From:	Schroeder, Margaret <m.mohr@uky.edu>
Sent:	Thursday, October 08, 2015 12:47 PM
To:	Brothers, Sheila C; Hippisley, Andrew R
Subject:	MS in Applied Statistics
Attachments:	Master of Applied Statistics-signed revised.pdf

Proposed New MS: Applied Statistics

This is a recommendation that the University Senate approve, for submission to the Board of Trustees, the establishment of a new MS degree: Applied Statistics, in the Department of Statistics within the College of Arts & Sciences.

Please find the revised proposal attached.

Please note this proposal was nearing the end of the CPE 45 day review period and Mia anticipated no problems moving forward.

Best-

Margaret

Margaret J. Mohr-Schroeder, PhD | Associate Professor of STEM Education | COE Faculty Council Chair | SAPC University Senate Committee Chair | University Senator | Secondary Mathematics Program Co-Chair | STEM PLUS Program Co-Chair | Department of STEM Education | University of Kentucky | www.margaretmohrschroeder.com

UK

KENTUCKY

College of Arts and Sciences
Office of the Dean
202 Patterson Office Tower
Lexington, KY 40506-0027
859 257-8354
fax 859 323-1073

April 10, 2015

Dear Graduate Council:

I am pleased to express the College's strongest support of the proposed Master of Applied Statistics. The Applied Statistics Master would open up a number of opportunities for traditional and non-traditional students, working scientist, and professionals who seek new career opportunities by enhancing their statistical experiences. The enclosed proposal has been carefully vetted by the college's Education Policy Committee in close consultation with the Dean's office.

The proposed Master of Applied Statistics will utilize the strengths of the outstanding graduate faculty in Statistics.

The Applied Statistics Master is designed to train mathematical, social and natural scientists from a variety of disciplines to be professional statisticians.

The College of Arts and Sciences fully supports the proposed Master of Applied Statistics.

Sincerely,

Mark Lawrence Kornbluh
Dean

NEW MASTERS DEGREE PROGRAM FORM
(Attach completed "Application to Classify Proposed Program"[1])

GENERAL INFORMATION

College:	Arts & Sciences		Department:	Statistics	
Major Name:	Applied Statistics		Degree Title:	Master of Applied Statistics	
Formal Option(s):			Specialty Fields w/in Formal Option:		
Date of Contact with Associate Provost for Academic Administration[1]:			February 23, 2015		
Bulletin (yr & pgs):		CIP Code[1]:	27.0501	Today's Date:	December 8, 2014
Accrediting Agency (if applicable):					
Requested Effective Date:	☐ Semester following approval.		OR	☒ Specific Date[2]:	Summer 2016
Dept. Contact Person:	Constance L. Wood		Phone:	859-257-1208	Email:	cwood@uky.edu

CHANGE(S) IN PROGRAM REQUIREMENTS

1.	Number of transfer credits allowed	9
	(Maximum is Graduate School limit of 9 hours or 25% of course work)	
2.	Residence requirement (if applicable)	
3.	Language(s) and/or skill(s) required	
4.	Termination criteria	Probation for two consecutive semesters; Failure to pass Final Exam on second attempt
5.	Plan A Degree Plan requirements[3] (thesis)	NA
6.	Plan B Degree Plan requirements[3] (non-thesis)	30
7.	Distribution of course levels required	At least 1/2 at 600+ level; 2/3 in organized courses
	(At least one-half must be at 600+ level & two-thirds must be in organized courses.)	
8.	Required courses (if applicable)	STA 645,STA 646,STA 647, STA 648,STA 649
9.	Required distribution of courses within program (if applicable)	
10.	Final examination requirements	Oral Comprhensive Exam (Video Conference)
11.	Explain whether the proposed new program (as described in numbers 1 through 10) involve courses offered by another department/program. Routing Signature Log must include approval by faculty of additional department(s).	
	No	

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[1] Prior to filling out this form, you MUST contact the Associate Provost for Academic Administration (APAA). If you do not know the CIP code, the APAA can provide you with that during the contact.

[2] Programs are typically made effective for the semester following approval. No changes will be made effective until all approvals are received.

[3] If there is only one plan for the degree, plans involving a thesis (or the equivalent in studio work, etc.) should be discussed under Plan A and those not involving a thesis should be discussed under Plan B.

Rev 8/09

12.	What is the rationale for the proposed new program?

	See attached.

NEW MASTERS DEGREE PROGRAM FORM

Signature Routing Log

General Information:

Program Name: __Statistics__

Proposal Contact Person Name: __Constance L. Wood__   Phone: __257-1208__   Email: __cwood@uky.edu__

INSTRUCTIONS:
Identify the groups or individuals reviewing the proposal; note the date of approval; offer a contact person for each entry; and obtain signature of person authorized to report approval.

Internal College Approvals and Course Cross-listing Approvals:

Reviewing Group	Date Approved	Contact Person (name/phone/email)	Signature
Statistics	3/8/15	Arny Stromberg 7-6115 / arny.stromberg@uky.edu	Arny Stromberg
A&S EPC	4/7/15	Anna Bosch / 7-1584 / anna.bosch@uky.edu	Anna Bosch
		/	
		/	
		/	

External-to-College Approvals:

Council	Date Approved	Signature	Approval of Revision[4]
Undergraduate Council			
Graduate Council	5/7/15	_Roshan Nikou_	
Health Care Colleges Council			
Senate Council Approval		University Senate Approval	

Comments:

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[4] Councils use this space to indicate approval of revisions made subsequent to that council's approval, if deemed necessary by the revising council.
Rev 8/09

Proposal for a New Program

Degree Title: Master of Applied Statistics

Major: Applied Statistics

Primary College: Graduate School

Department/Graduate Program: Statistics

CIP Code: 27.0501

Statistics Departmental Contact:

Name: Constance L. Wood
Director of Graduate Studies
Email: cwood@uky.edu
Phone: 859-257-1208

Section 1: Overview of Master of Applied Statistics Program.

The Master of Applied Statistics (MAS) is designed to train professional, practice-oriented statisticians. We propose a MAS degree which is housed in the Department of Statistics in the College of Arts & Sciences and administered by the graduate faculty in Statistics which also offers a MS with a Major in Statistics and a PhD with a major of Statistics as well as a Graduate Certificate in Applied Statistics. Specifically, the proposed MAS

- Is a thirty-hour, Plan B master's degree,
- Will be offered totally online,
- Will be accessible to practicing scientists and engineers,
- Can be completed in one or more calendar years.

Section 2: Rational and Description of the Program. The proposed Master of
Applied Statistics is an innovative online professional graduate degree that can be completed in a summer and two consecutive semesters or on a part-time basis. The goal of this program is to create professional, practice-oriented statisticians who have both data analytic and computing skills. This program is unique in that it uses data visualization and statistical computing to teach fundamental concepts in statistical inference to students who only have two semesters of calculus instead of the coursework normally required for an MS program in Statistics. This program is designed to train mathematical, social, and natural scientists from a variety of disciplines to be professional statisticians. Specifically, the curriculum focuses on how to manage 'big' data and successfully describe, analyze, and make inferences using current and rapidly evolving statistical methodologies.

This terminal degree qualifies students for entry-level positions as statisticians in industries such as Google, Intel, and Pfizer as well as Wall Street and numerous federal, state, and local government agencies. It also bridges the wide gap between the two educational programs we currently offer; i.e., a research-oriented Master of Science in Statistics and the Graduate Certificate in Applied Statistics.

Specifically, we are proposing a thirty-hour, Plan B, Master's degree which will be offered online. All courses will have a required interactive component using video conferencing which will allow the students to engage in discussion and interact with faculty. The strength of this program will be the emphasis on statistical methodology and its applications.

The online format ensures access for working scientists, traditional and non-traditional students, and professionals who seek new career opportunities by enhancing their statistical expertise.

Section 3: Potential Impact of the Program. As the flagship university in the Commonwealth and the only university in the state that offers graduate training in Statistics, the University of Kentucky can and should be instrumental in training professional statisticians to work in industry, government, and education. In-state employers include Humana, Lexmark, American Greeting, Corning, clinical research organizations, actuarial firms, research universities, and government agencies. The online format ensures access to all students across the state. Moreover, we plan to recruit a diverse pool of domestic and international students. We expect this program to attract numerous applicants; Texas A&M offers an online, video-based master's degree which averages 2000 applicants per year for 100 slots. Moreover, each year we receive approximately 50 applicants for the MS in Statistics who do not have the mathematical background for that program, but are ideally suited for the MAS.

The demand for well-trained statisticians is strong at local, state, national, and international levels. According to the *Occupational Outlook Handbook*, published by the Bureau of Labor Statistics, the US demand for statisticians is currently high and growing with a 27% projected increase in jobs from 2012 to 2022. The Bureau of Labor Statistics stated that "Growth is expected to result from more widespread use of statistical analysis to make informed business, healthcare, and policy decisions." The *Wall Street Journal* chronicled the increasing student demand and interest in Statistics in "The Upbeat Stats on Statistics." See http://blogs.wsj.com/numbers/the-upbeat-stats-on-statistics-1216 .

Eighty percent of the course work in the MAS program focuses on statistical methodology and computing in order to prepare students for entry level jobs as a practicing statisticians. The online format ensures access for access for working scientists, traditional and non-traditional students, and professionals who seek new career opportunities by enhancing their statistical expertise.

Section 4: Comprehensive Program Description. The graduate faculty in the Department of Statistics have developed new courses for this program that will prepare graduates

to function in the multiple roles of data analyst, data management technician, and statistical programmer. These courses are interrelated and will emphasize statistical inference and data visualization and management. Specifically, the program is designed to provide the student a firm grounding in linear and nonlinear models and address a wide variety of statistical and computing methods. See **New Courses** and **Appendix.** Under supervision, students will analyze data from multiple disciplines and learn to apply appropriate statistical methods and to verify assumptions required to use these techniques.

Student Learning Outcomes: At the end of the program, all students are required to meet the following set of learning outcomes that require mastery of material presented in multiple courses. Candidates must:

1) **Foundations and Statistical Inference**
    a.) demonstrate professional level knowledge of basic probability, the standard statistical distributions and their common usages to describe commonly occurring response variables;
    b.) demonstrate knowledge of fixed-sample and large-sample statistical properties of point and interval estimators appropriate for normal, categorical, discrete, and non-normal continuous data;
    c.) demonstrate knowledge of the properties of parametric, semi-parametric, and nonparametric testing procedures.
2) **Statistical Computing and Data Management**
    a.) demonstrate the ability to perform complex data management in SAS; and
    b.) demonstrate the ability to perform complex data analysis in SAS and R.
3) **Methodology**
    a.) demonstrate the ability to correctly apply linear, nonlinear, and generalized linear models and to verify the underlying assumptions required for these procedures to be valid;
    b.) demonstrate knowledge of how to design experiments and surveys for efficiency; and
    c.) demonstrate professional level knowledge of classical and repeated measures multivariate methods and computational techniques.

Curriculum: Eleven new online courses constitute the curriculum offerings for the MAS. These courses are designed to provide the instruction required for students to meet the Student Learning Outcomes detailed above. The unifying concept is the discovery of statistical techniques and approaches through data visualization and computing. All courses have been developed in a modular format to facilitate online delivery and interaction.

The curriculum consists of five required courses (17 hours) and thirteen hours of guided electives selected from six courses. The courses that have been developed are given in Table 1. Required courses are denoted by *. These courses have been submitted through ECATS and sample abbreviated syllabi are given in the Appendix.

Table1. MAS Courses

Course	Course Title	Hours
STA 645*	Computational Theory and Data Visualization	3
STA 646*	Foundations of Probability and Inference	4
STA 647*	Statistical Computing with SAS	2
STA 648*	Regression Modeling	4
STA 649*	Design of Experiments	4
STA 650	Applied Multivariate Statistics	3
STA 651	Advanced Programming with R	1
STA 652	Advanced Statistical Modeling	3
STA 654	Applied Bayesian Analysis	3
STA 656	Statistical Quality Control	3
STA 659	Advanced Statistical Methods (subtitle required)	3 (Repeatable up to 6 hours)

*Denotes Required Course

Curriculum Map: The courses in the MAS curriculum will *introduce, emphasize,* or *reinforce* one or more of the Student Leaning Outcomes. Student Learning Outcomes map onto the courses as represented in Table 2.

Table 2. Curriculum Map

KEY: I=Introduce, E=Emphasize, and R=Reinforce

Student Learning Outcome	STA 645	STA 646	STA 647	STA 648	STA 649	STA 651	STA 652	STA 650	STA 654	STA 656	STA 659
Foundations and Statistical Inference	I	I	R	E	E	R	E	E	E	R	E
Statistical Computing and Data Management	I	R	I	E	E	I	E	E	E	E	E
Methodology	I	E	E	I	I	E	I	I	I	I	I

Sample Programs of Study: The MAS is structured so that a student can complete the program in one calendar year. However, this is an intensive program of study and can also be pursued on a part-time basis by working professionals. Sample One-Year, Two-Year and Four-Year are shown below.

Table 3. One-Year Program of Study

Summer 2 (9 hours)	Fall Semester (11 hours)	Spring Semester (10 hours)
STA 645, STA 646, STA 647	STA 648, STA 654, STA 656, STA 651	STA 649 and two from STA 652, STA 650, or STA 659

Table 4. Sample Two-Year Program of Study

	Summer 2	Fall Semester	Spring Semester
Year 1	STA 645, STA 647	STA 646, STA 648	STA 649, STA 652
Year 2		STA 654, STA 656, STA 651	STA 650

Note: STA 652, STA 650, STA 659 are interchangeable in the Sample Two-Year Program of Study.

Table 5. Sample Four-Year Program of Study

	Summer 2	Fall Semester	Spring Semester
Year 1	STA 645, STA 647	STA 646	STA 648
Year 2		STA 654	STA 649
Year 3		STA 656	STA 659
Year 4		STA 652	

Note: STA 654 and STA 656 are interchangeable in the Sample Four-Year Program of Study. Similarly, STA 652, STA 650 are STA 659 are interchangeable.

Faculty Load and Course Rotation: In order to facilitate timely completion of the program, we propose to offer the eleven courses for the MAS in the following rotation:

- Summer (9 credit hours)

- STA 645　STA 646　STA 647

- Fall (15 credit hours)

  - 　　STA 646　STA 648　STA 654　STA 651　STA 656

- Spring (17 credit hours)

  - 　STA 648　STA 649　STA 652　STA 650　STA 659

Faculty/Student Interaction and Online Student Support: Since students in the online class will not have the benefit of working together in a classroom environment or face-to-face interaction with the instructor, we propose to use **"Real-time Discussion Boards"** and **"Talk to the Expert"** to provide this important component of classroom learning in an online environment.

> **Real-time Discussion and Response:** Discussion boards are far from novel, but have been used in interesting and perhaps unique ways to facilitate classroom discussion in our other online courses. *All* questions about the course material will be posted on the discussion board. Questions about grades or other personal matters are to be emailed directly to the instructional team; i.e., the instructor and teaching assistants. Canvas will be the course management system used for these online discussions among students and the instructional team.
>
> Specifically, forums will be set up on the course discussion board corresponding to different modules of material within the course. Within each forum there will be a post created for each day of the course. These threads will be fixed and students will be unable to create new threads. Our experience in other courses is that this greatly helps to minimize confusion. Students click on the day's material that they have questions about. Once the student selects the day, they can ask a question or respond to other students' questions. The instructional team will monitor these forums and follow up as necessary when peer answers are either in short supply or incomplete.
>
> Once a student posts to *any* of the threads on any of the forums, the instructional team will receive an email alerting them that there is a new post. This allows the instructional team to monitor the discussion board without having to constantly log into the Course Management System and troll and allows postings to be addressed from a variety of platforms convenient to the instructor, e.g. via computer, tablet, or smartphone.
>
> It should be emphasized that having the students post to the discussion board helps to eliminate having to answer the same question over and over. The organization of the forums allows students to easily find questions that were similar to their own, and allows them to answer other student's questions. Prior experience with these forums suggests

that students do not "fish" for answers to the homework questions, but used the discussion board as intended and asked genuine questions.

Talking with the Expert: We also propose 2-3 hours per week of online interaction with the instructor, which we are calling "Talking with the Expert." This time, essentially, online office hours, is certainly not unique, but has been effectively used our online courses. Adobe Connect, a web-conferencing software that allows an instructor to set up meeting times with individuals or groups of students, provides instructors the opportunity to present students with materials and have typed, audio or video discussions with students (video typically needs to be one-way only – instructor-to-student – because of bandwidth limitations). UK has a license to use this software so any student who signs up for any of our courses can access it as well, once the instructor has initiated access. Skype is an alternative method of direct communication which is easily accessible and allows students and instructors to connect face-to-face. Students tended to be more familiar with Skype, and it is easier to use than Adobe Connect. Skype, however, has fewer features and the instructor has less control over the communication and interaction.

MAS Administration: The faculty of record for the MAS is the Graduate Faculty in Statistics. The Director of Graduate Studies for Statistics will coordinate and approve all admissions to the program. In addition, a Director of MAS will be appointed who will assist in reviewing applications, will supervise day-to-day operations of the MAS, and have a primary role in assessment of the program and feedback for course assessment.

Relationship to MS in Statistics and Graduate Certificate in Applied Statistics: The MAS is an entirely separate degree program. Courses developed for the MAS do not carry degree credit for the MS in Statistics and students admitted to the MAS may not enroll in courses approved for the MS degree. http://stat.as.uky.edu/masters-program. These courses have a pre-requisite of graduate status in the MS /PhD program in Statistics.

Currently the Graduate Certificate in Applied Statistics is awarded to students who complete the required courses selected from the Department's graduate level service courses. http://stat.as.uky.edu/statistics-graduate-certificate. We plan to develop an online version of this certificate which will utilize the courses developed for the MAS. This certificate program will differ from the one currently offered in that applicants will be required to have two semesters of calculus for admission.

Section 5: Admissions and Graduation Requirements.
Applications to the MAS are welcome from all students holding a Bachelor's degree in the social, mathematical, physical or biological sciences as well as engineering and education. All applicants must submit GRE scores and meet the minimum requirements for admission to the Graduate School. Applications will be processed through ApplyYourself.

Admission requirements include:

1. Advanced undergraduate or graduate level Statistical Methods course; eg, STA 570 or STA 569, and
2. Two semesters of calculus.

Admissions are made on a competitive basis. Preference will be given to students with research or professional experience.

Section 6: Ongoing Assessment and Feedback.
The Master of Applied Statistics (MAS) is designed to prepare students to function in the multiple roles of data analyst, data management technician, and statistical programmer. The success of this program will be evaluated by A. students' achievement of Student Learning Outcomes in individual courses, B. students' overall mastery of program-specific Student Learning Outcomes, and C. the ability of the program to attract, retain, and graduate professionals capable of functioning as a practicing statistician.

Course-Level Assessment: An Application for New Course has been developed and is attached for each of the eleven new courses in the MAS curriculum. Included in this is a syllabus which contains course specific Student Learning Outcomes and assessment measures. At the end of each course, the instructor will summarize the students' performance and transmit this information to the Director of the Applied Statistics program. The results will be presented to the faculty at the first faculty meeting of the next semester. At this time, the Director will also organize a working meeting of the instructors from the previous semester and the instructors currently teaching in the program who will use the results of the assessment to modify current course learning activities to correct any observed deficiencies. Needed changes in pedagogy and infrastructure will also be addressed.

Program Specific Student Learning Outcomes Assessment: A students' overall mastery of the program-specific Student Learning Outcomes will be evaluated at the end of the program. The Department will develop a comprehensive final examination reflective of the curriculum in all constituent courses. Each question will be targeted to assess competency in several learning outcomes. Students will receive scores (1-5) on each of the learning outcomes based on their performance on the Final Examination for the MAS. Based on a student's performance on the targeted questions from his/her courses, questions on the Final Exam will target those outcomes that the student needs to demonstrate competency. This oral exam will be conducted by the student's Advisory Committee by video conferencing. A score of 3.0 or above is required for a Pass. Programmatic assessment will be based on the data for all students and be analyzed as an incomplete block design.

Program Assessment: The faculty in the program will collect data to allow us to assess the effectiveness of MAS in the preparation of professional, practicing statisticians and also allow

the program faculty to improve the ways we collaborate to provide effective instruction. We propose to collect information on program quality from the following involved parties:

- Candidate Program Feedback: Students enrolled in the MAS will complete questionnaires at the end of the first semester and at the end of the program.
- MAS Alumni Job Placement and Feedback: Two years after leaving the program, all MAS Alumni are surveyed to determine job placement, employment status and level of satisfaction with their preparation for the profession.
- Supervisor Feedback: Each graduate's job supervisors will be sent a questionnaire two years after the student has completed the program to document the effectiveness of the student in his/her current position.

In addition, the program will collect basic data on retention and completion rates, initial job placement and salary, and trends in distribution of scores on the Student Learning Outcomes.

Section 7: Required Instructional Resources.
The Department of Statistics is extremely fortunate to have several faculty who have extensive experience in online instruction; namely, Derek Young, Mark Gebert, and Bill Rayens

Derek Young has taught nearly 500 graduate students during 14 semesters (from 2008-2013) teaching for Penn State University's online graduate programs in Statistics. He rewrote the material for their Regression Methods course, which is still used today. He firmly understands the technological tools necessary for successfully conducting online classes as well as the overall needs of online students – especially those seeking an online degree while working full-time.

Mark Gebert created STA 569, the Departments first graduate online methods course and taught it to several hundred graduate students over several semesters (summer and regular term). He also created our first, online version of STA 291 and taught it to hundreds of undergraduate over a period of about five years. He will be working exclusively in the online Master's program.

Bill Rayens will not be teaching in the new program but has a instrumental role in the development of the MAS. His job, in part, has been to oversee the pedagogy of the courses that comprise the new program. He created and has taught a highly interactive, personal, and paced online version of the Department's general education statistics course, STA 210. That course has proved to be very popular with students over the last three years.

In addition, many of our graduate students have been instrumental in the development of our online courses and their delivery. In order to staff the rotation of courses proposed in Section 4. one additional lecturer will be required. Permission to fill this position in Fall 2016 been given by the Dean of Arts and Sciences.

Section 8: Required IT Resources.
Faculty who are teaching in MAS must have reliable access to a computer with video camera and microphone capabilities as well as a tablet computer

with touchscreen capability. This will allow for the development of course material, the means for effective delivery, and the ability to facilitate faculty/student interaction.

Development of course material will involve presentation software programs (e.g., PowerPoint and LaTeX) and statistical software packages (e.g., R and SAS). Delivery of instructional material will be a mixture of voice-over presentations, prepared written handouts, recorded short vignettes using applications like Jing and Doceri, and recorded presentations using the lightboard. The lightboard is a transparent dry-erase board that allows the course instructor to face the camera while everything that they write appears in the correct direction for the viewer. This will allow for all online MAS course developers to create engaging, informative lectures. The University has an operational version of the lightboard that is located in the Media Depot. For the component of faculty/student interaction involving "Talking with the Expert", the faculty will need to utilize Adobe Connect or a comparable meeting software program.

Given the technical resources required, a dedicated IT person will need to be available to help with unforeseen technical difficulties that might arise, including the integration of developed media with Canvas.

UNIVERSITY OF KENTUCKY

Department of Biostatistics, CPH

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kryscio@email.uky.edu

October 1, 2015

Margaret J. Mohr-Schroeder, Ph.D.
SAPC University Senate Committee Chair

Dear Margaret:

This is to let your know that I am familiar with the curricula proposed in the online Applied Statistics degree program currently under review by your committee. In my opinion the new degree has no more overlap with our courses in Biostatistics than the current STA 670-STA 678 series of service course offered to graduate students on this campus. Briefly, the new program emphasizes applications in broad areas of statistics including industrial and agricultural applications while our courses focus on applications to biomedical studies including population based studies, observational studies, and clinical studies. While the underlying statistical principles have some overlap, the applications differ substantially.

We (the Department of Biostatistics) welcome this on line degree program since it is breaking ground for this university. We wish the Department of Statistics the best in offering this degree program to off campus students.

Sincerely,

Richard J. Kryscio, Ph.D.
Chair, Biostatistics

cc. Constance Wood, DGS Statistics;
    Steve Browning, DGS Epidemiology-Biostatistics degree program