Meetings
Mondays and Wednesdays in Maybank 112 from 7:00 - 8:15 PM.

Prerequisites
Students must have a working knowledge of Linear Algebra, Vector Calculus and some computer programming skills.

Textbook

Course Description
This course provides an introduction to deterministic models in operations research. Topics include linear programming, network analysis, dynamic programming, and game theory.

Student Learning Outcomes:
After completing this course, students will be able to

1. Critique and investigate the importance of the mathematical theory in the development of the tools of linear programming and optimization methods.

2. Compare and contrast the use of linear programming and optimization techniques in specific applications.

3. Develop and construct mathematical proofs in the development of linear programming and optimization.

4. Develop linear programming and optimization models using computer packages.

These outcomes will be assessed in homework and on in class exams.

Graded Assignments
In this course, we will have one midterm exam, a final examination, and bi-weekly homework. Graduate students will also be expected to complete a project. Graduate students will be expected to show mastery of the more theoretical aspects of the course. This will involve extra homework exercises, additional problems on exams, and a project, culminating in a report synthesizing material learned from the course. This additional work will be optional for undergraduates.

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<tr>
<th>Grade</th>
<th>Percentage</th>
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<tr>
<td>Midterm</td>
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<td>Final Exam</td>
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<td>Homework</td>
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<td>Project</td>
<td>20%</td>
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Important Dates
Midterm: Wednesday, October 14
Final Exam: Wednesday, December 16
**Course Grades**

Midterm and Final Exams (25% each): These two in class exams will assess your understanding of the mathematical theory in the development of linear programming and optimization. You will be expected to reproduce short proofs, show facility with the mathematical tools, and perform calculations and predictions using the models.

Homework (50%): Every other week you will be expected to turn in assigned problems from the text. These problems may be a combination of theory and the application of models to real data. Some exercises will require the use of computer software packages.

Project (20%): Graduate students will be given a project to work on that will involve learning a more specialized topic in linear programming and optimization. These projects will demonstrate and synthesize the tools learned in the course and the application can be of interest to the student provided that the topic is approved by the instructor. Students will be required to read and understand literature in the field.

**Grading Scale:** Grades will be based on the percentage of points earned in the categories listed above. A (90-100%), B+ (87-89%), B (80-86%), C+ (77-79%), C (70-76%), D (60-69%), F (below 60%).

**Attendance Policy**

You are expected to attend class every day. If you miss class, you will need to obtain notes from one of your classmates and talk with me about material that you do not understand. If for some reason you are not able to attend class the day that an assignment is due, you should email me your assignment that day. Late assignments will not be awarded full credit. Late assignments will not be accepted after graded papers are returned or problem solutions have been distributed. Make-up exams are only possible with proper documentation from the Absence Memo Office.

**Accommodations for Students with Disabilities**

If there is a student in this class who has a documented disability and has been approved to receive accommodations through the Center for Disability Services/SNAP (Students Needing Access Parity), please come and discuss this with me during my office hours.

**Honor Code**

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**Supplementary Material E-Mail**

Supplementary materials for our course will be posted on OAKS.

The best way to contact me is by e-mail. Please always include your name, the course name, and the section number in your e-mails. In general, you should expect a response within two school days.

**Coverage of Topics**

Week 1-2: Introduction to Linear Programming.

Week 3-4: Solving Linear Programming Problems.

Week 5-6: Simplex Method and Duality Theory.

Week 7-8: Linear Programming under Uncertainty.

Week 9-10: Assignment Problems.
Week 11-12: Game Theory.

Week 13-14: Dynamic Programming.

Week 15: Review for Final Exam.
Contact Name___Robert Mignone (Chair), Annalisa Calini and Martin Jones (Graduate Program Co-directors)__________

Email___mignoner@cofc.edu, calinia@cofc.edu, jonesm@cofc.edu

Phone___3-5730__________

Department/Program_Mathematics____ School_SSM_

Catalog Year in Which Change Will Take Effect_Fall 2016__________

Does this proposal include:  □ Course title change*
□ Course number change*
X□ Course description change*
X□ Undergraduate/Graduate cross-listing
*complete Existing Course/New Course Information

A. If you are proposing to cross-list two existing courses at the same level, list the courses (acronym, title, number, course description) and provide a reason for cross-listing.

B. If you are proposing to cross-list an existing undergraduate course with an existing graduate course, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.

C. If you are proposing to cross-list an existing course with a new course at the same level, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach the appropriate new course proposal form.

D. If you are proposing to cross-list an existing course with a new course at a different level, list the courses (acronym, title, number, course description), provide a reason for cross-listing, and attach the appropriate new course proposal form(s). Also attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.
Proposed Cross-listed Courses
(course acronyms, numbers, titles, and descriptions)

**MATH 452 Operations Research (3)**

This course provides an introduction to probabilistic models in operations research. Topics include queueing theory, applications of Markov chains, simulation, integer programming, and nonlinear programming.

*Prerequisites:* MATH 203 (Linear Algebra), MATH 221 (Calculus III), and CSCI 220 (Computer Programming I) or MATH 245 (Numerical Methods and Mathematical Computing), or permission of the instructor.

**MATH 552 Operations Research (3)**

This course provides an introduction to probabilistic models in operations research. Topics include queueing theory, applications of Markov chains, simulation, integer programming, and nonlinear programming.

*Prerequisites:* Students must have a working knowledge of Linear Algebra, Vector Calculus, and some computer programming skills.

**Reason for Cross-listing**

This pair of courses has previously been approved for cross-level listing, and we propose that this be continued for the following reasons:

1. The core material taught at both the 400-level and 500-level is very similar.

2. On the other hand, the course objectives and student learning outcomes are distinguished, in that graduate students do additional, more independent work on projects and in wider reading, and do additional homework and test exercises which address the more advanced theoretical aspects of the material.

3. The cross-level listing allows some of our strongest undergraduate students to take courses that they would otherwise not see at the undergraduate level, thus better preparing them for graduate school and/or the employment marketplace.

4. In a typical semester, it would be difficult to justify the use of resources to teach this pair as two independent courses, since enrollments in higher level mathematics courses are often small; thus cross-listing expands opportunities for both undergraduate and graduate students.

We do not find that having undergraduate and graduate students in the same classes to be problematic. In fact, it seems to have a very positive effect on both groups through a greater degree of peer interaction and discussion.
Changes to Existing Course Numbers/Titles/Descriptions

Existing Course:

**MATH 452 Operations Research (3)**
An introduction to probabilistic models in operations research. Topics include queueing theory, applications of Markov chains, simulation, integer programming and nonlinear programming. eS.

*Prerequisites:* MATH 203, 430 and CSCI 220 or MATH 245.

**MATH 552 Operations Research (3)**
This course is designed to provide first-year graduate students with an introduction to probabilistic models in operations research. Topics include nonlinear programming, queueing theory, Markov chains, simulation and integer programming.

*Prerequisite:* MATH 221 (Calculus III), MATH 530 (Mathematical Statistics I), CSCI 220, or permission of the instructor. eS

Proposed Course Change:

1. Slightly change BOTH descriptions to the common description shown in the Proposed Cross-listed Courses box.

2. Modify the Prerequisites for MATH 452:

*Prerequisites:* MATH 203 (Linear Algebra), MATH 221 (Calculus III), and CSCI 220 (Computer Programming I) or MATH 245 (Numerical Methods and Mathematical Computing), or permission of the instructor.

3. Modify the Prerequisites for MATH 552 to:

*Prerequisites:* Students must have a working knowledge of Linear Algebra, Vector Calculus, and some computer programming skills.

4. Specify course rotation for Math 452: eS

5. The MATH 430/MATH 530 (Mathematical Statistics I) prerequisite is dropped as probabilistic concepts are introduced as needed during the course.
Math 452 Operations Research
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION
XXX
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Office Hours: T.B.A.
E-mail: xxx@cofc.edu

COURSE MEETINGS
Mondays and Wednesdays in Maybank 112 from 7:00 - 8:15 PM.

PREREQUISITES
Math 203 Linear Algebra, Math 221 Calculus III, and CSCI 220 Computer Programming I or Math 245 Numerical Methods and Mathematical Computing, or permission of the instructor.

TEXTBOOK

COURSE DESCRIPTION
This course provides an introduction to probabilistic models in operations research. Topics include queueing theory, applications of Markov chains, simulation, integer programming, and nonlinear programming.

STUDENT LEARNING OUTCOMES:
After completing this course, students will be able to

1. Explain the importance of the mathematical theory in the development of the tools of operations research.

2. Recognize the mathematical tools for use in specific situations that require operations research methods.

3. Demonstrate an understanding of mathematical proofs in the development of operations research.

4. Implement computer packages to work with operations research models.

These outcomes will be assessed in homework and on in class exams.

UNDERGRADUATE MATHEMATICS PROGRAM LEARNING OUTCOMES
Students are expected to display a thorough understanding of the topics covered. In particular, upon completion of the course, students will be able to

1. Using algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics, students model phenomena in mathematical terms.

2. Using algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics, students derive correct answers to challenging questions by applying the models from Student Learning Outcome 1.

3. Write complete, grammatically and logically correct arguments to prove their conclusions.

These outcomes will be assessed in homework and on in class exams.
Graded Assignments

In this course, we will have one midterm exam, a final examination, and bi-weekly homework. Graduate students will also be expected to complete a project. Graduate students will be expected to show mastery of the more theoretical aspects of the course. This will involve extra homework exercises, additional problems on exams, and a project, culminating in a report synthesizing material learned from the course. This additional work will be optional for undergraduates.

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Homework (50%): Every other week you will be expected to turn in assigned problems from the text. These problems may be a combination of theory and the application of models to real data. Some exercises will require the use of computer software packages.

Grading Scale: Final grades will be based on the percentage of points earned. Letter grades will be determined from the following scale: Grading Scale: A 93-100, A- 90-92, B+ 87-89, B 83-86, B- 80-82, C+ 77-79, C 73-76, C- 70-72, D+ 67-69, D 63-66, D- 60-62, F below 60. If your final exam grade is better than your pre-exam average, I will weight your final exam more heavily.

Attendance Policy

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Coverage of Topics

Week 1-2: Integer Programming.

Week 3-4: Nonlinear Programming.

Week 5-6: Metaheuristics.

Week 7-8: Decision Analysis.

Week 9-10: Queuing Theory.

Week 11-12: Inventory Theory.

Week 13-14: Markov Decision Processes.

Week 15: Review for Final Exam.
Math 552 Operations Research
College of Charleston
Department of Mathematics
Sample Syllabus

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XXX
Office: RSS XXX
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COVERAGE OF TOPICS

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Week 7-8: Decision Analysis.
**Week 9-10:** Queuing Theory.

**Week 11-12:** Inventory Theory.

**Week 13-14:** Markov Decision Processes.

**Week 15:** Review for Final Exam.
Contact Name__Robert Mignone (Chair), Annalisa Calini and Martin Jones (Graduate Program Co-directors)

Email__mignoner@cofc.edu, calinia@cofc.edu, jonesm@cofc.edu

Phone__3-5730

Department/Program__Mathematics____ School__SSM____

Catalog Year in Which Change Will Take Effect__Fall 2016____

Does this proposal include:  □  Course title change*
□ Course number change*
□ Course description change*
□ Undergraduate/Graduate cross-listing
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Proposed Cross-listed Courses
(course acronyms, numbers, titles, and descriptions)

MATH 455, Bayesian Statistical Methods (3)
Posterior distributions using observed data are calculated and used for inferences about model parameters. Classical statistical methods are compared with the Bayesian methods and classical models such as linear regression, ANOVA, and generalized linear models are extended to include the Bayesian paradigm. Monte Carlo methods, Gibbs sampling and Metropolis-Hastings algorithms. S

Prerequisite: MATH 430 (Mathematical Statistics I).

MATH 555, Bayesian Statistical Methods (3)
Posterior distributions using observed data are calculated and used for inferences about model parameters. Classical statistical methods are compared with the Bayesian methods and classical models such as linear regression, ANOVA, and generalized linear models are extended to include the Bayesian paradigm. Monte Carlo methods, Gibbs sampling and Metropolis-Hastings algorithms. S

Prerequisites: MATH 530 (Mathematical Statistics I) or equivalent.

Reason for Cross-listing
This pair of courses has previously been approved for cross-level listing, and we propose that this be continued for the following reasons:

1. The core material taught at both the 400-level and 500-level is very similar.

2. On the other hand, the course objectives and student learning outcomes are distinguished, in that graduate students do additional, more independent work on projects and in wider reading, and do additional homework and test exercises which address the more advanced theoretical aspects of the material.

3. The cross-level listing allows some of our strongest undergraduate students to take courses that they would otherwise not see at the undergraduate level, thus better preparing them for graduate school and/or the employment marketplace.

4. In a typical semester, it would be difficult to justify the use of resources to teach this pair as two independent courses, since enrollments in higher level mathematics courses are often small; thus cross-listing expands opportunities for both undergraduate and graduate students.

We do not find that having undergraduate and graduate students in the same classes to be problematic. In fact, it seems to have a very positive effect on both groups through a greater degree of peer interaction and discussion.
Changes to Existing Course Numbers/Titles/Descriptions

Existing Course:

**MATH 455 Bayesian Statistical Methods (3)**
Posterior distributions using observed data are calculated and used for inferences about model parameters. Classical statistical methods are compared with the Bayesian methods and classical models such as linear regression, ANOVA, and generalized linear models are extended to include the Bayesian paradigm. Monte Carlo methods, Gibbs sampling and Metropolis-Hastings algorithms.

*Prerequisite:* MATH 430.

**MATH 555 Bayesian Statistical Methods**
Posterior distributions using observed data are calculated and used for inferences about model parameters. Classical statistical methods are compared with the Bayesian methods and classical models such as linear regression, ANOVA, and generalized linear models are extended to include the Bayesian paradigm. Monte Carlo methods, Gibbs sampling and Metropolis-Hastings algorithms.

*Prerequisites:* MATH 430 Mathematical Statistics I

Proposed Course Change:

1. Clarify the Prerequisites for Math 455:

*Prerequisites:* MATH 430 (Mathematical Statistics I).

2. Modify the Prerequisites for Math 555 to:

*Prerequisites:* MATH 530 (Mathematical Statistics I) or equivalent.

4. Specify course rotation for both courses: S
Math 455 Bayesian Methods
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION
XXX  Office Hours: T.B.A.
Office: RSS XXX  E-mail: xxx@cofc.edu

COURSE MEETINGS
Mondays and Wednesdays in Maybank 223 from 7:00 - 8:15 PM.

PREREQUISITES
Math 430 Mathematical Statistics I.

TEXTBOOK
A First Course in Bayesian Statistical Methods by Peter Hoff.

COURSE DESCRIPTION
Posterior distributions using observed data are calculated and used for inferences about model parameters. Classical statistical methods are compared with the Bayesian methods and classical models such as linear regression, ANOVA, and generalized linear models are extended to include the Bayesian paradigm. Monte Carlo methods, Gibbs sampling and Metropolis-Hastings algorithms.

STUDENT LEARNING OUTCOMES:
After completing this course, students will be able to

1. Explain the importance of the statistical theory behind the construction of Bayesian models.

2. Recognize the differences and similarities between Bayesian approaches and classical approaches to statistical modeling and the advantages and disadvantages of each.

3. Demonstrate an understanding of the mathematical proofs in the development of Bayesian theory.

4. Implement the statistical package R to analyze new data sets.

These outcomes will be assessed in homework and on in class exams.

UNDERGRADUATE MATHEMATICS PROGRAM STUDENT LEARNING OUTCOMES
This course can be used to satisfy some requirements of the undergraduate mathematics degree program, for which there are also some standard goals. Students are expected to display a thorough understanding of topics covered. In particular, upon completion of the course, students will be able to

1. Use algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics to model phenomena in mathematical terms.

2. Use algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics to derive correct answers to challenging questions by applying the models from the previous Learning Outcome; and

3. Write complete, grammatically and logically correct arguments to prove their conclusions.

These outcomes will be assessed in homework and on in class exams.
Graded Assignments

In this course, we will have one midterm exam, a final examination, and bi-weekly homework.

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<td>Midterm</td>
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Course Grades

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Homework (50%): Every other week you will be expected to turn in assigned problems from the text. These problems may be a combination of theory and the application of Bayesian methods to real data. Some exercises will require the statistical software package R.

Grading Scale: Final grades will be based on the percentage of points earned. Letter grades will be determined from the following scale: Grading Scale: A 93-100, A- 90-92, B+ 87-89, B 83-86, B- 80-82, C+ 77-79, C 73-76, C- 70-72, D+ 67-69, D 63-66, D- 60-62, F below 60.

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Coverage of Topics

Week 1: Introduction to the course.
Week 2: Probabilistic background and discrete Baye’s Theorem.

Week 3: Binomial and Poisson models.

Week 4: Monte Carlo approximation.

Week 5: Normal model.

Week 6: Gibbs sampler.

Week 7: MCMC Diagnostics.

Week 8: Multivariate Normal model.

Week 9: Hierarchical models.

Week 10: Linear Regression.

Week 11: Metropolis-Hastings algorithms.

Week 12: Applications to Generalized Linear Models.

Week 13: Mixed Effects models.

Week 14: Latent variable methods for ordinal data.

Week 15: Review for Final Exam.
Math 555 Bayesian Methods
College of Charleston
Department of Mathematics
Sample Syllabus

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Textbook
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Course Description
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Student Learning Outcomes:
After completing this course, students will be able to

1. Critique and investigate the statistical theory behind the construction of Bayesian models.
2. Compare and contrast Bayesian approaches and classical approaches to statistical modeling and the advantages and disadvantages of each.
3. Develop and construct proofs of aspects of the development of Bayesian theory.
4. Develop models to analyze real data using the statistical package R.

These outcomes will be assessed in homework and on in class exams.

Graded Assignments
In this course, we will have one midterm exam, a final examination, and bi-weekly homework. Graduate students will also be expected to complete a project. Graduate students will be expected to show mastery of the more theoretical aspects of the course. This will involve extra homework exercises, additional problems on exams, and a project, culminating in a report synthesizing material learned from the course. The project will involve reading and understanding primary literature in the field.

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<tr>
<td>Midterm:</td>
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<tr>
<td>Final Exam:</td>
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<td>Homework:</td>
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<tr>
<td>Project:</td>
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Important Dates

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<tbody>
<tr>
<td>Midterm:</td>
<td>Wednesday, March 2</td>
</tr>
<tr>
<td>Final Exam:</td>
<td>TBA</td>
</tr>
</tbody>
</table>
Midterm and Final Exams (20% each): These two in class exams will assess your understanding of the mathematical theory in the development of Bayesian methods. You will be expected to reproduce short proofs, show facility with the probabilistic tools, and perform calculations and predictions using the models.

Homework (40%): Every other week you will be expected to turn in assigned problems from the text. These problems may be a combination of theory and the application of Bayesian methods to real data. Some exercises will require the statistical software package R.

Project (20%): Graduate students will be given a project to work on that will involve learning a more specialized topic. These projects will demonstrate and synthesize the tools learned in the course and the application can be one of interest to the student provided that the topic is approved by the instructor. Students will be expected to read literature in the field.

Grading Scale: Grades will be based on the percentage of points earned in the categories listed above. A (90-100%), B+ (87-89%), B (80-86%), C+ (77-79%), C (70-76%), D (60-69%), F (below 60%).

You are expected to attend class every day. If you miss class, you will need to obtain notes from one of your classmates and talk with me about material that you do not understand. If for some reason you are not able to attend class the day that an assignment is due, you should email me your assignment that day. Late assignments will not be awarded full credit. Late assignments will not be accepted after graded papers are returned or problem solutions have been distributed. Make-up exams are only possible with proper documentation from the Absence Memo Office.

If there is a student in this class who has a documented disability and has been approved to receive accommodations through the Center for Disability Services/SNAP (Students Needing Access Parity), please come and discuss this with me during my office hours.

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Supplementary materials for our course will be posted on OAKS.

The best way to contact me is by e-mail. Please always include your name, the course name, and the section number in your e-mails. In general, you should expect a response within two school days.

Week 1: Introduction to the course.

Week 2: Probabilistic background and discrete Baye’s Theorem.

Week 3: Binomial and Poisson models.

Week 4: Monte Carlo approximation.

Week 5: Normal model.
Week 6: Gibbs sampler.

Week 7: MCMC Diagnostics.

Week 8: Multivariate Normal model.

Week 9: Hierarchical models.

Week 10: Linear Regression.

Week 11: Metropolis-Hastings algorithms.

Week 12: Applications to Generalized Linear Models.

Week 13: Mixed Effects models.

Week 14: Latent variable methods for ordinal data.

Week 15: Review for Final Exam.
Contact Name__Robert Mignone (Chair), Annalisa Calini and Martin Jones (Graduate Program Co-directors)__________

Email__mignoner@cofc.edu, calinia@cofc.edu, jonesm@cofc.edu

Phone__3-5730________

Department/Program__Mathematics_____ School__SSM__

Catalog Year in Which Change Will Take Effect__Fall 2016________

Does this proposal include: □ Course title change*
 X ☐ Course number change*
 X ☐ Course description change*
 X ☐ Undergraduate/Graduate cross-listing
 *complete Existing Course/New Course Information

A. If you are proposing to cross-list two existing courses at the same level, list the courses [acronym, title, number, course description] and provide a reason for cross-listing.

B. If you are proposing to cross-list an existing undergraduate course with an existing graduate course, list the courses [acronym, title, number, course description], provide a reason for cross-listing, and attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.

C. If you are proposing to cross-list an existing course with a new course at the same level, list the courses [acronym, title, number, course description], provide a reason for cross-listing, and attach the appropriate new course proposal form.

D. If you are proposing to cross-list an existing course with a new course at a different level, list the courses [acronym, title, number, course description], provide a reason for cross-listing, and attach the appropriate new course proposal form(s). Also attach a syllabus (or separate syllabi) that clearly indicates student learning outcomes, assignments, and rigor appropriate for each level.
**Proposed Cross-listed Courses**

*(course acronyms, numbers, titles, and descriptions)*

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
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</thead>
<tbody>
<tr>
<td>MATH 460</td>
<td>Stochastic Processes (3)</td>
<td>MATH 430 (Mathematical Statistics I)</td>
</tr>
<tr>
<td>MATH 560</td>
<td>Stochastic Processes (3)</td>
<td>MATH 530 (Mathematical Statistics I) or equivalent</td>
</tr>
</tbody>
</table>

**Reason for Cross-listing**

This pair of courses has previously been approved for cross-level listing, and we propose that this be continued for the following reasons:

1. The core material taught at both the 400-level and 500-level is very similar.

2. On the other hand, the course objectives and student learning outcomes are distinguished, in that graduate students do additional, more independent work on projects and in wider reading, and do additional homework and test exercises which address the more advanced theoretical aspects of the material.

3. The cross-level listing allows some of our strongest undergraduate students to take courses that they would otherwise not see at the undergraduate level, thus better preparing them for graduate school and/or the employment marketplace.

4. In a typical semester, it would be difficult to justify the use of resources to teach this pair as two independent courses, since enrollments in higher level mathematics courses are often small; thus cross-listing expands opportunities for both undergraduate and graduate students.

We do not find that having undergraduate and graduate students in the same classes to be problematic. In fact, it seems to have a very positive effect on both groups through a greater degree of peer interaction and discussion.
Changes to Existing Course Numbers/Titles/Descriptions

Existing Course:

MATH 460 Stochastic Processes (3)
Stochastic Processes are sequences of random variables indexed in either discrete or continuous time unit. They can be used to model systems that involve random elements as they evolve over time. In this course we will study Poisson processes, Markov chains, renewal processes, martingales, random walks, and Brownian motion.

Prerequisite: MATH 430

MATH 660 Stochastic Processes (3)
Stochastic Processes are sequences of random variables indexed in either discrete or continuous time unit. They can be used to model systems that involve random elements as they evolve over time. In this course we will study Poisson processes, Markov chains, renewal processes, martingales, random walks, and Brownian motion.

Prerequisite: MATH 530

Proposed Course Change:

1. Clarify the Prerequisites for Math 460:

Prerequisites: MATH 430 (Mathematical Statistics I).

2. Change course number from MATH 660 to MATH 560.

2. Modify slightly the Prerequisites for Math 560 to:

Prerequisites: MATH 530 (Mathematical Statistics I) or equivalent.
**Math 460 Stochastic Processes**  
*College of Charleston*  
*Department of Mathematics*  
*Sample Syllabus*

**INSTRUCTOR INFORMATION**  
XXX  
Office Hours: T.B.A.  
Office: RSS XXX  
E-mail: xxx@cofc.edu

**COURSE MEETINGS**  
Mondays and Wednesdays in Maybank 224 from 7:00 - 8:15 PM.

**PREREQUISITES**  
Math 430 Mathematical Statistics I.

**TEXTBOOK**  
*Stochastic Processes* by Sidney I. Resnick. In this course, we will cover selections from Chapters 1-6.

**COURSE DESCRIPTION**  
Stochastic Processes are sequences of random variables indexed in either discrete or continuous time units. They can be used to model systems that involve random elements as they evolve over time. In this course we will study Poisson processes, Markov chains, renewal processes, martingales, random walks, and Brownian motion.

**STUDENT LEARNING OUTCOMES:**  
After completing this course, students will be able to

1. Recognize and apply different stochastic models.
2. Explain the importance of the theory behind the construction of stochastic processes.
3. Demonstrate an understanding of the proofs behind the theory of stochastic models.
4. Implement the statistical package R to construct stochastic processes in real applications to model random phenomena.

These outcomes will be assessed in homework and on in class exams.

**UNDERGRADUATE MATHEMATICS PROGRAM STUDENT LEARNING OUTCOMES**  
This course can be used to satisfy some requirements of the undergraduate mathematics degree program, for which there are also some standard goals. Students are expected to display a thorough understanding of topics covered. In particular, upon completion of the course, students will be able to

1. Use algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics to model phenomena in mathematical terms.
2. Use algebra, geometry, calculus and other track-appropriate sub-disciplines of mathematics to derive correct answers to challenging questions by applying the models from the previous Learning Outcome; and
3. Write complete, grammatically and logically correct arguments to prove their conclusions.

These outcomes will be assessed in homework and on in class exams.
Graded Assignments

In this course, we will have one midterm exam, a final examination, and bi-weekly homework.

<table>
<thead>
<tr>
<th>Midterm:</th>
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<tr>
<td>Final Exam:</td>
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<tr>
<td>Homework:</td>
<td>60%</td>
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Important Dates

<table>
<thead>
<tr>
<th>Midterm:</th>
<th>Wednesday, October 08</th>
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<tbody>
<tr>
<td>Final Exam:</td>
<td>Wednesday, December 08</td>
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</table>

Course Grades

Midterm and Final Exams (20% each): These two in class exams will assess your understanding of the mathematical theory in the development of stochastic processes. You will be expected to reproduce short proofs, show facility with the probabilistic tools, and perform calculations and predictions using the stochastic models.

Homework (60%): Every other week you will be expected to turn in assigned problems from the text. These problems may be a combination of the theory of stochastic processes and their applications. Some will require the statistical software package R to aid in the calculations and simulations of stochastic processes.

Grading Scale: Grades will be based on the percentage of points earned in the categories listed above. A (93-100%), A- (90-92%), B+ (87-89%), B (84-86%), B- (80-83%), C+ (77-79%), C (74-76%), C- (70-73%), D+ (67-69%), D (64-66%), D- (60-63%), F (below 60%).

Attendance Policy

You are expected to attend class every day. If you miss class, you will need to obtain notes from one of your classmates and talk with me about material that you do not understand. If for some reason you are not able to attend class the day that an assignment is due, you should email me your assignment that day. Late assignments will not be awarded full credit. Late assignments will not be accepted after graded papers are returned or problem solutions have been distributed. Make-up exams are only possible with proper documentation from the Absence Memo Office.

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Supplementary Material E-Mail

Supplementary materials for our course will be posted on OAKS.

The best way to contact me is by e-mail. Please always include your name, the course name, and the section number in your e-mails. In general, you should expect a response within two school days.

Coverage of Topics

Weeks 3 and 4: Markov chain construction, higher order transition probabilities, transience and recurrence, periodicity, canonical decomposition of Markov chains, absorption probabilities, invariant measures, stationary distributions.

Weeks 5 through 7: Introduction to renewal processes, renewal reward processes, renewal limit theorems, Blackwell and key renewal theorems, regenerative processes, queueing examples.

Weeks 8 and 9: Introduction to point processes, Poisson processes, transforming Poisson processes, the order statistic property, thinning of Poisson processes, records.

Weeks 10 through 12: Continuous time Markov chains, the backward equations and the generator matrix, Laplace transform methods, queueing networks, reversibility and uniformizability.

Weeks 13 through 15: Brownian motion construction, the reflection principle, strong Markov property, distribution of the maximum of Brownian motion, Brownian motion with a drift, the Brownian bridge and the Kolmogorov-Smirnov statistic, Khintchine's law of the iterated logarithm for Brownian Motion.
Math 560 Stochastic Processes
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION
XXX
Office: RSS XXX
Office Hours: T.B.A.
E-mail: xxx@cofc.edu

COURSE MEETINGS
Mondays and Wednesdays in Maybank 224 from 7:00 - 8:15 PM.

PREREQUISITES
Math 530 Mathematical Statistics I or equivalent.

TEXTBOOK
Stochastic Processes by Sidney I. Resnick. In this course, we will cover selections from Chapters 1-6.

COURSE DESCRIPTION
Stochastic Processes are sequences of random variables indexed in either discrete or continuous time units. They can be used to model systems that involve random elements as they evolve over time. In this course we will study Poisson processes, Markov chains, renewal processes, martingales, random walks, and Brownian motion.

STUDENT LEARNING OUTCOMES:
After completing this course, students will be able to

1. Develop and formulate different stochastic models.
2. Critique and investigate the theory behind the construction of stochastic processes.
3. Develop and construct proofs for the theory of stochastic models.
4. Develop models of stochastic processes in real applications to model random phenomena.

These outcomes will be assessed in homework and on in class exams.

GRADED ASSIGNMENTS
In this course, we will have one midterm exam, a final examination, and bi-weekly homework. Graduate students will also be expected to complete a project. Graduate students will be expected to show mastery of the more theoretical aspects of the course. This will involve extra homework exercises, additional problems on exams, and a project, culminating in a report synthesizing material learned from the course. The project will involve reading and understanding primary literature in the field.

| Midterm: 20% |
| Final Exam: 20% |
| Homework: 40% |
| Project: 20% |

IMPORTANT DATES
Midterm: Wednesday, October 08
Final Exam: Wednesday, December 06

COURSE GRADES
Midterm and Final Exams (20% each): These two in class exams will assess your
understanding of the mathematical theory in the development of stochastic processes. You will be expected to reproduce short proofs, show facility with the probabilistic tools, and perform calculations and predictions using the stochastic models.

**Homework (40%)**: Every other week you will be expected to turn in assigned problems from the text. These problems may be a combination of the theory of stochastic processes and their applications. Some will require the statistical software package R to aid in the calculations and simulations of stochastic processes.

**Project (20%)**: Graduate students will be given a project to work on that will involve constructing computer simulations of stochastic processes to model various stochastic phenomena. These projects will demonstrate and synthesize the tools learned in the course and the application can be one of interest to the student provided that the topic is approved by the instructor. Students will be expected to read literature in the field.

**Grading Scale**: Grades will be based on the percentage of points earned in the categories listed above. A (90-100%), B+ (87-89%), B (80-86%), C+ (77-79%), C (70-76%), D (60-69%), F (below 60%).

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The best way to contact me is by e-mail. Please always include your name, the course name, and the section number in your e-mails. In general, you should expect a response within two school days.

**Coverage of Topics**

**Weeks 1 and 2**: Generating Functions, Simple Branching Processes, Limit Distributions, Stopping Times, Wald’s Identity.

**Weeks 3 and 4**: Markov chain construction, higher order transition probabilities, transience and recurrence, periodicity, canonical decomposition of Markov chains, absorption probabilities, invariant measures, stationary distributions.

**Weeks 5 through 7**: Introduction to renewal processes, renewal reward processes, renewal limit theorems, Blackwell and key renewal theorems, regenerative processes, queueing examples.
Weeks 8 and 9: Introduction to point processes, Poisson processes, transforming Poisson processes, the order statistic property, thinning of Poisson processes, records.

Weeks 10 through 12: Continuous time Markov chains, the backward equations and the generator matrix, Laplace transform methods, queueing networks, reversibility and uniformizability.

Weeks 13 through 15: Brownian motion construction, the reflection principle, strong Markov property, distribution of the maximum of Brownian motion, Brownian motion with a drift, the Brownian bridge and the Kolmogorov-Smirnov statistic, Khintchine’s law of the iterated logarithm for Brownian Motion.
Contact Name: Robert Mignone (Chair), Annalisa Calini and Martin Jones (Graduate Program Co-directors)__________

Email: mignoner@cofc.edu, calinia@cofc.edu, jonesm@cofc.edu

Phone: 3-5730__________

Department/Program: Mathematics______ School: SSM_

Catalog Year in Which Change Will Take Effect: Fall 2016______

Does this proposal include: □ Course title change*
X□ Course number change*
X□ Course description change*
X□ Undergraduate/Graduate cross-listing
*complete Existing Course/New Course Information

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Proposed Cross-listed Courses
(course acronyms, numbers, titles, and descriptions)

MATH 461 Time Series (3)

Time series are sequences of data points measured typically at successive uniform time intervals. They are used in signal processing, pattern recognition, econometrics, mathematical finance, weather forecasting, and control engineering. Time series analysis is a collection of methods for analyzing time series data in order to extract meaningful characteristics of the data. In this course we will study stationary processes, forecasting techniques, ARMA models, spectral analysis, non-stationary and seasonal models, and multivariate time series.

Prerequisites: MATH 430 (Mathematical Statistics I).

MATH 561 Time Series Analysis (3)

Time series are sequences of data points measured typically at successive uniform time intervals. They are used in signal processing, pattern recognition, econometrics, mathematical finance, weather forecasting, and control engineering. Time series analysis is a collection of methods for analyzing time series data in order to extract meaningful characteristics of the data. In this course we will study stationary processes, forecasting techniques, ARMA models, spectral analysis, non-stationary and seasonal models, and multivariate time series.

Prerequisites: MATH 530 (Mathematical Statistics I) or equivalent.
**Reason for Cross-listing**

This pair of courses has previously been approved for cross-level listing, and we propose that this be continued for the following reasons:

1. The core material taught at both the 400-level and 500-level is very similar.

2. On the other hand, the course objectives and student learning outcomes are distinguished, in that graduate students do additional, more independent work on projects and in wider reading, and do additional homework and test exercises which address the more advanced theoretical aspects of the material.

3. The cross-level listing allows some of our strongest undergraduate students to take courses that they would otherwise not see at the undergraduate level, thus better preparing them for graduate school and/or the employment marketplace.

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We do not find that having undergraduate and graduate students in the same classes to be problematic. In fact, it seems to have a very positive effect on both groups through a greater degree of peer interaction and discussion.

**Changes to Existing Course Numbers/Titles/Descriptions**

**Existing Course:**

**MATH 461 Time Series (3)**

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*Prerequisite: MATH 430*

**MATH 661 Time Series Analysis (3)**

Time series are sequences of data points measured typically at successive uniform time intervals. They are used in signal processing, pattern recognition, econometrics, mathematical finance, weather forecasting, and control engineering. Time series analysis is a collection of methods for analyzing time series data in order to extract meaningful characteristics of the data. In this course we will study stationary processes, forecasting techniques, ARMA models, spectral analysis, non-stationary and seasonal models, and multivariate time series.

*Prerequisite: MATH 530*
Proposed Course Change:

1. Clarify the Prerequisites for Math 461:

*Prerequisites:* MATH 430 (Mathematical Statistics I).

2. Change course number from MATH 661 to MATH 561.

2. Modify slightly the Prerequisites for Math 561 to:

*Prerequisites:* MATH 530 (Mathematical Statistics I) or equivalent.
Math 461 Time Series
College of Charleston
Department of Mathematics
Fall 2013 Syllabus

INSTRUCTOR INFORMATION
XXX Office Hours: T.B.A.
Office: RSS XXX E-mail: xxx@cofc.edu

Course Meetings
Mondays and Wednesdays in Maybank 224 from 7:00 - 8:15 PM.

Prerequisites
Math 430 Mathematical Statistics I.

Textbook
Time Series Analysis and Its Applications, 3rd Edition by Robert H. Shumway. In this course, we will cover selections from Chapters 1–7.

Course Description
Time series are sequences of data points measured typically at successive uniform time intervals. They are used in signal processing, pattern recognition, econometrics, mathematical finance, weather forecasting, and control engineering. Time series analysis is a collection of methods for analyzing time series data in order to extract meaningful characteristics of the data. In this course we will study stationary processes, forecasting techniques, ARMA models, spectral analysis, non-stationary and seasonal models, and multivariate time series.

Student Learning Outcomes:
After completing this course, students will be able to
1. Recognize and apply different time series models.
2. Explain the importance of the theory behind the construction of time series models.
3. Demonstrate an understanding of the proofs behind the theory of time series models.
4. Implement time series methods to analyze real data sets using the statistical package R.

These outcomes will be assessed in homework and on in class exams.

Graded Assignments
In this course, we will have one midterm exam, a final examination, and bi-weekly homework.

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Important Dates
Midterm: Wednesday, October 08
Final Exam: Wednesday, December 06

Course Grades
Midterm and Final Exams (20% each): These two in class exams will assess your
understanding of the mathematical theory in the development of time series models. You will be expected to reproduce short proofs, show facility with the probabilistic tools, and be able to analyze time series data using these models.

**Homework (60%)**: Every other week you will be expected to turn in assigned problems from the text. These problems may be a combination of theory ideas and applications. Some will require the statistical software package R to aid in the calculations and analysis of time series data.

**Grading Scale**: Grades will be based on the percentage of points earned in the categories listed above. A (93-100%), A- (90-92%), B+ (87-89%), B (84-86%), B- (80-83%), C+ (77-79%), C (74-76%), C- (70-73%), D+ (67-69%), D (64-66%), D- (60-63%), F (below 60%).

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Supplementary materials for our course will be posted on OAKS.

**E-Mail**
The best way to contact me is by e-mail. Please always include your name, the course name, and the section number in your e-mails. In general, you should expect a response within two school days.

**Coverage of Topics**
- **Weeks 1 and 2**: Characteristics of time series data, measures of dependence, stationary time series, estimation of correlation, multidimensional series.
- **Week 3**: Classical regression in time series, exploratory data analysis, smoothing time series.
- **Weeks 4 through 6**: Autoregressive moving average models, difference equations, autocorrelation and partial autocorrelation, forecasting, building ARIMA models, multiplicative seasonal ARIMA models.
- **Weeks 7 through 9**: Cyclical behavior and periodicity, spectral density, periodogram and Fourier transforms, nonparametric and parametric estimation, multiple series and cross spectra, linear filters, wavelets, signal extraction and optimal filtering.
- **Weeks 10 and 11**: Long memory ARMA models, unit root testing, GARCH models,
threshold models, multivariate ARMAX models.

**Weeks 12 and 13:** Filtering and forecasting with state-space models, maximum likelihood estimation, missing data modifications, structural models, bootstrapping state-space models, stochastic volatility, Monte Carlo methods.

**Weeks 14 and 15:** Spectral matrices, regression for jointly stationary series, regression with deterministic inputs, random coefficient regression, cluster analysis, principal component and factor analysis, the spectral envelope.
Math 561 Time Series
College of Charleston
Department of Mathematics
Sample Syllabus

INSTRUCTOR INFORMATION

XXX
Office: RSS XXX
Office Hours: T.B.A.
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PREREQUISITES

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TEXTBOOK

Time Series Analysis and Its Applications, 3rd Edition by Robert H. Shumway. In this course, we will cover selections from Chapters 1-7.

COURSE DESCRIPTION

Time series are sequences of data points measured typically at successive uniform time intervals. They are used in signal processing, pattern recognition, econometrics, mathematical finance, weather forecasting, and control engineering. Time series analysis is a collection of methods for analyzing time series data in order to extract meaningful characteristics of the data. In this course we will study stationary processes, forecasting techniques, ARMA models, spectral analysis, non-stationary and seasonal models, and multivariate time series.

STUDENT LEARNING OUTCOMES:

After completing this course, students will be able to

1. Develop and formulate different time series models.

2. Critique and investigate the theory behind the construction of time series models.

3. Develop and construct proofs for the theory of time series models.

4. Develop time series models to analyze real data sets using the statistical package R.

These outcomes will be assessed in homework and on in class exams.

GRADED ASSIGNMENTS

In this course, we will have one midterm exam, a final examination, and bi-weekly homework. Graduate students will be expected to show mastery of the more theoretical aspects of the course. This will involve extra homework exercises, additional problems on exams, and a project, culminating in a report synthesizing material learned from the course. The project will involve reading and understanding primary literature in the field.

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<tr>
<th>Assignment</th>
<th>Percentage</th>
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<td>Midterm</td>
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<td>Final Exam</td>
<td>20%</td>
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<td>Homework</td>
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<td>Project</td>
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IMPORTANT DATES

Midterm: Wednesday, October 08
Final Exam: Wednesday, December 06
Midterm and Final Exams (20% each): These two in class exams will assess your understanding of the mathematical theory in the development of time series models. You will be expected to reproduce short proofs, show facility with the probabilistic tools, and be able to analyze time series data using these models.

Homework (40%): Every other week you will be expected to turn in assigned problems from the text. These problems may be a combination of theory ideas and applications. Some will require the statistical software package R to aid in the calculations and analysis of time series data.

Project (20%): Graduate students will be given a project to work on that will involve using computer packages to analyze real time series data and write a report summarizing the findings. These projects will demonstrate and synthesize the tools learned in the course and the application can be one of interest to the student provided that the topic is approved by the instructor. Students will be expected to read literature in the field.

Grading Scale: Grades will be based on the percentage of points earned in the categories listed above. A (90-100%), B+ (87-89%), B (80-86%), C+ (77-79%), C (70-76%), D (60-69%), F (below 60%).

You are expected to attend class every day. If you miss class, you will need to obtain notes from one of your classmates and talk with me about material that you do not understand. If for some reason you are not able to attend class the day that an assignment is due, you should email me your assignment that day. Late assignments will not be awarded full credit. Late assignments will not be accepted after graded papers are returned or problem solutions have been distributed. Make-up exams are only possible with proper documentation from the Absence Memo Office.

If there is a student in this class who has a documented disability and has been approved to receive accommodations through the Center for Disability Services/SNAP (Students Needing Access Parity), please come and discuss this with me during my office hours.

Any violation of the College's Honor Code will be reported to the Honor Board. For more details, see http://studentaffairs.cofc.edu/honor-system/ and the Student Handbook at http://studentaffairs.cofc.edu/honor-system/studenthandbook/.

Supplementary materials for our course will be posted on OAKS.

The best way to contact me is by e-mail. Please always include your name, the course name, and the section number in your e-mails. In general, you should expect a response within two school days.

Weeks 1 and 2: Characteristics of time series data, measures of dependence, stationary time series, estimation of correlation, multidimensional series.

Week 3: Classical regression in time series, exploratory data analysis, smoothing time series.

Weeks 4 through 6: Autoregressive moving average models, difference equations, autocorrelation and partial autocorrelation, forecasting, building ARIMA models, mul-
multiplicative seasonal ARIMA models.

**Weeks 7 through 9:** Cyclical behavior and periodicity, spectral density, periodogram and Fourier transforms, nonparametric and parametric estimation, multiple series and cross spectra, linear filters, wavelets, signal extraction and optimal filtering.

**Weeks 10 and 11:** Long memory ARMA models, unit root testing, GARCH models, threshold models, multivariate ARMAX models.

**Weeks 12 and 13:** Filtering and forecasting with state-space models, maximum likelihood estimation, missing data modifications, structural models, bootstrapping state-space models, stochastic volatility, Monte Carlo methods.

**Weeks 14 and 15:** Spectral matrices, regression for jointly stationary series, regression with deterministic inputs, random coefficient regression, cluster analysis, principal component and factor analysis, the spectral envelope.