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 661 Time Series Analysis

I. CATEGORY OF REVIEW (Check all that apply)

NEW COURSE       CHANGE COURSE       DELETE COURSE

----- (Complete all sections below that apply including those indicated)-----

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

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

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 the theory and applications of stationary processes, forecasting techniques, ARMA models, spectral analysis, non-stationary and seasonal models, and multivariate time series.
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. The growing use of time series analysis in the practice of statistics warrants the transition of this course from a topics course to a regularly offered course.

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>
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<td><strong>Student Learning Outcomes</strong></td>
<td><strong>Assessment Method and Performance Expected</strong></td>
</tr>
<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. Recognize different time series models and understand 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 time series 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 models in more complex situations.</td>
</tr>
<tr>
<td>2. Understand the mathematical and probabilistic theory behind the construction of time series models.</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 time series models 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 work with real time series data sets, apply the concepts of the theory and analyze the results.</td>
<td>4. Students will be assessed on homework projects and on in-class tests. Students are expected at the minimum to successfully apply the acquired knowledge to the modelling of random processes in a variety of key application areas. Excellent students</td>
</tr>
</tbody>
</table>
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. Time series are used to model financial markets and production line processes. As a result, students having taken this course 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. It may be of interest to students in Economics and Finance.

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: 11/14/2014

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: 1/27/2015

Signature of Chair of the Graduate Council: ___________________________ Date: ______________

Signature of Faculty Senate Secretary: ___________________________ Date: ______________

Date Approved by Faculty Senate: ______________

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September 2011

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Math 661 Time Series  
College of Charleston  
Department of Mathematics  
Fall 2013 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  
*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  
Topics will include characteristics of time series, exploratory data analysis, ARIMA models, spectral analysis and filtering, state-space models, statistical methods in the frequency domain.

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

1. Recognize and apply different time series models.
2. Understand the theory behind the construction of time series models.
3. Understand the proofs behind the theory of time series models.
4. Use time series methods to analyze real data sets.

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.

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

**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**: 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.