Program Cover Document - MAT 498/STA 498 - Capstone

I. Basic Course Information

This course is intended for students in their final semester at TCNJ. The content in this course builds on the earlier courses in the mathematics and statistics program, and brings together topics from different courses. The course is project-based. Students will identify a project area, work with other students in the same area to learn background material, and complete an independent project. The project will culminate in a written paper and a poster, which will be presented at the Celebration of Student Achievement. *This course is writing intensive.*

Course prerequisites: Senior standing – the Capstone is to be taken in a student's last or penultimate semester at TCNJ. MAT 310, MAT 326, CSC 220 or CSC 250, and 2 MAT or STA 300 or 400 level courses are prerequisites. Two MAT or STA 300/400 level courses are Co-requisites. At most three of the four options can be STA courses. Prerequisites for individual specializations are detailed below.

Applied Mathematics: MAT 310, MAT 326, CSC 220 or CSC 250, and two mathematics/statistics options at the 300/400 level. Corequisite: two additional mathematics/statistics options at the 300/400 level. At most three of the four options can be STA courses.

Mathematics: MAT305, MAT310, and two mathematics options at the 300-level or above, at least one of these at the 400-level or above. Corequisite: two additional mathematics options at the 300-level or above.

Statistics: MAT 316 (Probability) and two statistics options at the 300-level or above

II. Learning Goals

The primary goals of the course are for students to develop their abilities to learn mathematics or statistics independently and to demonstrate proficiency in reading, writing, and explaining mathematics or statistics orally. Students will develop increased mathematical maturity by learning new material within small groups and independently. Accordingly student projects will be on material which is new to the student but which builds upon curricular knowledge acquired at TCNJ. Students will further develop their oral and written communication skills.

By the end of the course students will:
1. Demonstrate the ability to master new mathematical or statistical material independently.
2. Demonstrate proficiency in reading mathematics and statistics.
3. Demonstrate proficiency in writing mathematics and statistics for an audience of peers.
4. Demonstrate proficiency in the verbal communication of mathematical or statistical ideas to peers and to a general audience.

III. Learning Activities

Learning activities will include group and individual project work, group and individual student in-class presentations, a poster summarizing the project presented to department faculty and to a general audience, and an expository paper with multiple drafts on material that is new to the

student. Students will also provide feedback to their peers. Lectures or other activities may also be included.

IV. Student Assessment

Students will receive feedback on presentations, the poster, and three or more paper drafts (partial or complete) prior to submission of the final paper. Faculty will assess student mastery of the mathematical or statistical content of the project and student mathematical or statistical communication skills. The paper will constitute the final evaluation for the course. As such it will contribute between 15 and 50% to the final grade for the course, and the final due date will occur during the final exam period.

SYLLABUS
CAPSTONE
Spring, 2017

Course Title & Number: Capstone - MAT498
Professor: Cynthia Curtis
Office Address: SCP208
Email Address: ccurtis@tcnj.edu
Meeting Times: Mon and Thurs, 11:00am - 12:20pm; Wed 10am (Optional group time)
Office Hours: Mon 9 - 10:50Am; Wed 8:30 - 9:20am

Course Description and goals

This course is intended for students in their final semester at TCNJ. The course is project-based. Students will identify a project area, work with other students in the same area to learn background material, and complete an independent project. The project will culminate in a written paper, an oral presentation, and a poster presentation of the project at the Celebration of Student Achievement.

The primary goals of the course are for students to exhibit their ability to learn mathematics independently and to demonstrate proficiency in reading, writing, and explaining mathematics orally. Accordingly student projects will be on material which is new to the student but which builds upon curricular knowledge acquired at TCNJ. Students will give presentations throughout the semester and will receive feedback on multiple paper drafts. Students will also provide feedback to their peers.

There is no textbook for this course. Students will find background materials for their projects by referencing books in the library or from faculty members, using MathSciNet, and through the mathematics arXiv.

COURSE REQUIREMENTS

Classroom activities: Class time will be used for my lectures (few of these), occasional exercises to foster presentation or writing skills, group and individual work, and meetings with me. You will be given a participation grade, constituting 5% of your final grade.

Work log: You will maintain an electronic work log, submitted weekly on Canvas, in which you will articulate weekly goals, account for work done, and identify accomplishments. This will be graded, contributing 5% to your final

grade.

Group work and presentation: You will work in groups of 2 - 4 students in a general area. The early part of your project will consist of learning background material for this area together. You will give a group presentation on this material to the class. You will be given a grade for your group work, consisting of a group grade for the presentation as well as an individual grade for your participation in group work. Your grade will contribute 15% to your final grade.

Individual presentation: Late in the semester you will give an individual presentation on your project. This will be graded, constituting 15% of your final grade.

Poster: You will prepare a poster for the Celebration of Student Achievement, held on the final Wednesday of the semester. Students from the mathematics, applied mathematics, and statistics capstone courses will join students from across campus in presenting posters summarizing their work. Department faculty and members of the campus community will be in attendance. Your poster will be graded; this grade will contribute 20% to your final grade.

Paper: You will write an expository paper on your project. This paper will be accessible to your peers. It will include an introduction, a statement of your problem, at least one proof, at least one example, and references. More guidelines will be provided later in the semester. You will submit an outline and references and three drafts, the first receiving feedback from me, the second receiving feedback from a peer, and the final receiving feedback from me. You will be graded on the quality of each draft, your response to feedback, and the quality of the final paper. The grade on your paper will constitute 35% of your final grade in the course.

Peer feedback: You will provide feedback to your peers on their presentations and on the second draft of a paper. You will be graded on your participation and seriousness in providing feedback. This grade will constitute 5% of your final grade.

Attendance and fourth hour: This class meets for 80 minutes on each Monday and Thursday. Regular attendance is expected. The 10am Wednesday class period is not required, but I have reserved our room for your use for group work if desired. Make-ups for presentations should be arranged in advance if a student anticipates an absence due to a scheduled TCNJ function such as a sporting

event. Make-ups due to illness should be requested prior to the start of the class period. If illness leads to an absence of more than one day this should be substantiated by a note from a physician or from health services.

COURSE SCHEDULE

Topic area selection: January 30
Group presentations: February 13, 16, and 20
Outline due: February 26
First draft of paper due: March 5
Second draft of paper due: April 2
Peer feedback on peer paper due: April 9
Individual presentations: April 10, 13, and 17
Poster due: April 20
Third draft of paper due: April 23
Poster print deadline: April 27
Celebration of Student Achievement: May 3
Final paper due: May 10

GRADING

Paper: 35%
Poster: 20%
Individual presentation: 15%
Group work and presentation: 15%
Peer feedback: 5%
Work log: 5%
Participation: 5%

SELECTED TCNJ POLICIES

TCNJ's final examination policy is available on the web:
http://policies.tcnj.edu/policies/digest.php?docId=9136

Attendance
Every student is expected to participate in each of his/her courses through regular attendance at lecture and laboratory sessions. It is further expected that every student will be present, on time, and prepared to participate when scheduled class sessions begin. At the first class meeting of a semester, instructors are expected to distribute in writing the attendance policies which apply to their courses. While attendance itself is not used as a criterion for academic evaluations, grading is frequently based on participation in class discussion, laboratory work, performance, studio practice, field experience, or other activities which may take place during class sessions. If these areas for evaluation make

class attendance essential, the student may be penalized for failure to perform satisfactorily in the required activities. Students who must miss classes due to participation in a field trip, athletic event, or other official college function should arrange with their instructors for such class absences well in advance. The Office of Academic Affairs will verify, upon request, the dates of and participation in such college functions. In every instance, however, the student has the responsibility to initiate arrangements for make-up work.

Students are expected to attend class and complete assignments as scheduled, to avoid outside conflicts (if possible), and to enroll only in those classes that they can expect to attend on a regular basis. Absences from class are handled between students and instructors. The instructor may require documentation to substantiate the reason for the absence. The instructor should provide make-up opportunities for student absences caused by illness, injury, death in the family, observance of religious holidays, and similarly compelling personal reasons including physical disabilities. For lengthy absences, make-up opportunities might not be feasible and are at the discretion of the instructor. The Office of Academic Affairs will notify the faculty of the dates of religious holidays on which large numbers of students are likely to be absent and are, therefore, unsuitable for the scheduling of examinations. Students have the responsibility of notifying the instructors in advance of expected absences. In cases of absence for a week or more, students are to notify their instructors immediately. If they are unable to do so they may contact the Office of Records and Registration. The Office of Records and Registration will notify the instructor of the student's absence. The notification is not an excuse but simply a service provided by the Office of Records and Registration. Notifications cannot be acted upon if received after an absence. In every instance the student has the responsibility to initiate arrangements for make-up work.

Academic Integrity Policy

Academic dishonesty is any attempt by the student to gain academic advantage through dishonest means, to submit, as his or her own, work which has not been done by him/her or to give improper aid to another student in the completion of an assignment. Such dishonesty would include, but is not limited to: submitting as his/her own a project, paper, report, test, or speech copied from, partially copied, or paraphrased from the work of another (whether the source is printed, under copyright, or in manuscript form). Credit must be given for words quoted or paraphrased. The rules apply to any academic dishonesty, whether the work is graded or ungraded, group or individual, written or oral.

TCNJ's academic integrity policy *is available on the web:*
http://policies.tcnj.edu/policies/digest.php?docId=9394

Americans with Disabilities Act (ADA) Policy
**Any student who has a documented disability and is in need of academic accommodations should notify the professor of this course and contact the Office of Differing Abilities Services (609-771-2571).
Accommodations are individualized and in accordance with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1992.**

TCNJ's Americans with Disabilities Act (ADA) policy is available on the web:
http://policies.tcnj.edu/policies/digest.php?docId=9206

Policy Prohibiting Discrimination in the Workplace/Educational Environment

The College of New Jersey Policy Prohibiting Discrimination in the Workplace/Educational Environment governs the college's commitment to and expectations of having an environment

that respects the diversity of all members of the campus community. The link to this policy is: http://policies.tcnj.edu/policies/digest.php?docId=9122. Under this policy, forms of discrimination or harassment based upon specific protected categories are prohibited and will not be tolerated. If you wish to report a concern, please contact Kerri Thompson Tillett, Chief Diversity Officer, at 771-3139, or via email at thompsok@tcnj.edu.

APPLIED MATHEMATICS CAPSTONE
MAT 498-01, Spring 2017

COURSE DESCRIPTION

MAT 498/Applied Mathematics Capstone: The content in this course builds on the earlier courses in the mathematics program, and brings together topics from different prerequisite courses. The first major goal of this course is that students develop a greater level of mathematical maturity by learning mathematics topics within small groups and independently. The second major goal of this course is that students strengthen their oral and verbal presentation skills. After the first few course meetings, any lectures will be presented by student groups. It is the responsibility of the non-presenting students to learn from the presenters, and also to provide constructive feedback on how the presenters can improve their presentation skills. As the semester progresses, group work will give way to each student focusing on an individual topic. Each student will write an expository paper on their topic, and prepare a poster for presentation to the Department.
(1 course unit)

Background: The prerequisite for the Applied Mathematics Capstone is MAT 326 (Differential Equations) and MAT 310 (Real Analysis). To allow students from different specializations to enroll in the Applied Math Capstone, the prerequisites are being relaxed this semester. As a result, students may be grouped based on how much of the prerequisite material they have been exposed to.

Theme: Dynamical Systems – Theory, Applications and Control

INSTRUCTOR INFORMATION

Instructor: Dr. Jana Gevertz   **Email**: gevertz@tcnj.edu

Office: Science Complex P247   **Phone**: 609-771-3314

Office Hours: Monday and Wednesday from 10:00 – 11:00am, Thursday from 12:30-1:30

COURSE INFORMATION

Time: Monday and Thursday, 11:00-12:20

Location: Science Complex P221

Course Website: This course utilizes the Canvas course management system. General course material, assignments, project details, and any other important documents will be posted on Canvas. In order to ensure that you get all course announcements, please do not change the default setting in Canvas; the default setting is such that you get immediately notified via email when I post a course announcement.

4th Hour: In this class, deep learning outcomes associated with TCNJ's 4th hour are accomplished by a series of rigorous educational assignments that extend beyond the typical scheduled class time. These include the preparation of oral presentations, the writing of an original paper, and the completion of a semester-culminating poster.

COURSE MATERIALS

There is no text for this course. I have placed several texts on reserve in the library and students are strongly encouraged to consult them along with other library sources. In addition, I have a collection of dynamical systems and optimal control books that students may sign out for short periods of time. A thorough exploration of your topic may require you to use MATLAB, Mathematica, or another computing language of your choosing. MATLAB and Mathematica are freely available for download from TCNJ, and are available from any TCNJ computer.

COURSE PURPOSE & LEARNING GOALS

By the end of the course students will:
1. Develop the skills to independently learn an unfamiliar mathematical topic in depth.
2. Have enhanced their ability to orally communicate mathematics to a group of peers.
3. Gain experience writing an expository paper in mathematics.

COURSE REQUIREMENTS AND GRADING

To assess growth throughout the course, students will give multiple presentations, give feedback to peers on their work, write an expository paper, and prepare a poster on the contents of their paper. The importance of keeping track of one's weekly goals and accomplishments will be assessed through a work log.

Presentations	20%
Paper drafts	15%
Final paper	20%
Poster drafts	5%
Final poster	15%
Work log	15%
Participation	10%

Presentations: Students will present material to the class several times throughout the semester. Some of those presentations will be group presentations, and others will be individual presentations. Details on the expectation for each presentation will be clearly delineated. Students not presenting will be expected to ask questions during the presentations.

Capstone Paper: Each student will select a topic related to Dynamical Systems. The student will investigate the topic by referring to texts and/or publications, with the goal of producing an expository paper on their topic. The paper should be approximately 8-10 pages long, and should be accessible to a junior or senior level undergraduate mathematics major with no background in Dynamical Systems. Each paper must include a numerical calculation, and a

derivation or proof. Students will be required to submit a paper proposal in mid-February, and paper drafts will be due approximately once every two weeks starting early March. Each paper draft will build on the following draft in two ways: 1) it will incorporate changes in response to professor comments on the previous draft; 2) it will contain new content that extends the length and substance of the paper.

Work Logs: During the semester you will maintain a work log that includes daily/weekly goals set by you, work done, and outcomes produced to achieve the stated goals.

Participation: As this is a seminar course, it is essential that all students are actively attending and participating in the class discussions and asking questions during student presentations. Participation also entails giving high-quality assessment and feedback to your peers' using the agreed-upon rubric.

SCHEDULE AND DEADLINES (Subject to Change)

- Thursday 2/9 – First group presentations
- Thursday 2/16 – Project proposal due (approximately one page, with at least 2 sources)
- Thursday 3/2 – Paper draft #1 due (2-3 pages)
- Monday 3/6 and Thursday 3/9 – Second group/individual presentations
- Thursday 3/23 – Paper draft #2 due (4-5 pages)
- Thursday 4/6 – Paper draft #3 due (entire paper)
- Monday 4/17 – Poster draft #1 due
- Thursday 4/27 and Monday 5/1– Poster draft #2 due and individual poster presentations
- Monday 5/1 – Posters must be printed by now!
- Wednesday 5/3 – Celebration of Student Achievement (presentation of poster to Department)
- Wednesday 5/10, 5:00 pm – Paper due (final version)

GENERAL POLICIES

Attendance, Lateness and Make-ups: Details on TCNJs College Attendance Policy can be found at: http://policies.tcnj.edu/policies/digest.php?docId=9134.

Academic integrity: You are expected to know the college's policy on academic integrity, which can be found at http://policies.tcnj.edu/policies/digest.php?docId=7642. While I encourage you to work with your classmates on assignments, anything you submit must represent your own work. Resources used must be carefully cited.

Students in need of accommodations: Students with documented needs for in-class accommodations should make me aware of this AS SOON AS POSSIBLE! All documented accommodations will be respected, as specified by the Americans with Disabilities Act Policy (http://policies.tcnj.edu/policies/digest.php?docId=8082).

STA498: Statistical Capstone
Course Syllabus

Textbook: Young and Smith, *Essentials of Statistical Inference*
Instructor: Professor Michael Ochs
        Office: P246 Phone: 609-771-2189
        Email (preferred): ochsm@tcnj.edu
Office Hours: W: 10:00 - 11:00 AM, Th 1:00 - 2:00 PM, and Additional Hours as Requested

Course Description: This course will review statistical inference that students have previously learned using formal nomenclature and introduce students to perhaps previously unseen core methods in inference. Methods will include Maximum Likelihood Theory, Decision Theory, Bayesian Inference, and Bootstrapping. All methods will first be addressed theoretically, and then students will use SAS and R to perform calculations. A final project in the form of a research paper will be the main outcome.

Course Philosophy: Our world has become data full, to the point of bursting in many domains. The recovery of knowledge from data has been the focus of statistical study since the early days of the scientific revolution, demonstrated by the works of Hume, Kant, Bayes, and Laplace. Thanks to computers and user-friendly programs, it has become trivially simple to apply many statistical methods to data. However, proper application of these methods requires an understanding of the mathematical assumptions underlying the methods and knowledge of the available methods. This course will provide an initial introduction to these areas.

Students in this class will have been well trained in standard statistical methods and theory, so this class will formalize previous work, such as hypothesis testing and maximum likelihood estimation, and introduce new areas, such as decision theory. Students are expected to complete a project with a expert statistical analysis and present this project in a formal paper and in a poster.

Evaluation: Evaluation will be based partly on in-class presentations and problem solving (30%), which will be done in four core groups, with responsibilities of group members rotating with each presentation. Groups will present once every two weeks, and it is expected that group members will meet outside of class prior to their presentation to plan out all aspects of their presentation, which will include presentation of theory in powerpoint

slides and chalkboard work, presenting a sample problem to the class, leading the class in solving one of the problems from the book, and summarizing the pitfalls that students could have or did fall into in approaching the problem.

The final paper and poster presentation will account for 50% of the grade, with an additional 20% assigned to the intermediate final project stages (I - IV), due according to the schedule:

I - Project Selection Due	17-Feb
II - Data Summary Due	10-Mar
III - Introduction Due	31-Mar
IV - Analysis Draft Due	18-Apr
V - Final Paper Due	5-May

THERE ARE NO EXTENSIONS.   ALL DEADLINES ARE FINAL.

Schedule

Date	Topic	Chapter	Project	Date	Topic	Chapter	Project
24-Jan	Introduction and Planning			17-Mar	SPRING BREAK		
27-Jan	Notation	1		21-Mar	Refresher for Chapters 1 - 9		
31-Jan	Decision Rules	2.1 - 2.4		24-Mar	Likelihood Parameterization	9.1 - 9.4	
3-Feb	Finite Decision Rules	2.5 - 2.7		28-Mar	Likelihood Expansions	9.5 - 9.7	
7-Feb	Bayesian Methods	3.1 - 3.3		31-Mar	p* and Modifications	9.8 - 9.12	III - Int
10-Feb	Shrinkage and Empirical Bayes	3.4 - 3.6		4-Apr	Predictive Inference	10	
14-Feb	Computational Approaches	3.7 - 3.9		7-Apr	The Bootstrap	11	
17-Feb	Hypothesis Testing	4	I - Sel	11-Apr	SAS and R I		
21-Feb	Special Models	5		14-Apr	SAS II		
24-Feb	Sufficiency and Completeness	6		18-Apr	R II		IV - Ana
28-Feb	Conditional Inference	7		21-Apr	SAS III		
3-Mar	Maximum Likelihood Theory	8.1 - 8.3		25-Apr	R III		
7-Mar	Asymptotics and Likelihood Ratios	8.4 - 8.6		28-Apr	SAS IV		
10-Mar	NO CLASS		II - Sum	2-May	R IV		
14-Mar	SPRING BREAK			5-May	Coffee and Pastry		V - Due

Classroom Policies

In this class, the deep learning outcomes associated with TCNJ's 4th hour are accomplished by a series of rigorous educational assignments that extend beyond the typical scheduled class time. These include developing the ability to present topics to fellow students and to lead fellow students in problem solving. This also includes significant work outside of the classroom in small groups to prepare presentations throughout the semester.

Attendance: All students are expected to attend all classes and are responsible for all information provided. A student who is absent for a test will not be permitted to make up the test unless prior arrangements with the instructor have been made. Approval for missing a test will only be permitted in exceptional circumstances. In the case of illness, a doctor's note will be required. Please view TCNJ's attendance policy at http://policies.tcnj.edu/policies/digest.php?docId=9134

Academic Honesty: Please make sure you are familiar with TCNJ's academic integrity policy. Any suspected violation of this policy will be confronted in the strict accordance with the policy:
http://policies.tcnj.edu/policies/digest.php?docId=7642

Americans with Disability Act Policy:
http://policies.tcnj.edu/policies/digest.php?docId=8082

Final Exam-Evaluation-Reading Days Policy:
http://policies.tcnj.edu/policies/digest.php?docId=9136