Contact Name: Martin Jones  
Email: jonesm@cofc.edu  
Phone: 953-5735

Department Name: Mathematics  
Graduate Program name: Master of Science in Mathematics

Course Prefix, Number, and Title: Math 660 Stochastic Processes

I. CATEGORY OF REVIEW (Check all that apply)

NEW COURSE  CHANGE COURSE  DELETE COURSE

X New Course  □ Change Number (IV, VII, VIII, IX)  □ Delete Course (IV, VII, IX)

(attach syllabus*)  □ Change Title (IV, VII, VIII, IX)
□ Change Credits/Contact hours (II, IV, VII, IX)
□ Prerequisite Change (IV, VII, VIII, IX)
□ Edit Description (III, IV, VII, VIII, IX)

□ Approve for Cross-listing (attach Graduate Permission to Cross-list Form)

Date (Semester/Year) the course will first be offered, course changes or deletion will go into effect: Fall 2015

NEW COURSE:

*ATTACH THE SYLLABUS FOR A NEW GRADUATE COURSE to include:

- Course description and objectives
- Method of teaching (e.g., lecture, seminar, on-line, hybrid)
- Required and optional texts and materials
- Graduate School Grading Scale
- Assignments, student learning outcomes and assessment components
- Policies to include attendance, Honor Code, American Disabilities Act statement
- Tentative course schedule with specific topics
List prerequisites and / or other restrictions below

Math 530 Mathematical Statistics I

Will this course be added to the Degree Requirements?

a) ☐ Yes  X No

b) If yes, explain

This course will be an elective in the MS in Mathematics degree program as well as an elective in the Statistics Certificate Program.

II. NUMBER OF CREDITS and CONTACT HOURS per week

A. Contact Hours

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Lab</th>
<th>Seminar</th>
<th>Ind. Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

B. Credit Hours

| 3 | 0 | 0 | 0 |

Is this course repeatable? ☐ yes  X no  If so, how many credit hours may the student earn in this course?

III. CATALOG DESCRIPTION Limit to 50 words EXACTLY as you want it to appear in the catalog; include prerequisites, co-requisites, and other restrictions. If changing course description, please include both old and new course descriptions.

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 the theory and application of Poisson processes, Markov chains, renewal processes, martingales, random walks, and Brownian motion.
IV. RATIONALE / JUSTIFICATION: If course change – please indicate the course change details. If course change or deletion—please provide reasons for change(s) to or deletion of a course. If a new course—briefly address the goals/objectives for the course and the relationship to the strategic plan.

We have offered this course on many occasions now as a topics course and we would like to add it to our list of elective courses to be taught on a regular basis. Stochastic processes are a central topic to the advanced study of statistics and warrants being added to the regular course offerings in our statistics program.

V. STUDENT LEARNING OUTCOMES and ASSESSMENT

<table>
<thead>
<tr>
<th>Student Learning Outcomes</th>
<th>Assessment Method and Performance Expected</th>
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</thead>
<tbody>
<tr>
<td>What will students know and be able to do when they complete the course?</td>
<td>How will each outcome be measured? Who will be assessed, when, and how often? How well should students be able to do on the assessment?</td>
</tr>
<tr>
<td>1. Be able to recognize different stochastic models and how to apply them.</td>
<td>1. Students will be assessed on homework projects and on in-class tests. Students are expected at the minimum to identify appropriate stochastic models in a variety of situations other than those discuss in the classroom and in the textbook. Excellent students will be able to combine different stochastic models in more complex situations.</td>
</tr>
<tr>
<td>2. Understand the mathematical and probabilistic theory behind the construction of stochastic processes.</td>
<td>2. Students will be assessed on homework projects and on in-class tests. Students are expected at the minimum to show mastery of basic theoretical notions and understanding of fundamental theorems. Excellent students will be able to discuss fluently deeper or more complex theoretical constructions and to demonstrate a number of theoretical results, beyond those presented in the classroom and in the textbook, independently and using competent language.</td>
</tr>
<tr>
<td>3. Be able to understand the mathematical proofs used in the development of the theory of stochastic processes and be able to reproduce these ideas.</td>
<td>3. Students will be assessed on homework projects and on in-class tests. The Performance Expected is similar as in point 2.</td>
</tr>
<tr>
<td>4. Be able to use stochastic processes in real applications to model random phenomena.</td>
<td>4. Students will be assessed on homework projects and on in-class tests. Students are expected at the</td>
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</tbody>
</table>
minimum to successfully apply the acquired knowledge to the modelling of random processes in a variety of key application areas. Excellent students will be able to establish connections, identify common features, and draw general conclusions about certain classes of random phenomena arising in different applications.

How does this course align with the student learning outcomes articulated for the major, program, or general education? What program-level outcome or outcomes does it support? Is the content or skill introduced, reinforced, or demonstrated in this course?

This course will provide students with skills that are highly sought after in business and industry. Stochastic processes are used to model financial markets and production line processes. As a result, students having taken a course in Stochastic Processes will have a much higher marketability in the workplace.

VII. IMPACT ON EXISTING PROGRAMS and COURSES: Please briefly document the impact and expected changes of this new/changed/deleted course on other departments, programs and courses; if deleting a course—list all departments and programs that include the course; if adding/changing a course—explain any overlap with existing courses in the same or different departments; if adding or deleting a course that will be part of a joint program identify the partner institution.

No other departments use this course. It will be an elective course in our MS in Mathematics program and available to anyone with the necessary prerequisites.
VIII. COSTS ASSOCIATED WITH THE ACTION REQUESTED: List all of the new costs or cost savings, (including new faculty/staff requests, library or equipment, etc.) associated with the action requested. New courses requiring additional resources will need special justification.

There are no additional costs associated with this course. We have been teaching this course as a topics course for several years and will now be able to offer it as a regularly listed course.
IX. APPROVAL AND SIGNATURES

Signature of Program Director: ______________________ Date: 11/19/2014

Signature of Department Chair: ______________________ Date: 11/19/2014

Signature of Additional Chair*: ______________________ Date: __________

Signature of Schools’ Dean: ______________________ Date: 11/21/2014

Signature of Additional Schools’ Dean*: ______________________ Date: __________

Signature of the Provost: ______________________ Date: 12/22/14

Signature of Budget Director/Business Affairs Office: ______________________ Date: __________

*For interdisciplinary courses

Return form to the Graduate School Office for Further Processing

Signature of Chair of the Faculty Committee on Graduate Education, Continuing Education & Special Programs: ______________________ Date: 1/29/15

Signature of Chair of the Graduate Council: ______________________ Date: __________

Signature of Faculty Senate Secretary: ______________________ Date: __________

Date Approved by Faculty Senate: ______________________
Math 660 Stochastic Processes  
College of Charleston  
Department of Mathematics  
Fall 2012 Syllabus

**Instructor Information**
Dr. Martin Jones  
Office Hours: T.B.A.  
Office: RSS 345  
E-mail: jonesm@cofc.edu

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

**Prerequisites**
Math 530 Mathematical Statistics I or permission of the instructor.

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

**Course Description**
Topics will include probabilistic tools, Markov chains, renewal theory, point processes, continuous time Markov chains, and Brownian motion.

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

1. Recognize and apply different stochastic models.
2. Understand the theory behind the construction of stochastic processes.
3. Understand the proofs behind the theory of stochastic models.
4. Use 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.

<table>
<thead>
<tr>
<th>Graded Assignments</th>
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<tbody>
<tr>
<td>Midterm: 20%</td>
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<tr>
<td>Final Exam: 20%</td>
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<tr>
<td>Homework: 40%</td>
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<tr>
<td>Project: 20%</td>
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</tbody>
</table>

**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.

**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.

**Disability Policy**: If you have a documented disability that will affect your performance in this class, you should contact Disability Services (953-1431) and speak with me in private. No special testing accommodations can be made without a letter from Disability Services. It is the student’s responsibility to provide me with the accommodation envelope at least one week before any scheduled exam. Without exception, an examination must be taken at our scheduled class meeting time.

**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**

**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.