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Re: Revision of the Statistics MS and PhD Programs

October 9, 2023

Dear Colleagues and Panel Members,

On behalf of the Department of Statistics, I am pleased to put forward our proposals to revise the Masters of Science (MS) in Statistics and Doctor of Philosophy (PhD) in Statistics degrees. As described in more detail in the proposals themselves, these revisions respond to changes in the field and feedback from a variety of sources. We believe that the changes will improve the experience and training for many of our students. The proposed revisions for the MS and PhD programs are closely intertwined, since under the current curriculum, the first year courses for these programs are nearly identical.

In addition, the department is a key partner in the Interdisciplinary PhD in Biostatistics. Again, the first year courses in the current curriculum for this program are nearly identical to the statistics MS and PhD programs. Our faculty have been communicating our proposed course changes with the faculty of the Interdisciplinary PhD in Biostatistics. This faculty has shared with us their proposed curriculum that responds to our course changes, and we include this document for context. We also include a letter of concurrence from the chair of the Division of Biostatistics, which is the other major partner in the program.

We hope that you agree that our revisions to the Statistics MS and PhD programs will better serve our students, the Department of Statistics, and the university.

Sincerely,

Eloise E. Kaizar
Professor and Chair
Department of Statistics

Response to ASCC Natural and Mathematical Sciences Subcommittee Feedback for Proposals

1. Statistics MS

    a. The Subcommittee asks the department to verify the wording in the proposal regarding the MS non-thesis as a steppingstone to the PhD program. The current wording gives the impression that the department is excluding MS thesis students from the PhD. If the department does not mean to imply this, the Subcommittee advises them to open the statement up by saying that the MS program can be a steppingstone to the PhD or to include the means by which MS thesis students can qualify for the program (if the requirements for them are meant to be different from the non-thesis students). [Proposal pg. 6]

    Following the suggestion, we changed the sentence from "The Non-thesis route may serve as a steppingstone to the Ph.D. degree if later admitted to the Ph.D. program." to "The Non-thesis route may better serve as a steppingstone to the Ph.D. degree if later admitted to the Ph.D. program." The non-thesis route (passing the MS exam) is clearly better than the thesis route for those MS students who may continue to the PhD program, and that is consistent with how we advise MS students. It is because PhD students in our program are required to pass the MS exam at a high level as their first qualifying exam, and the second qualifying exam can be attempted only after the first qualifying exam has been passed. For this reason, while we do not exclude MS thesis students from the PhD, the thesis route will take much longer for students to fulfill the requirements for the PhD program. As an additional piece of information, most of our MS students take the non-thesis option, and with proper advising, to this date, there hasn't been a single MS thesis student who went on to the PhD program.

    b. The Subcommittee would like the department to describe how, if at all, they are working with the Graduate School to address the conflict of the timing of the MS exam and student enrollment requirements given that Spring semester ends in April and the exam is in May.

    c. The Subcommittee is concerned that the exam is not in concurrence with the Graduate School's definition of a master's exam and asks if the Graduate School has approved the details of the MS exam for the department. See section 6.2 of the Graduate School handbook https://gradsch.osu.edu/all/graduate-school-handbook-gsh#section6.2.

Comments b and c are about the timing of the MS exam in our department. As stated in the proposal p.2, the MS program in statistics is designed to serve students who obtain an MS degree en route to a PhD in statistics or biostatistics as well as those who complete their education at the master's level. Because of this dual purpose, the coursework for the first year of the MS program and PhD program are identical, and the MS exam is designed to assess students' mastery of the core courses in the first year. The exam is scheduled for May following their first year, with a second chance in August if needed. This timing is *critical* for guiding both MS and PhD students in selecting their second-year courses based on their MS exam results. This MS exam arrangement was formally approved by the Graduate School during the semester conversion. With the Subcommittee's request, we sought confirmation from the Graduate School that the Graduate School supports the current exam arrangement for the MS program, which has proven to be successful for many years since semester conversion. The Associate Dean Maria Miriti immediately responded to our request positively as in the attached letter.

2. Statistics PhD

   a. **Contingency**: The Subcommittee asks that the department retitle the MS exam, perhaps describing it as an exam similar in nature to an MS exam without using that title, so that the Graduate School's master's examination rules do not prevent the department from enacting the exam as spelled out in the proposal. See section 6.2 of the Graduate School handbook https://gradsch.osu.edu/all/graduate-school-handbook-gsh#section6.2.

      The Subcommittee's initial concern was from the timing of our current MS exam being in the summer term after the first-year coursework rather than in the final term when the student plans to graduate according to the Graduate School Handbook. As in our response to the Subcommittee's feedback on Statistics MS program revision proposal, the specific timing of the exam was proposed to guide both PhD and MS students more effectively during the semester conversion. This exam arrangement was formally approved by the Graduate School at the time and reconfirmed recently. Given the Graduate School's reapproval and the Subcommittee's recent approval of our MS program revision proposal, we trust that retitling of the MS exam is no longer a contingency.

   b. **Contingency**: The Subcommittee asks that the department submit a request in curriculum.osu.edu to withdraw the course STAT 7303, as this course is no longer offered per the new requirements for the program and currently there are two courses on the books (STAT 7303 and 7302) with the same title. [Proposal pg. 4]

      We have submitted a request to withdraw STAT 7303 (effective from Autumn 2025).

   c. *Recommendation*: The Subcommittee recommends referring to freshman and sophomore status as 1st and 2nd year. [Proposal pgs. 5-6]

      We have made the recommended change in the revised proposal.

   d. *Recommendation*: The Subcommittee recommends that the department reach out to the Graduate School concerning the policies surrounding the scheduling of placement exams prior to the start of the semester/student arrival and how this might impact students (e.g., finances, living arrangements, visa status). In the scenario that the exam cannot be scheduled prior to the start of the semester, the Subcommittee notes that the exam can likely be done in the first two days of the semester without impeding students' course enrollment. [Proposal pgs. 5-6]

      Over the past three years, our MS/Q1 exams have been scheduled for August 16-17, 17-18, and 18-19, respectively, while the GTA appointments have always started on August 16. Consequently, the MS/Q1 exam has consistently occurred after the GTA appointment date, imposing no additional travel date constraints on our students. Most of our incoming PhD students come to our program with either GTA appointment or fellowship. Furthermore, international students are mandated to attend one of the OIA's in-person orientation sessions before the Autumn semester begins. For example, this year the two sessions were held on August 7-11 and August 14-18. As a result, many international students typically arrive at least one week before the semester begins, regardless of whether they are taking the MS/Q1 exam or not.

e. *Recommendation*: The Subcommittee recommends that the department include the timing of the exams (e.g., 2nd year spring semester or following year 2) on the sample tracks in the proposal. [Proposal pgs. 8-9]

   We have added the timing of the exams on sample programs in the proposal (see Proposal pgs. 8-9) as recommended.

3. Biostatistics PhD

   a. **Contingency**: The Subcommittee asks that the department include courses PUBHEPI 6410 and 6010 in the sample program since they are required courses for the program. The Subcommittee notes that this was likely a simple oversight, but it makes the sample program look incomplete.

      We have added the two courses in the sample program (see Proposal pg. 11).

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Statistics PhD Program Revision

Background

The Department of Statistics proposes a curricular revision to the PhD program with the desired implementation term of Fall 2024. The last major changes to the PhD program in statistics were made during the semester conversion in 2011-2012, and some minor changes have been made to the program since then as summarized in Section C in the Appendix. With multiple years of offering of the program and feedback from students and faculty over the years (e.g., external review in Spring 2022), we believe that the time is ripe for revision of the program. During the academic year 2020-2021, the statistics faculty considered various curricular revisions and voted to adopt the proposed curriculum framework that provides students with a wider range of pathways depending on their educational background. During the fall semester of 2022, we developed new courses and revised some of the core courses for revision of the PhD program.

Rationale

The main impetus for the proposed revision is twofold.
i) Our program has been successful in recruiting students with diverse backgrounds and mathematical and statistical knowledge. While we view this diversity of the student body as our strength, the current program lacks flexibility in steering them toward different pathways to achieve the learning goals of the statistics PhD program (see Section A in the Appendix for the learning goals). For example, a sizable number of our students now enter the PhD program with a master's degree from an R1 university, and they would likely find the first-year coursework in the current curriculum to be repetitive. Under the revised program, they can take an accelerated pathway with increased opportunities for an early start in research. By contrast, those students with a limited exposure to rigorous statistical courses prior to the program are steered to a standard pathway, and we are adding a new mathematical support course during the first year that can help students with a more limited mathematical background succeed in our program. Similar to the current curriculum, the revised program partially overlaps with the MS program, and the standard pathway consists of full first year sequences in statistical theory and application followed by the second-year sequences in advanced probability, statistical theory, modeling, and computation.

ii) In addition to providing a range of pathways for a customized experience in the program, the proposed revision aims to modernize the current curriculum and refocus the content of some of the core courses to broaden the foundation beyond statistical theory. The revised program puts an increased emphasis on high-level applications, computation, and modeling of complex data. This change aligns well with the expectation of broader roles that statistics and data science play in data-driven decision making and problem solving, and this would make our curriculum more forward looking and relevant to contemporary applications.

Outline of the Proposed Changes

Course changes

Revisions to the PhD curriculum include changes to the following 8 courses, among which three are new courses and five are revisions of the existing courses.

- 6111 (3 credits) & 6112 (3 credits): a new sequence for reviewing and introducing mathematical foundations necessary for the coursework in PhD and MS programs. This sequence with 6 credits total will replace MATH 4545 (4 credits) and STAT 6860 (2 credits).
- 6910 (4 credits) & 6950 (4 credits): resequencing of 6910 and 6950 changing their order.
- 7301 (3 credits): reduce redundancy with 6802 (first-year theory course) and introduce topics in high dimensional estimation which are relevant to contemporary applications.
- 7302 (3 credits): add more computational and modeling elements of Bayesian analysis to 7303 since 6570 (2 credits) Applied Bayesian Analysis is no longer required for the PhD program. The change will better prepare students for research in Bayesian analysis.
- 7410 (3 credits): refocus course content to cover more applied statistical modeling techniques.
- 7541 (3 credits): a new course on stochastic processes with more emphasis on applications and simulation replacing 7540 (Theory of Stochastic Processes)

See the table below for comparison between the proposed and current curricula in math prerequisites and core required courses.

Math Prerequisite

Current			**Proposed**			
Code	Credits	Title	Code	Credits	Title	Notes
MATH 4545	4	Analysis Overview				Removed
			6111	3	Foundations of Statistical Theory I	New course*
			6112	3	Foundations of Statistical Theory II	New course*

*6111-6112 replace Math 4545 and STAT 6860

Core Required Courses

Current			**Proposed**			
Code	Credits	Title	Code	Credits	Title	Notes
6570	2	Applied Bayesian Analysis	6570[F]	2		Changed to elective

6750	2	Statistical Consulting and Collaboration	6750	2		
6801	4	Statistical Theory I	6801[F]	4		
6802	4	Statistical Theory II	6802[F]	4		
6860	2	Foundations of the Linear Model				Removed*
6910	4	Applied Statistics I	6910[F]	4	Applied Statistics II	Resequenced and revised
6950	4	Applied Statistics II	6950[F]	4	Applied Statistics I	Resequenced and revised
7201	3	Theory of Probability	7201[S]	3		
7301	3	Advanced Statistical Theory I	7301[S]	3	Advanced Statistical Theory	Revised
7303	3	Bayesian Analysis and Decision Theory	7302[S]	3	Bayesian Analysis and Decision Theory	Revised and renumbered
7410	3	Theory of the Linear Model	7410[S]	3	Linear Models	Revised
7540	3	Theory of Stochastic Processes	7540	3		Changed to elective
			7541[S]	3	Advanced Stochastic Processes	New course replacing 7540
7730	3	Advanced Computational Statistics	7730[S]	3		

[F] First year courses

[S] Second year courses

The percent change of the revision:
The proposed program revision adds 6111 (3 cr), 6112 (3 cr), and 7541 (3 cr) as new courses although they can be viewed as replacements of the existing courses covering similar course contents. The rest of the revised courses (6910, 6950, 7301, 7302 and 7410) have about 15% of change on average in the course content (5-25% change depending on the course). In addition, 6570 (2 cr) is removed from the PhD requirements. This leads to a change of 13.55 (=11 + 17*0.15) credits total out of 80 credits representing 16.94% of change to the program.

Customized tracks

The revised program allows an individualized pathway to achieve the learning goals of the PhD program depending on the student's educational background.

- Standard track:
  This is a typical pathway designed for students matriculating in the program without master-level statistical knowledge. The curriculum for this track is a redesign of the current program with two years of coursework in statistical theory, application, modeling, and computing. Students in this track take the PhD qualifying exam after passing the second-year courses. See Sample Program A in the program guide for more information.
- Accelerated track:
  This is a new track designed for students matriculating with master-level statistical knowledge and advanced mathematical background. The curriculum for this track consists of the second-year advanced courses. Students in this track take the PhD qualifying exam after one year of required coursework. See Sample Program B in the program guide.
- Personalized tracks:
  Depending on the educational background and skills, students may take a mix of first year and second-year courses in their first year. For example, most students on the standard track will take the mathematical foundations courses (6111 & 6112), but a student with a strong mathematical background but limited statistical knowledge might not take these courses and take electives instead. A student coming in with excellent applied training might skip the first-year applied sequence (6910 & 6950) and start the second-year applied sequence instead (7410 & 7541).

See Section B in Appendix for sample programs.

Placement test and qualifying exams

To decide the individual pathway, every student entering the program will be informed of the option to be placed in the second-year courses in their first year if they demonstrate mastery of the first-year course contents. For this assessment, we will use the MS exam. Students in the current PhD program are required to pass a first qualifying (Q1) exam after the first-year coursework, and strongly recommended to take an MS exam with similar content and offered on the previous day. Passing the MS exam is required for the Statistics MS degree. The Q1 exam has previously been used as an instrument for screening students for the PhD program. The second offering of the MS and Q1 exams is currently in August every year right before the fall semester begins, and incoming students in the revised program who wish to skip the first-year coursework will take this offering. In the past, a few students with strong background were given this option at the discretion of the Graduate Studies Chair on a case-by-case basis, and such cases led to successful outcomes invariably. In the revised program, we plan to use the MS exam for this purpose and formalize this process more widely by providing information on the

MS exam and study materials in advance to incoming students so that they understand the level of knowledge expected to pass the MS exam and make their own assessment of whether they are ready to begin the second-year coursework. In addition, to assess whether students meet mathematics prerequisites (currently at the level of MATH 4545 and STAT 6860) for the PhD program and to identify students who would benefit from the new mathematical foundation sequence (6111-6112), we plan to have a placement test separately from the MS exam in August. This math placement test will be required for every incoming student while the MS exam for skipping the first-year coursework is optional.

Change in the learning goals and assessment plan

We reviewed the current learning goals and revised wordings of some goals that are assessed based on the candidacy exam and the dissertation. This change is to better reflect the diverse research topics that our PhD students work on for their dissertations and different contributions to the field of statistics, ranging from theory, to methodology, to computational methods, to applications. These learning goals will be assessed using the PhD qualifying exam, candidacy exam and dissertation including the oral defense. Our assessment plan largely remains the same. See the description of our plan in Section D of the Appendix.

Impacts on the MS Program and Biostatistics PhD Program

The proposed course changes in the PhD program will affect those courses in the MS program shared with the PhD program. See the MS program revision proposal for the changes to the MS program.

The Interdisciplinary PhD program in Biostatistics is largely a collaboration between the Department of Statistics and the Division of Biostatistics in the College of Public Health. The first two years of coursework in the Biostatistics PhD program are similar to those in the Statistics PhD program. The same course changes will apply to courses shared by the Biostatistics PhD program. See the Biostatistics PhD program revision proposal for the corresponding changes to that program.

Transition Plan

We will enact this program change for students entering the program in the academic year 2024-2025. Students who matriculate in 2024 and wish to pursue the standard track will be able to do so according to the revised curriculum. Students who matriculate in 2024 and wish to pursue the accelerated track may seek approval to do so from the Graduate Studies Chair. Upon approval, these students may skip the first-year courses and directly begin the unrevised versions of the second-year courses (7301, 7303, 7410) and the more theoretical version of the stochastic processes course (7540 rather than the new 7541). Students who matriculated prior to Autumn 2024 will continue with the current program and will not be impacted by this redesign either in terms of progress towards their degree or their expected date of graduation.

We do not anticipate any students will have taken only part of the applied statistics sequence (STAT 6910/6950) and thus be ‘out of sequence’ due to the course sequence change starting in Autumn 2024. In the unlikely event that this would occur, the Graduate Studies Chair will work individually with the student and appropriate instructors. We expect that STAT 6570 will be offered every year for the foreseeable future, since this is a required course for the Master of Applied Statistics.

Appendix

A. Learning Goals

A student graduating with a Ph.D. in Statistics should meet the following learning goals:

1. Understand, at an advanced level, the theory that underlies statistical methods.
2. Formulate and evaluate statistical models and implement them for analyzing data relevant to subject-matter research studies.
3. Conduct thorough literature reviews to summarize and evaluate the state of statistical science in specialized research areas.
4. Develop new statistical theory, statistical methodology, and/or computational methods when existing methods are not appropriate or can be improved upon, or expand knowledge of existing methods.
5. Communicate effectively the role of statistical theory, statistical methodology, and/or computational methods in data analysis to professional and lay audiences.

B. Sample Programs

Below are some sample programs (first three years) for the new PhD program: our standard track, our accelerated track, and one example of a personalized track. The standard track and accelerated track are included in the program guide for students; personalized tracks will be developed as needed for particular students.

Sample program (standard track):

First Year (22)	**Autumn**	**Spring**
	6801 (4)	6802 (4)
	6950 (4)	6910 (4)
	6111 (3)	6112 (3)
MS Exam	After Year 1	
Second Year (21)	**Autumn**	**Spring**
	7201 (3)	7302 (3)
	7301 (3)	7541 (3)
	7410 (3)	7730 (3)
	8895 (1)	8010 (1)
		8895 (1)
PhD Qualifier	After Year 2	
Third Year (14-19)	**Autumn**	**Spring**
(select advisor)	6750 (2)	8895 (1)
	8895 (1)	Elective
	Elective	Elective
	Elective	Elective

Sample program (accelerated track, assuming previous Master's Degree)

	MS Exam in August before Year 1	
First Year (21)	**Autumn**	**Spring**
	7201 (3)	7302 (3)
	7301 (3)	7541 (3)
	7410 (3)	7730 (3)
	8895 (1)	8010 (1)
		8895 (1)
PhD Qualifier	After Year 1	
Second Year (14-19)	**Autumn**	**Spring**
(select advisor)	6750 (2)	8895 (1)
	8895 (1)	Elective
	Elective	Elective
	Elective	Elective
Third Year (11)	**Autumn**	**Spring**
	8998 (7)	8895 (1)
	8895 (1)	8999 (2)

Sample program (personalized track, assuming a student coming from an undergraduate program, with a very strong math background but no previous statistics training):

First Year (22)	**Autumn**	**Spring**
	6801 (4)	6802 (4)
	6950 (4)	6910 (4)
	Elective	Elective
MS Exam	After Year 1	
Second Year (21)	**Autumn**	**Spring**
	7201 (3)	7302 (3)
	7301 (3)	7541 (3)
	7410 (3)	7730 (3)
	8895 (1)	8010 (1)
		8895 (1)
PhD Qualifier	After Year 2	
Third Year (14-17)	**Autumn**	**Spring**
(select advisor)	6750 (2)	8895 (1)
	8895 (1)	8998 (4)
	Elective	Elective
	Elective	

C. Changes in the Current PhD Curriculum since Semester Conversion (2011)

See (p. 7) [the PhD curriculum]() approved at the semester conversion (2011) for comparison.

Math Prerequisite

2011			**Current**		
Code	Credits	Title	Code	Credits	Notes
MATH 4545	4	Analysis Overview	MATH 4545	4	

Core Required Courses

2011			**Current**		
Code	Credits	Title	Code	Credits	Notes
6570	2	Applied Bayesian Analysis	6570	2	
6801	4	Statistical Theory I	6801	4	
6802	4	Statistical Theory II	6802	4	
6860	2	Foundations of the Linear Model	6860	2	
6910	4	Applied Statistics I	6910	4	
6950	4	Applied Statistics II	6950	4	
7201	3	Theory of Probability	7201	3	
7301	3	Advanced Statistical Theory I	7301	3	
7302	3	Advanced Statistical Theory II			Removed from requirement since 2020
7303	3	Bayesian Analysis and Decision Theory	7303	3	
7410	3	Theory of the Linear Model	7410	3	
7540	3	Theory of Stochastic Processes	7540	3	
7730	3	Advanced Computational Statistics	7730	3	
8410	3	Capstone Applications			Removed from requirement, Autumn 2015
8750.xx*	1	Research Group			Counted as elective Autumn 2015. No longer required.
8750.xx*	1	Research Group			Counted as elective Autumn 2015. No longer required.

* The decimal values for 8750.xx must be different.

Pick one of the following:

2011			Current		
Code	Credits	Title	Code	Credits	Notes
6750	2	Statistical Consulting and Collaboration	6750	2	
7755	2	Biostatistical Collaboration	7755* (PUBHBIO 7245)	2	Typically taken by students pursuing a PhD in Biostatistics, but allowing this option gives flexibility.

* This course stopped being cross-listed in May 2022.

Elective Courses

2011: At least 9 credits of letter-graded Statistics at the 6000-level or higher, of which at least **6** credits must be at the 7000-level or higher

Current: At least 9 credits of letter-graded Statistics at the 6000-level or higher, of which at least **4** credits must be at the 7000-level or higher

In addition, some restriction was introduced (Spring 2018) in counting credit hours of elective courses covering similar topics to ensure that students acquire a broad background in many areas of Statistics.

Research-Related Courses

2011			Current		
Code	Credits	Title	Code	Credits	Notes
8010	1	Research Topics Seminar	8010	1	Enroll in spring of 2nd year [See note below]
8895	1	Statistics Seminar	8895	1	Enroll after passing QI before candidacy [See note below]
8998	*	Dissertation Research	8998	*	Pre-candidacy
8999	*	Dissertation Research	8999	*	Post-candidacy (3 credits)

*Credit hours vary.

Rationale and timeline for minor changes to the program since semester conversion

In Spring 2015, faculty met to discuss changes to the second and third year of the Statistics PhD program. The worry was that students were taking too many courses before starting research. The two offerings of STAT 8750.xx (1) became electives instead of being required, and STAT 8410 (3) was dropped from the curriculum. Elective hours increased from 9 to 11 credit hours. The following text was also added to the program guide around this date: "Second-year PhD students are also expected to enroll in STAT 8010 (1 hour, Seminar on Research Topics in Statistics), although this course does not count toward the core or elective requirements." These changes came into operation in Autumn 2015.

At some point between Spring 2016 and Autumn 2017, the following text was added to the program guide as regards the Statistics PhD program: "After passing the QI exam, all students are expected to attend the colloquium on a regular basis. Additionally, such students who have not yet passed the candidacy exam are expected to enroll in STAT 8895 each autumn and spring semester." This was to encourage students to attend colloquium to learn about what other research is being carried out in the field of Statistics. This was discussed in a faculty meeting.

In Spring 2018 we met several times in the departmental curriculum committee and in faculty meetings to discuss electives. To acquire a broad background in many areas of Statistics, we voted to pair up courses that were similar – students could only pick one course from each set; e.g. STAT 6500 and STAT 7620; STAT 6530 and STAT 8530.

In Spring 2020, we dropped STAT 7302 (3) from the curriculum immediately. Key points in the faculty discussion in favor of this change included the desire to reduce the number of required courses for our students; the lack of relevance of some of the development/material; the material not matching our faculty/program goals. We also moved STAT 7730 from an autumn to a spring offering at this time. The elective hours increased to 14 hours with this change.

In Autumn 2021, faculty were concerned that the elective hours were too high. To increase the ability for students to work on their Ph.D. research, we reduced the elective hours to 9 hours; at least 4 credit hours must be 7000 level and above.

D. Supplementary Documents

- Current Program Guide (See p. 6 of the Program Guide to Graduate Studies in Statistics)
- Revised Program Guide
- Plan of Study Form (revised version)
- Assessment Plans (both current and revised versions)
- Concurrence letter from Biostatistics
- Syllabi of new and revised courses

PHD IN STATISTICS PROGRAM

The core of the Ph.D. program consists of course work in mathematical statistics, applied statistics, and computational methods. Students also engage in statistical research, and complete and defend a dissertation. The Ph.D. program in statistics presupposes a mathematical background which includes linear algebra and advanced calculus. The typical time to degree is five years.

Course Requirements (80 credit hours)

Mathematics		Program coursework requires Advanced Calculus, Linear Algebra, and Real Analysis. Stat 6111 and Stat 6112 are recommended; previous coursework or courses in the Math department could also be used to meet this requirement.
Core (36 hours)	6801 (4), 6802 (4)	Statistical Theory I & II
	6950 (4), 6910 (4)	Applied Statistics I & II
	7201 (3)	Theory of Probability
	7301 (3)	Advanced Statistical Theory
	7302 (3)	Bayesian Analysis and Decision Theory
	7410 (3)	Linear Models
	7541 (3)	Advanced Stochastic Processes
	7730 (3)	Advanced Computational Statistics
	6750 (2)	Statistical Consulting and Collaboration
Electives* (12 hours)		At least 12 credits of letter-graded Statistics at the 6000-level or higher, of which at least 4 credits must be at the 7000-level or higher
Research Topics Seminar	8010 (1)	Students are to enroll in Statistics 8010 in the spring semester of their second year.
Statistics Seminar	8895 (1)	After passing their first year, all students are expected to attend the colloquium on a regular basis. Additionally, such students who have not yet passed the candidacy exam are expected to enroll in STAT 8895 each autumn and spring semester.
Dissertation Research	8999 (3)	After passing the candidacy exam, students are required to enroll in 3 credit hours each autumn and spring semester. Students typically fulfill this requirement by enrolling in 8999 with their advisor.

1. Course Grades – All courses used towards the degree requirements must be taken and passed with a grade

of B- or above in a letter-graded course and with a grade of S in a S/U course. Note that all graduate students are required to maintain a cumulative GPA of at least 3.0 both overall and in their statistics courses in order to remain in good standing.

2. Exams – The student must pass all examinations as described below.

3. Credit Hours – The student must satisfy university rules on residency and total credit hours. A minimum of 80 credit hours is required, which typically includes a considerable number of hours of STAT 8998 and STAT 8999 (Ph.D. Research). A minimum of 50 credit hours is required for students with a master's degree. If a student gets approval to skip courses (e.g., if a student skips the first year courses and begins in the second year), they must still meet these credit hour requirements; the difference may be made up through reading courses or electives (or a combination).

Students in the Ph.D. program are subject to the policies set forth by the Graduate School. See the Graduate School Handbook for details.

Sample Ph.D. in Statistics Course Program

Two sample programs (for students on the standard track and for students coming in with advanced background at the Master's level) are presented below. Personalized tracks may also be developed with the vice chair for graduate studies.

(Courses are typically only offered in the terms in which they are listed in the sample program below. Individual electives are not offered on a regular basis. See Buckeyelink for details on previous/current offerings and enrollment requirements, including prerequisites. Note that offerings are subject to change. Refer to the Courses page on our department website for additional information.)

Sample program (standard track):

First Year (22)	**Autumn**	**Spring**
	6801 (4)	6802 (4)
	6950 (4)	6910 (4)
	6111 (3)	6112 (3)
Second Year (21)	**Autumn**	**Spring**
	7201 (3)	7302 (3)
	7301 (3)	7541 (3)
	7410 (3)	7730 (3)
	8895 (1)	8010 (1)
		8895 (1)
Third Year (14-19)	**Autumn**	**Spring**
(select advisor)	6750 (2)	8895 (1)
	8895 (1)	Elective
	Elective	Elective
	Elective	Elective
Fourth Year* (12-17)	**Autumn**	**Spring**
	8998 (8-13)	8895 (1)

	Autumn	Spring
	8895 (1)	8999 (2)
Fifth Year (6)	**Autumn**	**Spring**
	8895 (1)	8895 (1)
	8999 (2)	8999 (2)

* Assuming student takes candidacy exam at the end of Autumn of their Fourth Year

Sample program (accelerated track, assuming previous Master's Degree)

First Year (21)	**Autumn**	**Spring**
	7201 (3)	7302 (3)
	7301 (3)	7541 (3)
	7410 (3)	7730 (3)
	8895 (1)	8010 (1)
		8895 (1)
Second Year (14-19)	**Autumn**	**Spring**
(select advisor)	6750 (2)	8895 (1)
	8895 (1)	Elective
	Elective	Elective
	Elective	Elective
Third Year* (11)	**Autumn**	**Spring**
	8998 (7)	8895 (1)
	8895 (1)	8999 (2)
Fourth Year (6)	**Autumn**	**Spring**
	8895 (1)	8895 (1)
	8999 (2)	8999 (2)

* Assuming student takes candidacy exam at the end of Autumn of their Third Year

Notes on the Elective Requirement:

Excludes STAT 6030, 6040, 6111, 6112, 6193, 6194, 6201, 6301, 6302, 6410, 6450, 6540, 6740, 6750, 7193, 7194, 7998, 7999, 8010, 8193, 8194, 8891, 8895, 8998 and 8999.

To ensure that students acquire a broad background in many areas of Statistics, at most one course from each of the following pairs of courses can be counted towards the 12-credit hour elective requirement:

6500; 7620
6530; 8530
6550; 7550
6560; 7560
6605; 7605
6610; 7610
6650; 7430

Students may, with approval of the Graduate Studies Committee, use up to two courses (up to 6 hours) from other departments as electives. These courses must be approved by the Graduate Studies Committee, must have appropriate content for a statistics degree, and must not duplicate the material covered in any course available from the Department of Statistics.

If a course is taken from another department and the course is cross-listed in statistics as an appropriate elective, the course may be applied towards elective requirements without special approval of the Graduate Studies Committee. The course will be counted at the level of the cross-listed statistics course (ex: PUBHBIO 7215 cross-listed as STAT 6615 counts as a 6000 level elective).

STAT 8410 and up to four hours of STAT 8750.xx may be counted toward the degree requirements as electives.

Examinations and Progress

Note on all exams: Students are expected to take exams on the usual schedule as they complete course work in order for funding (if applicable) to continue. None of these examinations may be taken more than twice. See the Graduate School website for details on examination requirements.

Math Placement Exam: This online examination should be taken in the summer before the first year. It is a self-paced exam that will lead to a recommendation about what courses to take to meet the Mathematics requirement.

M.S. Exam: This written examination covers material from the first year of course work (i.e., 6801, 6802, 6950, 6910). The exam is offered in May and a second offering is given in August if at least one student who failed the first offering wishes to retake the exam. Students who take these courses in their first year are expected to take the exam in May, and are also expected to request and take the subsequent August offering in the event of a failure on the May exam, as part of maintaining reasonable progress toward their degree. *Students who enter the program with more advanced training and wish to skip the first year of coursework (i.e., pursue the accelerated track) should take this exam at the start of their first year. Note: In general this exam may only be taken twice; however, if a student chooses to attempt the exam before their first year in order to place into the second year of courses, they may petition to take the exam a third time in the event that they fail their initial attempt and also the attempt in May of their first year.*

Ph.D. Qualifier: This is a comprehensive written examination testing knowledge acquired in the first two years of study and the ability to integrate and apply such knowledge. The exam will cover material from the first two years of course work in the standard track and may not be attempted until the M.S. Exam has been passed at a high level. It is offered in August and a second offering is given in January if at least two students who failed the first offering wish to retake the exam. To remain in the Ph.D. program, all standard track second year Ph.D. students are expected to take the August offering of the Ph.D. Qualifier Exam immediately following their second year and are also expected to request and take the next possible subsequent offering in the event of a failure on the August exam. To remain in the Ph.D. program, all accelerated track second year Ph.D. students are expected to take the August offering of the Ph.D. Qualifier Exam immediately following their first year and are also expected to request and take the next possible subsequent offering in the event of a failure on the August exam.

Candidacy Exam: After passing the Ph.D. Qualifier, the student chooses a dissertation advisor, who must be a Category P graduate faculty member in statistics. (Prior to passing the Ph.D. Qualifier, the Graduate Studies Chair serves as the advisor). The advisor should be chosen within one year of passing the Ph.D. Qualifier. After the dissertation advisor is chosen, the student also forms a Ph.D. Candidacy Examination Committee, consisting of at least four graduate faculty members from the statistics department or other departments consistent with the student's interests. This committee is responsible for approving a Plan of Study form to be filed with the Graduate Studies Committee prior to submitting the Application for Candidacy form.

After completion of all required courses (as specified by the student's Ph.D. Candidacy Examination Committee), the candidate's Ph.D. Candidacy Examination Committee will administer and grade a Ph.D.

Candidacy Examination. The candidacy examination should normally be completed by the end of the student's fourth year. The examination consists of two parts. A written portion covers material on some area in the statistical literature as agreed upon by the student and the Examination Committee. This portion will be administered within two years of the student's passing the Ph.D. Qualifier and will discuss open research topics in this area and possible research methodology for solving these problems. This portion will ordinarily be a dissertation proposal, but the student is not obliged to follow through with a dissertation in this area, and the examination need not be repeated if the dissertation topic is changed at a later date. After the Examination Committee accepts the written portion, they will administer a two-hour oral examination over this material. The student has two weeks to complete the written portion of the exam. The oral exam is scheduled at least two weeks after the due date for the written portion of the exam. The student must submit an Application for Candidacy form to the Graduate School via GRADFORMS.OSU.EDU and have the form approved at least two weeks before the proposed date of the oral portion of the candidacy exam.

Final Examination and Dissertation: After passing the Candidacy Exam, the student should form a Dissertation Committee. The dissertation committee is composed of the advisor who must be a Category P Graduate Faculty member in statistics and at least two other Graduate Faculty members. Once the student has made sufficient progress (as judged by the Ph.D. Dissertation Committee) on his/her Ph.D. dissertation to warrant holding the Final Oral Examination (dissertation defense), the student will submit the online Graduate School Application to Graduate form via GRADFORMS.OSU.EDU by the Graduate School deadline (see the Graduate School website for details) and schedule the Final Examination. Before a defense can be held, the student must submit a complete, word-processed dissertation draft to the dissertation committee and the Graduate School for review and approval or disapproval. See the Graduate School website for details on document preparation and format review requirements. The student must also submit the online Application for Final Examination form via GRADFORMS.OSU.EDU and have the form approved at least two weeks prior to the actual oral defense date. The Ph.D. Dissertation Committee then conducts a two-hour oral examination in which the candidate discusses/defends his/her dissertation. The dissertation document must be submitted and approved by the published Graduate School deadline. See the Graduate School website for details on final submission requirements.

DEPARTMENT OF
STATISTICS

THE OHIO STATE UNIVERSITY

PhD Plan of Study Form

Submit this form to the Graduate Studies Chair prior to submitting the Application for Candidacy form.

Student Name: ______________________________ **OSU. #**______________________________

Core Course Requirements (36 hours)

Fill in your grade for each course completed. For courses yet to be completed, indicate the term/year you plan to take the course. If you have received approval to substitute a course, cross off the required course and fill in the substituted course information and corresponding grade.

Course	Grade	Course	Grade	Course	Grade
6801 (4)	________	7201 (3)	________	7541 (3)	________
6802 (4)	________	7301 (3)	________	7730 (3)	________
6910 (4)	________	7302 (3)	________	6750 (2)	________
6950 (4)	________	7410 (3)	________		

Elective Course Requirements (at least 12 hours)*

Course	Course Title	Hours	Grade
____________	______________________________	______	______
____________	______________________________	______	______
____________	______________________________	______	______
____________	______________________________	______	______
____________	______________________________	______	______
____________	______________________________	______	______

Total Elective Hours ______

* Letter-graded STAT courses at the 6000-level or higher, of which at least 4 credits must be at the 7000-level or higher. Excludes Statistics 6030, 6040, 6060, 6111, 6112, 6193, 6194, 6201, 6301, 6302, 6410, 6450, 6540, 6740, 6750, 7193, 7194, 7998, 7999, 8010, 8193, 8194, 8891, 8895, 8998 and 8999. Students may, with approval of the Graduate Studies Committee, use two courses (up to 6 hours) from another department as an elective.

Qualifier Exam: Date: ________________ Result (circle): Pass Fail

Projected Date of Candidacy Exam: ______________ Projected Graduation (circle): SU AU SP 20___

The undersigned approve the listed program and agree to serve on the PhD Candidacy Exam Committee.

	Printed Name	Signature	Date
Advisor	______________________ /	______________________ /	__________
Committee Member	______________________ /	______________________ /	__________
Committee Member	______________________ /	______________________ /	__________
Committee Member	______________________ /	______________________ /	__________

FOR DEPARTMENT USE ONLY

All course requirements met: _____ Yes _____ No _____ Pending ______________________________

Approval: ______________________ ______________________ Date:______________
Print Sign

rev 3/2023

Current version

Assessment Plan for the Statistics Ph.D.

Learning Goals for the Statistics Ph.D.: A student graduating with a Ph.D. in Statistics should meet the following learning goals:

1. Understand, at an advanced level, the theory that underlies statistical methods.
2. Formulate and evaluate statistical models and implement them for analyzing data relevant to subject-matter research studies.
3. Conduct thorough literature reviews to summarize and evaluate the state of statistical science in specialized research areas.
4. Develop new statistical theory, statistical methodology, and/or computational methods when existing methods are not appropriate or can be improved upon, or expand knowledge of existing methods.
5. Communicate effectively the role of statistical theory, statistical methodology, and/or computational methods in data analysis to professional and lay audiences.

Assessment of Learning Goal 1: Understand, at an advanced level, the theory that underlies statistical methods.

The following *learning outcomes* are associated with Learning Goal 1:

a. Understanding of the advanced theory of statistical inference and estimation [including STAT 7301, 7302, and their prerequisites]
b. Understanding of advanced probability theory and stochastic models [including STAT 7201 and 7541, and their prerequisites]
c. Understanding of statistical models that underlie data analysis [including STAT 7410, for example]

Assessment Rubric: The program will directly assess students' achievement of the learning outcomes above by scoring the Ph.D. Qualifier Examination. For each learning outcome, the Ph.D. Qualifier Examination Committee will assess each student on the ordinal scale: "High Proficiency," "Satisfactory Proficiency," "Some Proficiency," or "Low Proficiency." This will be done separately from the committee's determination of who passes the exam on an overall basis, and the committee will decide which questions on the Ph.D. Qualifier Examination are appropriate for assessing each learning outcome. (Note that some questions on the Ph.D. Qualifier Examination could be appropriate for assessing more than one learning outcome.) The chair of the Ph.D. Qualifier Examination Committee will be responsible for communicating the rating summaries and remarks to the assessment program coordinator, to the chair of the curriculum committee, and to the Graduate Program Coordinator.

Criterion: The students assessed will be placed in three categories: "Already Completed the Ph.D.," "Currently Pursuing the Ph.D.," and "Other (Not Completing or Currently Pursuing the Ph.D.)." If at least 80% of the assessment ratings of students who have completed the Ph.D. are in the "High Proficiency" or "Satisfactory Proficiency" categories, we will consider this as evidence of success in achieving Learning Goal 1 for our Ph.D. graduates. We will also monitor the overall percentage of "High Proficiency" or "Satisfactory Proficiency" ratings for all students, not just those completing the Ph.D.

Use of Data: Aggregated data for each learning outcome will be examined by the Graduate Studies Committee and/or by the Curriculum Committee on an annual basis. If the data do not meet our criteria or are otherwise disappointing, the committee will bring this to the attention of the Statistics faculty to discuss possible remedies, including: meeting with students directly to discuss their performance, making improvements in course content, and making improvements in course delivery and learning activities within courses.

Assessment of Learning Goal 2: Formulate and evaluate statistical models and implement them for analyzing data relevant to subject-matter research studies.

The *learning outcomes* associated with Learning Goal 2 include good performance on the following:

a. Formulating statistical models and demonstrating their validity and appropriateness
b. Demonstrating the application (or potential application) of statistical models to data, or to scientific investigations

Assessment Rubric: [same as for Learning Goal 1]

Criterion: [same as for Learning Goal 1]

Use of Data: [same as for Learning Goal 1]

Assessment of Learning Goal 3: Conduct thorough literature reviews to summarize and evaluate the state of statistical science in specialized research areas.

The *learning outcomes* associated with Learning Goal 3 include good performance on the following:

a. Comprehensiveness of the literature review, with regard to good topical coverage
b. Providing a valid assessment and/or critique of the statistical methods that are presented in the literature review

Assessment Rubric: The program will directly assess students' achievement of the learning outcomes above by scoring each Ph.D. candidate on the candidacy examination and on the dissertation (including its oral defense). For each learning outcome, the relevant committee will assess each student on the ordinal scale: "High Proficiency," "Satisfactory Proficiency," "Some Proficiency," or "Low Proficiency." This will be done separately from the committee's overall determination of whether the student passes the relevant examination, and will usually be accompanied by additional remarks regarding the attainment or non-attainment of the learning outcomes, which will be specific to the student's dissertation topic. The chair of the relevant examination committee will be responsible for communicating the rating summaries and remarks to the assessment program coordinator, to the chair of the curriculum committee, and to the Graduate Program Coordinator.

Criterion: [same as for Learning Goal 1]

Use of Data: [same as for Learning Goal 1]

Assessment of Learning Goal 4: Develop new statistical theory, statistical methodology, and/or computational methods when existing methods are not appropriate or can be improved upon, or expand knowledge of existing methods.

The *learning outcomes* associated with Learning Goal 4 include good performance on the following:

a. Demonstrating the appropriateness and novelty of the methodology
b. Developing appropriate statistical theory to justify the new methodology and to study its properties

Assessment Rubric: [same as for Learning Goal 3]

Criterion: [same as for Learning Goal 1]

Use of Data: [same as for Learning Goal 1]

Assessment of Learning Goal 5: Communicate effectively the role of statistical theory, statistical methodology, and/or computational methods in data analysis to professional and lay audiences.

The *learning outcomes* associated with Learning Goal 5 include:

a. Clear, correct, and effective written presentation
b. Clear, correct, and effective oral presentation

Assessment Rubric: [same as for Learning Goal 3]

Criterion: same as for Learning Goal 1]

Use of Data: [same as for Learning Goal 1]

Revised version

Assessment Plan for the Statistics Ph.D.

Learning Goals for the Statistics Ph.D.: A student graduating with a Ph.D. in Statistics should meet the following learning goals:

1. Understand, at an advanced level, the theory that underlies statistical methods.
2. Formulate and evaluate statistical models and implement them for analyzing data relevant to subject-matter research studies.
3. Conduct thorough literature reviews to summarize and evaluate the state of statistical science in specialized research areas.
4. Develop new statistical theory, statistical methodology, and/or computational methods when existing methods are not appropriate or can be improved upon, or expand knowledge of existing methods.
5. Communicate effectively the role of statistical theory, statistical methodology, and/or computational methods in data analysis to professional and lay audiences.

Assessment of Learning Goal 1: Understand, at an advanced level, the theory that underlies statistical methods.

The following *learning outcomes* are associated with Learning Goal 1:

a. Understanding of the advanced theory of statistical inference and estimation [including STAT 7301, 7302, and their prerequisites]
b. Understanding of advanced probability theory and stochastic models [including STAT 7201 and 7541, and their prerequisites]
c. Understanding of statistical models that underlie data analysis [including STAT 7410, for example]

Assessment Rubric: The program will directly assess students' achievement of the learning outcomes above by scoring the Ph.D. Qualifier Examination. For each learning outcome, the Ph.D. Qualifier Examination Committee will assess each student on the ordinal scale: "High Proficiency," "Satisfactory Proficiency," "Some Proficiency," or "Low Proficiency." This will be done separately from the committee's determination of who passes the exam on an overall basis, and the committee will decide which questions on the Ph.D. Qualifier Examination are appropriate for assessing each learning outcome. (Note that some questions on the Ph.D. Qualifier Examination could be appropriate for assessing more than one learning outcome.) The chair of the Ph.D. Qualifier Examination Committee will be responsible for communicating the rating summaries and remarks to the assessment program coordinator, to the chair of the curriculum committee, and to the Graduate Program Coordinator.

Criterion: The students assessed will be placed in three categories: "Already Completed the Ph.D.," "Currently Pursuing the Ph.D.," and "Other (Not Completing or Currently Pursuing the Ph.D.)." If at least 80% of the assessment ratings of students who have completed the Ph.D. are in the "High Proficiency" or "Satisfactory Proficiency" categories, we will consider this as evidence of success in achieving Learning Goal 1 for our Ph.D. graduates. We will also monitor the overall percentage of "High Proficiency" or "Satisfactory Proficiency" ratings for all students, not just those completing the Ph.D.

Use of Data: Aggregated data for each learning outcome will be examined by the Graduate Studies Committee and/or by the Curriculum Committee on an annual basis. If the data do not meet our criteria or are otherwise disappointing, the committee will bring this to the attention of the Statistics faculty to discuss possible remedies, including: meeting with students directly to discuss their performance, making improvements in course content, and making improvements in course delivery and learning activities within courses.

Assessment of Learning Goal 2: Formulate and evaluate statistical models and implement them for analyzing data relevant to subject-matter research studies.

The *learning outcomes* associated with Learning Goal 2 include good performance on the following:

a. Formulating statistical models and demonstrating their validity and appropriateness
b. Demonstrating the application (or potential application) of statistical models to data, or to scientific investigations

Assessment Rubric: [same as for Learning Goal 1]

Criterion: [same as for Learning Goal 1]

Use of Data: [same as for Learning Goal 1]

Assessment of Learning Goal 3: Conduct thorough literature reviews to summarize and evaluate the state of statistical science in specialized research areas.

The *learning outcomes* associated with Learning Goal 3 include good performance on the following:

a. Comprehensiveness of the literature review, with regard to good topical coverage
b. Providing a valid assessment and/or critique of the statistical methods that are presented in the literature review

Assessment Rubric: The program will directly assess students' achievement of the learning outcomes above by scoring each Ph.D. candidate on the candidacy examination and on the dissertation (including its oral defense). For each learning outcome, the relevant committee will assess each student on the ordinal scale: "High Proficiency," "Satisfactory Proficiency," "Some Proficiency," or "Low Proficiency." This will be done separately from the committee's overall determination of whether the student passes the relevant examination, and will usually be accompanied by additional remarks regarding the attainment or non-attainment of the learning outcomes, which will be specific to the student's dissertation topic. The chair of the relevant examination committee will be responsible for communicating the rating summaries and remarks to the assessment program coordinator, to the chair of the curriculum committee, and to the Graduate Program Coordinator.

Criterion: [same as for Learning Goal 1]

Use of Data: [same as for Learning Goal 1]

Assessment of Learning Goal 4: Develop new statistical theory, statistical methodology, and/or computational methods when existing methods are not appropriate or can be improved upon, or expand knowledge of existing methods.

The *learning outcomes* associated with Learning Goal 4 include good performance on the following:

a. Demonstrating the appropriateness and novelty of the theory and/or methodology
b. Developing appropriate statistical justification of the new development and/or study of its properties

Assessment Rubric: [same as for Learning Goal 3]

Criterion: [same as for Learning Goal 1]

Use of Data: [same as for Learning Goal 1]

Assessment of Learning Goal 5: Communicate effectively the role of statistical theory, statistical methodology, and/or computational methods in data analysis to professional and lay audiences.

The *learning outcomes* associated with Learning Goal 5 include:

a. Clear, correct, and effective written presentation
b. Clear, correct, and effective oral presentation

Assessment Rubric: [same as for Learning Goal 3]

Criterion: same as for Learning Goal 1]

Use of Data: [same as for Learning Goal 1]

Re: Concurrence Letter from Biostatistics

Archer, Kellie <archer.43@osu.edu>
Mon 7/24/2023 8:28 AM
To:MacEachern, Steven <snm@stat.osu.edu>
Cc:Sinnott, Jennifer <jsinnott@stat.osu.edu>;Lee, Yoonkyung <yklee@stat.osu.edu>;Kaizar, Elly <kaizar.1@osu.edu>;MacEachern, Steven <snm@stat.osu.edu>

Hi Steve,

The Division of Biostatistics is happy to support your PhD program revisions by supplying a letter of concurrence. Our Interdisciplinary Biostatistics PhD program will be making corresponding changes as well to take effect during the 2024-2025 academic year.

Let me know if you need anything else.

Best regards,
Kellie

Kellie J. Archer
Professor and Chair
Division of Biostatistics
College of Public Health
The Ohio State University
1841 Neil Ave.
Columbus, OH 43210
Email: archer.43@osu.edu
Phone: 614-247-6167

From: MacEachern, Steven <snm@stat.osu.edu>
Date: Thursday, July 6, 2023 at 1:25 PM
To: Archer, Kellie J. <archer.43@osu.edu>
Cc: Sinnott, Jennifer <jsinnott@stat.osu.edu>, Lee, Yoonkyung <yklee@stat.osu.edu>, Kaizar, Elly <kaizar.1@osu.edu>, MacEachern, Steven <snm@stat.osu.edu>
Subject: Fw: Concurrence Letter from Biostatistics

Hi Kellie.

We've been working on the revision of the PhD in Statistics for some time now. We would like to have a letter of concurrence from you, as head of the Biostatistics in CPH. A copy of the proposed revision is attached.

I've copied our two leads on the revision - Jen Sinnott and Yoon Lee - on this email, as well as our next chair, Elly Kaizar.

My best,

Steve

SYLLABUS: STAT 6111

Foundations of Statistical Theory I
Autumn 2023 (full semester)
3 credit hours

COURSE OVERVIEW

Instructor

<NAME TO BE ANNOUNCED>

Email address: <TO BE ANNOUNCED>

Lectures: This class will meet 3 days a week for 55 minutes. <LOCATION TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Graduate teaching assistant

<NAME>

Email address: <TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Prerequisites

Entry to this course is restricted to graduate standing in the Statistics MS program, Statistics PhD program, or Interdisciplinary Biostatistics PhD program; Or permission of instructor.

Course description

This is the first part of a course that reviews and introduces the mathematical foundations that are necessary for the coursework in the PhD programs in Statistics and Biostatistics, focusing on applying univariate and multivariate calculus, linear algebra, strategies of proof, and real analysis to statistical theory and methods.

Course learning outcomes

By the end of this course, students should successfully be able to:

- Demonstrate a thorough understanding of how to use both univariate and multivariate calculus tools to obtain results in Statistics and Biostatistics.
- Demonstrate understanding of Euclidean spaces and concepts relating to a vector basis for use in statistical regression models.
- Apply multiple strategies of proof to obtain results in statistical theory.
- Demonstrate understanding of convergence of sequences to obtain results in probability and statistical theory.

COURSE MATERIALS AND TECHNOLOGIES

Textbooks

Required

- P.D. Lax and M.S. Terrell. *Multivariable Calculus with Applications*. Springer, 2017. Available online through OSU library: https://link-springer-com.proxy.lib.ohio-state.edu/book/10.1007/978-3-319-74073-7 **[LT in schedule]**
- J.E. Gentle. *Matrix Algebra: Theory, Computations, and Applications in Statistics*. Springer, 2007. Available online through OSU library: https://ebooks.ohiolink.edu/content/f18d4bcc-c05c-11ea-b48a-0a28bb48d135 **[G in schedule]**
- D.W. Cunningham. *Real Analysis with Proof Strategies*. CRC Press, 2021. Available online through OSU library: https://www-taylorfrancis-com.proxy.lib.ohio-state.edu/books/mono/10.1201/9781003091363/real-analysis-daniel-cunningham **[C in schedule]**

Recommended/optional

- None.

Necessary Software

- This class will require you to use the statistical software packages called R (The R Project for Statistical Computing; http://www.r-project.org/) and RStudio (https://posit.co). These software packages are available as Free Software.

GRADING AND FACULTY RESPONSE

ASSIGNMENT CATEGORY	PERCENTAGE
Homework	**45**
Quizzes	**40**
Participation	**15**
Total	**100**

Class time will be a mix of lecture and group work on practice problems and homework problems. Instead of having traditional exams, there will be approximately 8 short quizzes throughout the semester consisting of questions very similar to those on the homework.

Late assignments

<Policy will be added when the course is offered>

Instructor feedback and response time

<Policy will be added when the course is offered>

COURSE SCHEDULE

Refer to the Carmen course for up-to-date assignment due dates.

Week	Dates	Topics	Reading	Assignments
1	Aug 23, 25	Univariate Differentiation	Course Notes	
2	Aug 28, 30, Sep 1	Taylor Series, Univariate Integration	Course Notes	HW 1 due, Quiz 1
3	Sep 6, 8	Finish Univariate Calculus Review	Course Notes; LT 1.1, 1.4	
4	Sep 11, 13, 15	Introduction to Multivariate Calculus	LT 2.1, 3.1-3.3	HW 2 due, Quiz 2
5	Sep 18, 20, 22	Multivariate Integration	LT 4.1-4.3, 6.1-6.3	HW 3 due
6	Sep 25, 27, 29	Multivariate Integration Continued	LT 6.4-6.5	HW 4 due, Quiz 3
7	Oct 2, 4, 6	Introduction to Vectors and Vector Spaces	G 1, 2.1.1-2.1.3	HW 5 due, Quiz 4
8	Oct 9, 11	Inner Products, Norms	G 2.1.4-2.1.9	
9	Oct 16, 18, 20	Vector Geometry	G 2.1.8, 2.2.1-2.2.5	HW 6 due, Quiz 5
10	Oct 23, 25, 27	Strategies of Proof	C 1.1-1.4	HW 7 due
11	Oct 30, Nov 1, 3	The Real Numbers	C 2.2-2.3, 3.1	HW 8 due, Quiz 6
12	Nov 6, 8	Sequences	C 3.2, 3.3	
13	Nov 13, 15, 17	Sequences Continued	C 3.4-3.6	HW 9 due, Quiz 7
14	Nov 20	Sequences Continued	C 3.7	
15	Nov 27, 29, Dec 1	Continuity	C 4.1-4.3	HW 10 due
16	Dec 4, 6	Continuity Continued	C 4.4	Quiz 8

OTHER COURSE POLICIES

Academic integrity policy

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct **http://studentlife.osu.edu/csc/**.

If I suspect that a student has committed academic misconduct in this course, I am obligated by university rules to report my suspicions to the Committee on Academic Misconduct. If COAM determines that you have violated the university's *Code of Student Conduct* (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in this course and suspension or dismissal from the university.
If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact me.
Other sources of information on academic misconduct (integrity) to which you can refer include:

- Committee on Academic Misconduct web page (go.osu.edu/coam)
- Ten Suggestions for Preserving Academic Integrity (go.osu.edu/ten-suggestions)

Copyright for instructional materials

The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Statement on Title IX

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.edu or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu

Commitment to a diverse and inclusive learning environment

The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.

Land Acknowledgement

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Your mental health

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ACCESSIBILITY ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

Requesting accommodations

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Accessibility of course technology

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- Canvas accessibility (go.osu.edu/canvas-accessibility)
- Streaming audio and video
- CarmenZoom accessibility (go.osu.edu/zoom-accessibility)
- Collaborative course tools

THE OHIO STATE UNIVERSITY

College of Arts & Sciences
Department of Statistics

SYLLABUS: STAT 6112

Foundations of Statistical Theory II
Spring 2024 (full semester)
3 credit hours

COURSE OVERVIEW

Instructor

<NAME TO BE ANNOUNCED>

Email address: <TO BE ANNOUNCED>

Lectures: This class will meet 3 days a week for 55 minutes. <LOCATION TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Graduate teaching assistant

<NAME>

Email address: <TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Prerequisites

Entry to this course is restricted to graduate standing in the Statistics MS program, Statistics PhD program, or Interdisciplinary Biostatistics PhD program; Or permission of instructor.

Course description

This is the second part of a course that reviews and introduces the mathematical foundations that are necessary for the coursework in the PhD programs in Statistics and Biostatistics, focusing on applying univariate and multivariate calculus, linear algebra, strategies of proof, and real analysis to statistical theory and methods.

Course learning outcomes

By the end of this course, students should successfully be able to:

- Demonstrate understanding of convergence of sequences for application in probability and statistical theory.
- Demonstrate understanding of Riemann-Stieltjes integration for application in probability and statistical theory.
- Demonstrate understanding of matrix algebra and matrix decompositions applied in statistical and biostatistical contexts.

COURSE MATERIALS AND TECHNOLOGIES

Textbooks

Required

- J.E. Gentle. *Matrix Algebra: Theory, Computations, and Applications in Statistics*. Springer, 2007. Available online through OSU library: https://ebooks.ohiolink.edu/content/f18d4bcc-c05c-11ea-b48a-0a28bb48d135 **[G in schedule]**
- D.W. Cunningham. *Real Analysis with Proof Strategies*. CRC Press, 2021. Available online through OSU library: https://www-taylorfrancis-com.proxy.lib.ohio-state.edu/books/mono/10.1201/9781003091363/real-analysis-daniel-cunningham **[C in schedule]**

Recommended/optional

- None.

Necessary Software

- This class will require you to use the statistical software packages called R (The R Project for Statistical Computing; http://www.r-project.org/) and RStudio (https://posit.co). These software packages are available as Free Software.

GRADING AND FACULTY RESPONSE

ASSIGNMENT CATEGORY	PERCENTAGE
Homework	**45**
Quizzes	**40**
Participation	**15**
Total	**100**

Class time will be a mix of lecture and group work on practice problems and homework problems. Instead of having traditional exams, there will be approximately 8 short quizzes throughout the semester consisting of questions very similar to those on the homework.

Late assignments

<Policy will be added when the course is offered>

Instructor feedback and response time

<Policy will be added when the course is offered>

COURSE SCHEDULE

Refer to the Carmen course for up-to-date assignment due dates.

Week	Dates	Topics	Reading	Assignments
1	Jan 8, 10, 12	Continuity Continued, Differentiation	C 4.5, 5.1.1	HW 1 due
2	Jan 17, 19	Differentiation, The Mean Value Theorem	C 5.1.2, 5.2.1	Quiz 1
3	Jan 22, 24, 26	The Mean Value Theorem	C 5.2.2, 5.2.3	HW 2 due, Quiz 2
4	Jan 29, 31, Feb 2	Riemann-Stieltjes Integration	C 6.1, 6.2	HW 3 due
5	Feb 5, 7, 9	Families of Integrable Functions	C 6.3	HW 4 due, Quiz 3
6	Feb 12, 14, 16	Infinite Series	C 7.1-7.2, 8.1	HW 5 due
7	Feb 19, 21, 23	Sequences and Series of Functions	C 8.2-8.4	Quiz 4
8	Feb 26, 28, Mar 1	Return to Matrix Algebra	G 3.1-3.2	HW 6 due
9	Mar 4, 6, 8	Rank and Inverse	G 3.3	HW 7 due, Quiz 5
10	Mar 18, 20, 22	Linear Systems of Equations, Generalized Inverse	G 3.5-3.6	HW 8 due
11	Mar 25, 27, 29	Eigenanalysis	G 3.8.1-3.8.4	Quiz 6
12	Apr 1, 3, 5	Spectral and Other Decompositions	G 3.8.5, 3.8.10-3.8.11, 3.8.13	HW 9 due
13	Apr 8, 10, 12	Data Matrices, Symmetric Matrices	G 8.1-8.2	Quiz 7
14	Apr 15, 17, 19	Definite, Idempotent, Projection Matrices	G 8.3-8.5	HW 10 due, Quiz 8
15	Apr 22	Catch-Up		

OTHER COURSE POLICIES

Academic integrity policy

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If I suspect that a student has committed academic misconduct in this course, I am obligated by university rules to report my suspicions to the Committee on Academic Misconduct. If COAM determines that you have violated the university's *Code of Student Conduct* (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in this course and suspension or dismissal from the university.
If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact me.
Other sources of information on academic misconduct (integrity) to which you can refer include:

- Committee on Academic Misconduct web page (go.osu.edu/coam)
- Ten Suggestions for Preserving Academic Integrity (go.osu.edu/ten-suggestions)

Copyright for instructional materials

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Statement on Title IX

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.edu or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu

Commitment to a diverse and inclusive learning environment

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Accessibility of course technology

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- Collaborative course tools

THE OHIO STATE UNIVERSITY

College of Arts & Sciences
Department of Statistics

SYLLABUS: STAT 6910

Applied Statistics II
Spring 2024 (full semester)
4 credit hours

COURSE OVERVIEW

Instructor

<NAME TO BE ANNOUNCED>

Email address: <TO BE ANNOUNCED>

Lectures: Tuesdays and Thursdays 110 min lectures. <TIMES TBA> <LOCATION TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Graduate teaching assistant

<NAME>

Email address: <TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Prerequisites

Statistics 6801 and Statistics 6950, or permission of instructor. Not open to students who have taken Statistics 6410.

Course description

Statistics 6910 is a course on applied statistics. It will quickly cover material on categorical data and inference for proportions. The course then covers an introduction to generalized linear models (GLM), including binomial regression and Poisson regression. Following the introductory material, we will move on to experimental design. We will cover the basic principles of design and the techniques used to analyze experiments that follow standard experimental designs. Specific designs to be covered include one-way analysis of variance

(ANOVA), two-and-higher-way ANOVA, analysis of covariance (ANCOVA), block designs, random and mixed effect models.

Course learning outcomes

By the end of this course, students should successfully be able to:

- Grasp the basics of descriptive and inferential statistics from an applied perspective;
- Fit, interpret, and perform statistical inference based on common generalized linear regression models;
- Describe, estimate and interpret variance components;
- Appreciate the importance of the assumptions that the models are based on;
- Make sound decisions for an analysis and recommendations for study design;
- Understand and use appropriate statistical notation and terminology;
- Implement formal techniques flawlessly;
- Summarize an analysis appropriately.

COURSE MATERIALS AND TECHNOLOGIES

Textbooks

Required

- **S. Weisberg (2014), Applied Linear Regression (ALR), 4th Edition, John Wiley & Sons, Inc., NJ.**
  An electronic version of the book can be accessed for free through The Ohio State University Libraries at https://library.ohio-state.edu/record=b8665795~S7.
  You will need to click on "Connect to resource EBSCOhost"; you may also need to supply your OSU credentials. The online resource is best suited for screen reading; each individual is allowed to print/e-mail/save/download a limited number of pages.
  Errata and more information about the textbook can be found at http://users.stat.umn.edu/~sandy/alr4ed/.

- M. Dean, D. Voss, and D. Draguljic (DVD) (2017), Design and Analysis of Experiments, 2nd Edition, Springer, NY.

  You can download the eBook from https://link-springer-com.proxy.lib.ohio-state.edu/book/10.1007%2F978-3-319-52250-0

Errata and datasets available from
http://www.wright.edu/~dan.voss/DeanVossDraguljic.html

Recommended/optional

- I will highlight other useful references as the course progresses.

Necessary Software and Equipment

- This class requires you to use the statistical software packages called R (The R Project for Statistical Computing; http://www.r-project.org/) and RStudio (https://posit.co/). These software packages are available as Free Software with versions compatible with current macOS and Windows operating systems. More details will be given in lectures.
- Access to a computer capable of running the required software, which includes Mac and PC devices running the current macOS or Windows operating system.

GRADING AND FACULTY RESPONSE

ASSIGNMENT CATEGORY	PERCENTAGE
Homework	**15**
Midterm 1	**25**
Midterm 2	**25**
Take-home final exam	**35**
Total	**100**

Grades will be recorded on the class website.

Homework will typically be assigned weekly and usually due on Thursday of the following week at the beginning of class. Check Carmen for exact due dates. Typically, no late homework will be accepted. Contact me as soon as possible if there is an event that prevents you from submitting homework on time. You are encouraged to work together on the homework, but do not copy any part of a homework. Each student must produce his/her own homework to be handed in. All homework must be submitted online as a PDF file through the class website. Feel free to ask me or the GTA for help after you have attempted the questions. I will endeavor to create homework solutions that are detailed enough to allow you to understand how the question could be approached.

Homework preparation rules: Put your name on your homework assignment. Submit the problems in order, clearly numbered, making sure that the computer output and discussion is placed together (do not put computer output at the end of homework). Raw computer output is not acceptable. Make it clear what parts of the output are relevant and show how they answer the questions posed in the homework.

Exams: There will be two midterms and one final exam:

Midterm 1	Thur Feb 15	in class
Midterm 2	Tue Mar 26	in class
Final	<DATE>	<TIME>

All exams will be **closed book/closed notes**. A basic calculator is allowed – tablets, laptops, cellphones, and communication devices are not. There are no make-up exams. Contact me as soon as possible if there is an event that prevents you from taking an exam on the scheduled day/time. Further details will be given in advance of each exam.

The first midterm covers the material up to and including Thu Feb 8.
The second midterm covers the material up to and including Tues Mar 19.
The final will cover all the material for the course.

Late assignments

<Policy will be added when the course is offered>

Instructor feedback and response time

<Policy will be added when the course is offered>

COURSE SCHEDULE

Refer to the Carmen course for up-to-date assignment due dates.

Week	Dates	Topics	Reading	Homework
1	Jan 9 Jan 11	Introduction to categorical data Simpson/Yule paradox Inference for proportions	Class notes	
2	Jan 16 Jan 18	Binomial regression, residuals, and diagnostics	ALR4, Sections 12.1–12.2	HW 1 due
3	Jan 23 Jan 25	Binomial regression, residuals, and diagnostics Poisson regression and goodness of fit	ALR4, Sections 12.2–12.5	HW 2 due
4	Jan 30 Feb 1	Poisson regression and goodness of fit Principles of designing experiments (causal vs. observational experiments)	ALR4, Sections 12.3–12.5 DVD Chapters 1 and 2	HW 3 due
5	Feb 6 Feb 8	One-way ANOVA	DVD, Sections 3.1-3.6	HW 4 due
6	Feb 13 Feb 15	One-way ANOVA Midterm 1	DVD, Sections 3.1-3.5, 4.1-4.3	
7	Feb 20 Feb 22	One-way ANOVA	DVD, Sections 4.1-4.3, Chapter 5	
8	Feb 27 Feb 29	Two-way ANOVA	DVD, Sections 6.1-6.7, 6.9	HW 5 due
9	Mar 5 Mar 7	Two-way ANOVA	DVD, Sections 6.1-6.7, 6.9	HW 6 due
10	Mar 19 Mar 21	Higher order ANOVA	DVD, Sections 7.1-7.5	HW 7 due

Week	Dates	Topics	Reading	Homework
11	Mar 26 Mar 28	Midterm 2 Block designs	DVD, Chapter 10	
12	Apr 2 Apr 4	ANCOVA	DVD, Section 7.6, Chapter 9	HW 8 due
13	Apr 9 Apr 11	Random and mixed effects	DVD, Sections 17.1-17.5	HW 9 due
14	Apr 16 Apr 18	Random and mixed effects	DVD, Sections 17.6-17.11, 19.1-19.3	HW 10 due
15	Week of Apr 22	Final exams (Last day of classes, Mon Apr 22)		

OTHER COURSE POLICIES

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Accessibility of course technology

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- Canvas accessibility (go.osu.edu/canvas-accessibility)

SYLLABUS: STAT 6950

Applied Statistics I
Autumn 2023 (full semester)
4 credit hours

COURSE OVERVIEW

Instructor

<NAME TO BE ANNOUNCED>

Email address: <TO BE ANNOUNCED>

Lectures: Tuesdays and Thursdays 110 min lectures. <TIMES TBA>
<LOCATION TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Graduate teaching assistant

<NAME>

Email address: <TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Prerequisites

Statistics 6801 (co-requisite), or permission of the instructor. Not open to students who have taken Statistics 6450.

Course description

One and two-sample problems, exploratory data analysis, simple and multiple linear regression, diagnostics and model selection. Intended primarily for students in the PhD program in Statistics or Biostatistics.

Stat 6950 is an applied statistics course that emphasizes principles of data analysis in the linear model setting. While the focus is applied, the methods of data analysis are presented and motivated in the context of statistical theory at a level appropriate for first year graduate students in Statistics or Biostatistics. The theoretical background assumes facility with multivariable calculus

and basic matrix operations from linear algebra. The R language and environment for statistical computing and graphics will be used as the main tool for data analysis.

Course learning outcomes

By the end of this course, students should successfully be able to:

- identify and implement appropriate methods of data analysis in the one- and two-sample problem settings;
- use an exploratory analysis of data to guide the linear regression modeling process;
- fit, interpret, and perform statistical inference based on linear regression models;
- use appropriate diagnostics for model checking and case-influence analysis to identify deficiencies with a fitted model;
- recognize and employ appropriate modeling strategies for common examples of nonconstant variance functions;
- employ appropriate strategies for regression modeling with many predictors;
- summarize an analysis appropriately.

COURSE MATERIALS AND TECHNOLOGIES

Textbooks

Required

- S. Weisberg (2014), Applied Linear Regression, 4th Edition, John Wiley & Sons, Inc., NJ.

  An electronic version of the book can be accessed for free through The Ohio State University Libraries at https://library.ohio-state.edu/record=b8665795~S7. You will need to click on “Connect to resource EBSCOhost”; you may also need to supply your OSU credentials. The online resource is best suited for screen reading; each individual is allowed to print/e-mail/save/download a limited number of pages.

Errata and more information about the textbook can be found at http://users.stat.umn.edu/~sandy/alr4ed/.

Recommended/optional

- I will highlight other useful resources as the course progresses.

Necessary Software and Equipment

- This class requires you to use the statistical software packages called R (The R Project for Statistical Computing; http://www.r-project.org/) and RStudio (https://posit.co/). These software packages are available as Free Software with versions compatible with current macOS and Windows operating systems. More details will be given in lectures.
- Access to a computer capable of running the required software, which typically includes Mac and PC devices running the current macOS or Windows operating system.

GRADING AND FACULTY RESPONSE

ASSIGNMENT CATEGORY	PERCENTAGE
Homework	**20**
Midterm 1	**10**
Midterm 2	**20**
Project	**20**
Final Exam	**30**
Total	**100**

Homework will be assigned approximately weekly, with a few weeks off during the semester. There will be fewer homework assignments near the end of the semester when you are working on the project. While adjustments may need to be made, I expect that homework assignments will be due on Carmen on Thursdays by 11:59pm. Instructions for how to prepare and turn in your homework solutions will be given at the beginning of the semester.

Project: A group project will be due on November 21. The project will tie together the concepts learned throughout the course. Details will be provided in the beginning of October.

Exams: The first midterm is **tentatively** scheduled to be on **Tuesday, October 10** during our regularly scheduled class time. The second midterm is **tentatively** scheduled to be on **Tuesday, October 31** during our regularly scheduled class time. The first midterm will last for one hour, and the second midterm will last for 1 hour and 45 minutes. The final exam has been scheduled by the registrar for **<TO BE ANNOUNCED>**

All exams are closed book/closed notes. Further details will be given in advance of each exam. A basic calculator is allowed.

Late assignments

<Policy will be added when the course is offered>

Instructor feedback and response time

<Policy will be added when the course is offered>

COURSE SCHEDULE

Refer to the Carmen course for up-to-date assignment due dates.

Week	Dates	Topics	Reading	Homework
1	Aug 22 Aug 24	One and two-sample problems	Course Notes	
2	Aug 29 Aug 31	One and two-sample proportions	Course Notes	
3	Sep 5 Sep 7	EDA, statistical models, simple linear regression intro	ALR 1.1-1.6	HW1 Due
4	Sep 12 Sep 14	Simple linear regression	ALR 2.1-2.5	HW2 Due
5	Sep 19 Sep 21	Testing, techniques for model validation	ALR 2.6-2.8, 4.5.1	HW3 Due
6	Sep 26 Sep 28	Regression diagnostics, transformations	ALR 8.1, 8.3, 9.1.1,9.2-9.4	HW4 Due
7	Oct 3 Oct 5	Multiple linear regression intro and inference	ALR 3.1-3.5, 4.1.1-4.1.3, 4.2-4.4	HW5 Due
8	Oct 10	Midterm 1 (1hr) Multicollinearity	ALR 4.1.4-4.1.5, 4.5	
9	Oct 17 Oct 19	Transformations, F-tests, multiple comparisons, Regression with categorical predictors	4.1.6-4.1.7, 8.2, 8.4, 5.1-5.2, 6.1-6.3,6.5-6.6	
10	Oct 24 Oct 26	Variance functions and WLS	7.1-7.3, 7.5-7.7	HW6 Due
11	Oct 31 Nov 2	Midterm 2 (2hrs) MLR diagnostics	9.1,9.5-9.6	
12	Nov 7 Nov 9	Case analysis, Polynomial regression	5.3, Course Notes	

Week	Dates	Topics	Reading	Homework
13	Nov 14 Nov 16	Case study, model comparison	10.1-10.3	HW7 Due
14	Nov 21		Course Notes	Project Due
15	Nov 28 Nov 30	Model comparison and variable selection	Course Notes	HW8 Due

OTHER COURSE POLICIES

Academic integrity policy

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THE OHIO STATE UNIVERSITY

College of Arts & Sciences
Department of Statistics

SYLLABUS: STAT 7301

Advanced Statistical Theory
Autumn 2023 (full semester)
3 credit hours

COURSE OVERVIEW

Instructor

<NAME TO BE ANNOUNCED>

Email address: <TO BE ANNOUNCED>

Lectures: Mondays, Wednesdays, and Fridays for 55 minutes each

<LOCATION TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Graduate teaching assistant

<NAME>

Email address: <TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Prerequisites

STAT 6802 or permission of the instructor.

Course description

This is a course on statistical theory with a focus on multivariate point estimation. It covers fundamental concepts from mathematical statistics, derivation/classification of estimators, large sample asymptotic analysis, and non-asymptotic analysis of high-dimensional estimation problems. The course is intended primarily for Ph.D. students in Statistics or Biostatistics and is meant to introduce them to a mathematically rigorous (proof-based) approach to understanding and analyzing statistical estimation problems using classical and contemporary theoretical tools.

Course learning outcomes

By the end of this course, students should successfully be able to:

- Understand important and fundamental concepts of mathematical statistics.
- Formulate new and classify existing estimators in a variety of statistical problems.
- Analyze theoretical properties of estimators in large sample settings using asymptotics.
- Analyze theoretical properties of estimators in high-dimensional settings using concentration inequalities.
- Understand the assumptions that underly basic tools of theoretical analysis, and how those assumptions affect the use and results of these tools.

COURSE MATERIALS AND TECHNOLOGIES

Textbooks

Course material will be drawn from three books that are freely accessible from the OSU on-campus network or off-campus using the OSU Library proxy service.

Required

- Keener, R.: *Theoretical Statistics: Topics for a Core Course*. Springer. (https://link.springer.com/book/10.1007%2F0-387-30623-4)
- Vershynin, R.: *High-Dimensional Probability: An Introduction with Applications in Data Science*. Cambridge University Press. (https://doi.org/10.1017/9781108231596)
- Wainwright, M.: *High-Dimensional Statistics: A Non-Asymptotic Viewpoint.* Cambridge University Press. (https://doi.org/10.1017/9781108627771)

Necessary Software

- This class requires you to use the statistical software packages called R (The R Project for Statistical Computing; http://www.r-project.org/) and RStudio (https://posit.co). These software packages are available as Free Software. More details will be given in lectures.

GRADING AND FACULTY RESPONSE

Homework	22
Exam 1 (9/29)	22
Exam 2 (11/3)	22
Final Exam	32
Lecture scribing	2
Total	100

Homework will generally be assigned on a weekly basis, on CarmenCanvas, and collected in-class on the due date. All exams are closed book and given in-class. Students will be required to scribe two lectures using LaTeX and a template provided by the instructor. Students may use Overleaf or RStudio for working with LaTeX. Additional instructions and a sign-up sheet will be provided on CarmenCanvas.

Late assignments

<Policy will be added when the course is offered>

Instructor feedback and response time

<Policy will be added when the course is offered>

COURSE SCHEDULE

Refer to the Carmen course for up-to-date assignment due dates. Recommended reading is listed in parentheses following the topics.

Week	Dates	Topics
1	8/23, 8/25	Statistical models, decision theory overview; sufficiency and minimal sufficiency (Keener 3.1-3.4)
2	8/28, 8/30, 9/1	Exponential families: definitions, minimality, mean parameters (Keener 2.1-2.4)
3	9/6, 9/8	Convex losses, Jensen's inequality; Rao-Blackwell Theorem (Keener 3.6)
4	9/11, 9/13, 9/15	Fisher Information; Information Inequality (Keener 4.5-4.6)
5	9/18, 9/20, 9/22	Methods of estimation: plug-in, method of moments (MOM), maximum likelihood (ML) (Notes)
6	9/25, 9/27, 9/29	MOM/ML in exponential families; M- and Z-estimators (Keener 8.3, Notes); **[Exam 1]**
7	10/2, 10/4, 10/6	Convergence in probability/distribution; consistency; continuous mapping theorems; multivariate CLT; stochastic O notation (Keener 8.1-8.2)
8	10/9, 10/11	Delta method and its application to MLE in exponential families (Keener 8.2)
9	10/16, 10/18, 10/20	Uniform law of large numbers for C(K); consistency of M-estimators; consistency of MLE for (in)correctly specified models (Keener 9.1-9.2)
10	10/23, 10/25, 10/27	Asymptotic Normality of Z-estimators; asymptotic efficiency of MLE and one-step estimators (Keener 9.3, 9.7)
11	10/30, 11/1, 11/3	Hoeffding's and Chernoff's Inequalities; sub-Gaussian distributions and norms; sub-Gaussian inequality (Vershynin 2.1-2.3, 2.5; Wainwright 2.1); **[Exam 2]**
12	11/6, 11/8	Estimation of a sparse high-dimensional mean vector (Notes)
13	11/13, 11/15, 11/17	Sparse linear models in high dimensions (Wainwright 7.1,7.3; Vershynin 10.6)
14	11/20	Sparse linear models in high dimensions (continued)
15	11/27, 11/29, 12/1	Operator norm and covariance estimation, random matrices; Bernstein's and sub-exponential inequalities; epsilon nets (Vershynin 2.7-2.8, 4.2; Wainwright 6.1)
16	12/4, 12/6	High-dimensional covariance estimation (Vershynin 4.7; Wainwright 6.3)

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Accessibility of course technology

[DELETE ANY OF THE FOLLOWING IF NOT REQUIRED]

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- Collaborative course tools

The Ohio State University

College of Arts & Sciences
Department of Statistics

SYLLABUS: STAT 7302

BAYESIAN ANALYSIS AND DECISION THEORY

Spring 2024 (full semester)
3 credit hours

COURSE OVERVIEW

Instructor

<NAME TO BE ANNOUNCED>

Email address: <TO BE ANNOUNCED>

Lectures: This class will meet 3 days a week for 55 minutes each lecture. <LOCATION TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Graduate teaching assistant

<NAME>

Email address: <TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Prerequisites

STAT 7301 or permission of instructor

Course description

This course explores basic elements of decision theory and Bayesian inference. During the semester we will cover the following core topics:

- Bayesian Expected Loss, Frequentist Risk, Bayes Risk

- Decision Principles (Bayesian, Frequentist, Likelihood)
- Loss Functions
- Prior Distributions (Subjective, Noninformative, Improper, Empirical, Hierarchical)
- Posterior Distributions
- Bayes Inference (Estimation, Credible Sets, Hypothesis Testing, prediction)
- Empirical Bayes Analysis and Hierarchical Bayes Models
- Computation of Bayesian analysis. Gibbs Sampler and Metropolis-Hasting Algorithms.
- Bayesian Model Assessment and Robustness

Course learning outcomes

By the end of this course, students should successfully be able to:

- Understand central elements of decision theory
- Compute Bayes risk and frequentist risk and derive Bayes rules
- Understand important statistical principles that motivate various modes of inference
- Build realistic Bayesian models and specify appropriate prior distributions using a variety of approaches
- Fit Bayesian models to data using numerical techniques, including Gibbs sampling and Markov chain Monte Carlo
- Assess and validate the assumptions underlying empirical Bayes and hierarchical Bayes models

COURSE MATERIALS AND TECHNOLOGIES

Textbooks

Required

- Berger, J.O. (1985), “Statistical Decision Theory and Bayesian Analysis,” second edition, New York, NY: Springer. This eBook is freely available for download from the OSU library website: https://library.ohio-state.edu/record=b8694733
- Gelman, A., Carlin, J.B., Stern, H.S., Dunson, D.B., Vehtari, A. and Rubin, D.B. (2014), “Bayesian Data Analysis” third edition, Chapman & Hall. This book is also freely available in electronic format through the library: https://learning.oreilly.com/library/view/bayesian-data-analysis/9781439898222/

Recommended/optional

- Some topics covered in the course will be based on material presented in additional books and articles. Appropriate references will be provided as needed.

Necessary Software

- This class requires you to use the statistical software packages called R (The R Project for Statistical Computing; http://www.r-project.org/) and RStudio (https://posit.co). These software packages are available as Free Software. More details will be given in class.

GRADING AND FACULTY RESPONSE

ASSIGNMENT CATEGORY	PERCENTAGE
Homework	40%
Midterm	25%
Final Exam	35%
Total	**100%**

Homework: There will be regular homework assignments. Homework must be uploaded to Carmen by the posted deadline on the day it is due. Homework is not accepted by email. You are encouraged to work together on the homework, but do not copy any part of others' work. Each student must produce his/her own homework to be handed in.

Exams: There will be one midterm and one final exam. All exams will be administered in the classroom. The final exam will take place at the time and date established by the University. All exams are closed book/closed notes. There are no make-up exams. A basic calculator is allowed – tablets, laptops, and cellphones are not allowed. Statistical tables will be provided as needed.

Late assignments

<Policy will be added when the course is offered>

Instructor feedback and response time

<Policy will be added when the course is offered>

COURSE SCHEDULE

Refer to the Carmen course for up-to-date assignment due dates.

WEEK	DATES	TOPICS
1	1/8, 1/10, 1/12	Basic elements of decision theory; Bayesian expected loss; frequentist risk; Bayes risk; decision principles Reading: Berger, Chapter 1
2	1/17, 1/19	Minimax and admissible decision rules Reading: Berger, Chapter 5.2 and 5.3 (this would take much longer than 2 lectures if we wish to provide any detail)
3	1/22, 1/24, 1/26	Overview of Bayesian analysis; admissibility of Bayes rules; complete class theorem Reading: Berger, Chapter 4.1, 4.2, 4.4, 4.8.1, 8.1, 8.2, 8.5-8.9
4	1/29, 1/31, 2/2	Generalized Bayes rules; admissibility of generalized Bayes rules; relationships between minimax Bayes and admissible rules; James-Stein estimator; prior distributions Reading: Berger Chapter 4.4, 4.8.2, 5.3, 5.4, 8.9, 3
5	2/5, 2/7, 2/9	Prior distributions (continued); empirical Bayes analysis (nonparametric and parametric) Reading: Berger Chapter 3, 4.5
6	2/12, 2/14, 2/16	Empirical Bayes for regression structures; general hierarchical models; Bayesian analysis of the linear model Reading: Berger Chapter 4.5, 4.6, Lindley and Smith (1972), "Bayes Estimates for the Linear Model," JRSS-B
7	2/19, 2/21, 2/23	Distinct points of view about statistical hypothesis testing; checking Bayesian models; Bayesian model diagnostics Reading: Christensen, R. (2005), "Testing Fisher, Neyman, Pearson, and Bayes," The American Statistician, 59, 121-126; Lehmann, E. L. (1993), "The Fisher, Neyman-Pearson Theories of Testing Hypotheses: One Theory or Two?," JASA, 88, 1242-1249; Gelman et al. Ch. 6

WEEK	DATES	TOPICS
8	2/26, 2/28, 3/1	Bayes factors and testing; Bayesian model averaging; Bayesian model comparison Reading: Berger Chapter 4.3.3; Madigan, D. and Raftery, A. E. (1994). Model selection and accounting for model uncertainty in graphical models using Occam's window, Journal of the American Statistical Association 89(428): 1535–1546; Hoeting, J. A., Madigan, D., Raftery, A. E. and Volinsky, C. T. (1999). Bayesian model averaging: a tutorial, Statistical science pp. 382–401; Wasserman, L. (2000). Bayesian model selection and model averaging, Journal of mathematical psychology 44(1): 92–107; Kadane, J. B. and Lazar, N. A. (2004). Methods and criteria for model selection, Journal of the American statistical Association 99(465): 279–290; Clyde, M. and George, E. I. (2004). Model uncertainty, Statistical science pp. 81–94.
9	3/4, 3/6, 3/8	Computation of Bayesian analysis. Sampling from a distribution Reading: Gelman et al., Chapter 10
10	3/18, 3/20, 3/22	Gibbs sampler algorithm and examples in R Reading: Gelman et al., Chapter 11.1-11.3
11	3/25, 3/27, 3/29	Metropolis-Hasting algorithm and examples in R Reading: Gelman et al., Chapter 11.4-11.5
12	4/1, 4/3, 4/5	MCMC tuning and assessing convergence in R Reading: Gelman et al., Chapter 11.6-11.10
13	4/8, 4/10, 4/11	Bayesian analysis for hierarchical linear models Reading: Gelman et al., Chapter 15
14	4/15, 4/17, 4/19	Bayesian analysis for GLM Reading: Gelman et al., Chapter 16
15	4/22	Case study analysis

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College of Arts & Sciences
Department of Statistics

SYLLABUS: STAT 7410

Linear Models
Autumn 2023 (full semester)
3 credit hours

COURSE OVERVIEW

Instructor

<NAME TO BE ANNOUNCED>

Email address: <TO BE ANNOUNCED>

Lectures: Monday, Wednesday and Friday, with 55 minute lectures. <TIMES TBA>
<LOCATION TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Graduate teaching assistant

<NAME>

Email address: <TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Prerequisites

STAT 6802, 6910, 6950; or permission of instructor.

Course description

This is a course on linear models, the most commonly used statistical model. The course will present topics on the definition, estimation and hypothesis testing in this class of models. In addition, we will discuss statistical methods for multiple comparisons. Modern regression models that extend the linear model will be introduced and the concepts of penalized estimation will be explored.

Course learning outcomes

By the end of this course, students should successfully be able to:

- Demonstrate an understanding of the algebraic and geometric underpinnings and interpretation of the linear model;
- Demonstrate an understanding of the theory of the linear model;
- Discuss the definition and the assumptions of the general linear model;
- Carry out appropriate statistical inference under the general linear model;
- Describe the breadth of models that extend the linear model;
- Perform statistical inference and prediction for a variety of models that extend the linear model;
- Interpret the results of statistical analyses based on models that extend the linear model.

COURSE MATERIALS AND TECHNOLOGIES

Textbooks

Required

- *A First Course in Linear Model Theory* by N. Ravishanker and D.K Dey, 2001, CRC Press (This textbook is available on loan from OSU Library);
- *Advanced Linear Modeling: Statistical Learning and Dependent Data* by R. Christensen, 2019, Springer (This textbook is available for download for free from http://proxy.lib.ohio-state.edu/login?url=https://link.springer.com/book/10.1007/978-3-030-29164-8).

Recommended/optional

- I will highlight other useful resources as the course progresses.

Necessary Software and Equipment

- This class requires you to use the statistical software packages called R (The R Project for Statistical Computing; http://www.r-project.org/) and RStudio (https://posit.co). These software packages are available as Free Software with versions compatible with current macOS and Windows operating systems. More details will be given in lectures.

- Access to a computer capable of running the required software, which includes Mac and PC devices running the current macOS or Windows operating system.

GRADING AND FACULTY RESPONSE

ASSIGNMENT CATEGORY	PERCENTAGE
Homework	**25**
Midterm Exam	**35**
Final Exam	**40**
Total	**100**

Homework: There will be homework assignments posted on the course website. Homework is due approximately once per week, typically on Friday of the week following the homework posting. Check Carmen for exact dates and times. Homework assignments will be submitted for grading via Carmen.

Midterm Exam: There will be one midterm exam. The midterm will be delivered in person, during class time. Information about the exam will be posted well in advance through the course website. If mandated, exams will be delivered online, through Carmen.

Final Exam: There will be one final exam held during exam week in the Department of Statistics computer lab. The final exam will include analysis of provided data using R software. More information will be posted well in advance through the course website.

Midterm – Wednesday, 10/11/23.
Final Exam – To be announced.

Late assignments

<Policy will be added when the course is offered>

Instructor feedback and response time

<Policy will be added when the course is offered>

COURSE SCHEDULE

Refer to the Carmen course for up-to-date assignment due dates. RD indicates the Ravishanker and Dey textbook; C indicates the Christensen textbook.

Week	Dates	Topics	Reading	Homework
1	8/21/23 – 8/27/23	Introduction, Linear algebra	RD Chapter 1	
2	8/28/23 – 9/3/23	Linear models; Least squares; Geometry	RD 2.6, 4.1, 4.2	
3	9/4/23 – 9/10/23	Generalized inverses; Fitted values	RD 3.1, 3.2	Homework 1 due
4	9/11/23 – 9/17/23	Estimability; Gauss-Markov theorem; Generalized LS	RD 4.3, 4.4, 4.5	Homework 2 due
5	9/18/23 – 9/24/23	Multivariate normal pdf; Distr. Of quadratic forms	RD 5.1, 5.2, 5.3	Homework 3 due
6	9/25/23 – 10/1/23	Distr. Of quadratic forms; Inference for estimable functions	RD 5.4, 7.1	Homework 4 due
7	10/2/23 – 10/8/23	F-test	RD 7.1	Homework 5 due
8	10/9/23 – 10/15/23	F-test Midterm (10/11)		
9	10/16/23 – 10/22/23	Nonparametric Regression (wavelets, splines, trees)	C 1.1-1.5	
10	10/23/23 – 10/29/23	Nonparametric Regression (wavelets, splines, trees)	C 1.6-1.12	
11	10/30/23 – 11/5/23	Penalized Estimation (ridge, Lasso)	C 2.1-2.2	Homework 6 due
12	11/6/23 – 11/12/23	Penalized Estimation (ridge, Lasso)	C 2.3-2.6	

Week	Dates	Topics	Reading	Homework
13	11/13/23 – 11/19/23	Multivariate linear models	C 9.1-9.5	Homework 7 due
14	11/20/23 – 11/26/23	Multivariate linear models	C 9.6-9.9	
15	11/27/23 – 12/3/23	Principal Components, factor analysis	C Chapter 14	Homework 8 due

OTHER COURSE POLICIES

Academic integrity policy

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Statement on Title IX

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Commitment to a diverse and inclusive learning environment

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Land Acknowledgement

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Your mental health

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ACCESSIBILITY ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

Requesting accommodations

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Accessibility of course technology

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- Canvas accessibility (go.osu.edu/canvas-accessibility)
- Streaming audio and video
- CarmenZoom accessibility (go.osu.edu/zoom-accessibility)
- Collaborative course tools

THE OHIO STATE UNIVERSITY

College of Arts & Sciences
Department of Statistics

SYLLABUS: STAT 7541

Advanced Stochastic Processes
Spring 2024 (full semester)
3 credit hours

COURSE OVERVIEW

Instructor

<NAME TO BE ANNOUNCED>

Email address: <TO BE ANNOUNCED>

Lectures: 3 classes a week with 55 minute lectures. <LOCATION TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Graduate teaching assistant

<NAME>

Email address: <TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Prerequisites

STAT 7201 or permission of the instructor.

Course description

This course is an introduction to stochastic processes with emphases on applications, computations and data analyses. Students will learn about foundational models for dependent collections of random variables and computational methods for sampling. Topics include Markov chains, point processes, Gaussian processes, Brownian motion and stochastic differential equations. Other topics in stochastic processes will be covered as time permits, such as sequential Monte Carlo and exact sampling.

Course learning outcomes

By the end of this course, students should successfully be able to:

- Write probability models for a variety of dependent data generating processes and anticipate the typical behaviors of these models.
- Perform inference and prediction in the context of stochastic processes using appropriate statistical methods.
- Numerically simulate stochastic processes in discrete and continuous spaces.
- Use a stochastic process as a tool to sample from a complex or unknown probability distribution.

COURSE MATERIALS AND TECHNOLOGIES

Textbooks

Required

A. R. P. Dobrow (2016), Introduction to Stochastic Processes with R, Wiley. (https://onlinelibrary-wiley-com.proxy.lib.ohio-state.edu/doi/book/10.1002/9781118740712)

B. M. A. Pinsky & S. Karlin (2011), An introduction to stochastic modeling, 4th Edition, Elsevier Inc. (https://www-sciencedirect-com.proxy.lib.ohio-state.edu/book/9780123814166/an-introduction-to-stochastic-modeling)

C. S. M. Iacus (2008), Simulation and Inference for Stochastic Differential Equations, Springer Series in Statistics. (https://link-springer-com.proxy.lib.ohio-state.edu/book/10.1007/978-0-387-75839-8)

Recommended/optional

D. N. Chopin & O. Papaspiliopoulos (2020), An Introduction to Sequential Monte Carlo, Springer Series in Statistics. (https://link-springer-com.proxy.lib.ohio-state.edu/book/10.1007/978-3-030-47845-2)

E. L. Devroye (1986), Non-uniform random variate generation, Springer. (https://link.springer.com/book/10.1007/978-1-4613-8643-8)

Necessary Software

- This class requires you to use the statistical software packages called R (The R Project for Statistical Computing; http://www.r-project.org/) and RStudio (https://posit.co). These software packages are available as Free Software. More details will be given in lectures.

GRADING AND FACULTY RESPONSE

ASSIGNMENT CATEGORY	PERCENTAGE
Homework	**35**
Exam 1	**20**
Exam 2	**20**
Final	**25**
Total	**100**

Homework will be assigned approximately weekly and submitted for grading via Carmen.

Exams will be delivered in person during class time.

The **Final** exam will take place during exam week.

Late assignments

<Policy will be added when the course is offered>

Instructor feedback and response time

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COURSE SCHEDULE (EXAMPLE)

Refer to the Carmen course for up-to-date assignment due dates. In the Reading column, books are referred to by letter in book list, so A = Dobrow, B = Pinskey & Karlin, etc.

Week	Dates	Topics	Reading	Homework
1	**1/6/25 – 1/10/25**	**Introduction to stochastic processes, Definition & examples of Markov chains, transition probabilities**	**A ch 1-2**	
2	**1/13 – 1/17**	**Strong Markov Property, hitting times, classification of states**	**A 3.3-3.5, 3.9**	
3	**1/22 – 1/24**	**Stationary measures/distributions, Limit behavior, rates of convergence**	**A 3.1-3.2, 3.6-3.9, 5.5**	**Homework 1 due**
4	**1/27 – 1/31**	**Branching processes, Applications and simulation**	**A 4.2-4.4, 2.5, 5.1-5.3**	**Homework 2 due**
5	**2/3 – 2/7**	**Poisson process: definitions and simulation** *[Exam 1]*	**A chapter 6**	**Exam 1**
6	**2/10 – 2/14**	**Cox process: definition, simulation and inference**	**B 5.1.4, 6.7**	**Homework 3 due**
7	**2/17 – 2/21**	**Gaussian processes: definition, path properties, simulation**	**A 8.3, B**	**Homework 4 due**
8	**2/24 – 2/28**	**Gaussian processes: prediction, inference**		**Homework 5 due**
9	**3/3 – 3/7**	**Brownian motion: definition, path properties, computations**		**Homework 6 due**
	3/10 – 3/14	*Spring Break*		
10	**3/17 – 3/21**	**Ito integral: definition and Ito formula.** *[Exam 2]*		**Exam 2**
11	**3/24 – 3/28**	**Stochastic Differential Equations: numerical methods, simulation, inference**		**Homework 7 due**
12	**3/31 – 4/4**	**Applications of SDEs and/or Gaussian processes**		**Homework 8 due**
13	**4/7 – 4/11**	**Sequential Monte Carlo: introduction, state space models**		**Homework 9 due**

Week	Dates	Topics	Reading	Homework
14	**4/14 – 4/18**	**Sequential Monte Carlo: Hidden Markov models, filtering, applications**		**Homework 10 due**
15	**4/21**	**Applications of sequential Monte Carlo**		

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