

Stage I Comprehensive Exam

All Ph.D. students in the Department of Statistics and Actuarial Science are required to pass a Ph.D. comprehensive examination. This examination is divided into two parts, Stage I and Stage II. A student is automatically registered in this milestone in his or her first term in the Ph.D. program.

Purpose and Outcome

In Stage I of the Ph.D. Comprehensive, the aim is to ensure that the candidate has an adequate knowledge of basic topics covered in the Honours Statistics or Actuarial Science program at the University of Waterloo. Supervisors of new Ph.D. students will consult with them to informally determine if weaknesses are readily apparent, and to suggest courses or other means of rectifying those weaknesses. To demonstrate that he/she has this adequate knowledge, the student will be required to pass a comprehensive examination designed to test the student's ability to integrate the material from several topic areas (courses). The examination date is set by the Comprehensive Examination Committee. The results of the Comprehensive Examination are reported to the Graduate Operations Committee by the Comprehensive Examination Committee as a recommended decision based on the performance of each examination candidate.

The comprehensive exam consists of two papers: Paper I is common among all students in the department of Statistics and Actuarial Science. Paper II is given in two different versions, one for Ph.D. students in Statistics and the other for Ph.D. students in Actuarial Science. Ph.D. students in the department intending to write either paper should inform the Department graduate office at least two months in advance.

Paper I (Statistics and Actuarial Science)

- Probability theory
- Mathematical Statistics
- Statistical inference

Paper II (Statistics):

- Regression analysis
- Design of experiments
- Sampling theory

Paper II: (Actuarial Science)

- Loss Models
- Life Insurance Mathematics
- Financial Mathematics

When Offered and Taken

The Comprehensive Examination (Stage I) will be held the first week of the winter term on Friday (paper I) and the 2nd Monday of the winter term (paper II) from 9:00 a.m. to 1:00 p.m. A second Comprehensive Examination will be held in May. According to University regulations, all Stage I requirements must begin within four terms of a student's first registration in the Ph.D. program.

Eligibility

Normally, the examination is open only to students who have been accepted into the Ph.D. program.

Outcomes

For each paper, three basic outcomes are possible, Pass, Conditional Pass or Inadequate.

In each paper the recommended decision for the candidate is "Pass" if the performance in all topics examined is deemed to be satisfactory. If the recommended decision "Conditional Pass" is given in a paper, the Graduate Operations Committee will recommend specific appropriate remedial work in a related topic as well as the time frame in which the work is to be completed and by whom and how it should be assessed. When the remedial work is satisfactorily completed, the decision "Conditional Pass" will be changed to "Pass" for that paper.

If the recommended decision "Inadequate" is given in a paper, the Graduate Operations Committee will recommend specific remedial work in relevant topics. If the student is unsuccessful in the recommended work, the student will be required to rewrite the examination for that paper the next time it is offered.

A student will have successfully completed Stage I of the Ph.D. Comprehensive Examination when the decision "Pass" is received in both papers. The final decision as to whether a candidate has satisfied Stage I of the Comprehensive Examination will be made by the Graduate Operations Committee. Normally each candidate will be informed of the Graduate Operations Committee's decision on the results of the Comprehensive Examination within two to three weeks of the completion of the written exams.

A student may be required to withdraw from the program if he/she fails to complete the remedial work specified by the Graduate Operations Committee, or obtains the decision "Inadequate" on a second writing of the Comprehensive Examination.

Examination Committee

The Stage I Ph.D. Comprehensive Examination Committee is a standing committee of the department. The Associate Chair for Graduate Studies is an ex-officio member, a Chair and seven other faculty members, each of whom is appointed to serve for a two-year term, comprise the balance of the committee. Half of the committee members are new appointees in any given year. The remaining members continue, to provide

consistency over time. The committee prepares, administers and marks each offering of the Stage I Comprehensive.

Syllabus

Texts for Paper I:

1. *Introduction to Probability and Mathematical Statistics* by Bain and Engelhardt, 2nd Edition, 1992, Duxbury
 - Chapters 1, 2, 3, 4, 5, 6 (omit part of Section 6.5 on censored sampling), 7 (omit Section 7.8 on asymptotic distributions of extreme order statistics), 8, 9, 10, 11, 12 (omit Sections 12.9 and 12.10 on conditional and sequential tests of hypotheses, respectively)
 - Problems: All end of Chapter exercises (from 1 to 12) are relevant **except** for the following ones:
Chapter 7 – Exercises 25, 26, 27, 28
Chapter 12 – Exercises 36, 37, 38, 39
2. *Statistical Inference* by Casella and Berger, 2nd Edition, 2002, Duxbury
 - Chapters 1, 2, 3, 4, 5 (omit Sections 5.6.2 and 5.6.3 on indirect methods and the accept/reject algorithm for generating a random sample, respectively), 6, 7 (omit Section 7.2.4 on the EM algorithm), 8, 9, 10 (omit Sections 10.1.4 and 10.2.2 on bootstrap standard errors and robustness of M-estimators, respectively)
 - Problems: All end of Chapter exercises (from 1 to 10) are relevant **except** for the following ones:
Chapter 5 – Exercises 5.59, 5.60, 5.61, 5.62, 5.63, 5.64, 5.65, 5.67, 5.68,
5.69
Chapter 7 – Exercises 7.27, 7.28, 7.29, 7.30
Chapter 10 – Exercises 10.13, 10.14, 10.15, 10.16, 10.17, 10.29, 10.30,
10.39, 10.46
3. *Adventures in Stochastic Processes* by Resnick, 1992, Birkhauser
 - All un-starred sections of Chapters 1, 2, 3, 4, 5, as well as Sections 1, 2, 4, 5, 7, and 8 of Chapter 6
 - Problems: All un-starred end of Chapter exercises (from 1 to 6) are relevant **except** for the following ones:
Chapter 6 – Exercises 6.11, 6.12, 6.13, 6.14, 6.15, 6.18, 6.19, 6.21, 6.31

Texts for Paper II: Statistics

1a. *Linear Regression Analysis (2nd Ed)* George A.F. Seber and Alan J. Lee, (2003), Wiley Series in Probability and Statistics, ISBN 0-471-41540-5.

Chapters 1, 2, 3, 4, 5, sections 6.1, 6.2, 6.3, 6.4, 7.1, 8.1, 8.2, 8.3, 8.4, all of Chapters 9 and 10 and sections 12.1, 12.2, 12.3, 12.4. Also all of the material in Appendices A and B.

1b. *Introduction to Regression Modeling* Bovas Abraham and Johannes Ledolter (2006), Thomson Brooks/Cole, ISBN 0-534-42075-3

Chapters 1 – 7.

2. *Sampling: Design and Analysis (1st Edition)*, Sharon L. Lohr (1999), Duxbury Press, ISBN 0-534-35361-4 (Note that there is an instructor's manual for this book.) **OR** (2nd Edition) (2010), Cengage Learning, ISBN 0-495-10527-9 (No instructor's manual for the 2nd edition).

Chapters 1, 2, 3, 4, 5, and sections 6.6, 8.1, 8.2, 8.3 and 8.4.

3. *Design and Analysis of Experiments*, Douglas C. Montgomery 7th Ed, (2009) John Wiley and Sons, ISBN 978-0-470-12866-4. (Note that there is an instructor's manual for this book.)

Chapters 1, 2, 3, 4, sections 5.1, 5.2, 5.3, 6.1, 6.2, 6.3, 6.4, 6.5, 7.1, 7.2, 7.3, 7.4, 7.5, 8.1, 8.2, 8.3, and all of Chapter 10.

The student should concentrate on understanding concepts, proofs and fundamental theory. Simple data analysis will be expected but this will not be the main focus of Paper II. The students will be expected to be able to clearly explain all relevant concepts both in simple, clear English and more formally through detailed mathematical derivation.

Texts for Paper II: Actuarial Science

1. Life Contingencies (ACTSC 331)

David C.M. Dickson, Mary R. Hardy and Howard R. Waters: Actuarial Mathematics for Life Contingent Risks 2nd Edition (2013).

Chapters 7, 8 and 9

2. Loss Models (ACTSC 431/432)

S. Klugman, H. Panjer, and G. Willmot: Loss Models (fourth edition).

Chapters 3 (Sec. 3.4-3.5), 4, 5, 6, 7, 8, 9, 13 (Sec. 13.1-13.4), 14, 15, 17, 18, 19.

3. Mathematical Models in Finance (ACTSC 446)

H.H. Panjer (Ed.): Financial Economics With Applications to Investment, Insurance and Pensions.

Chapters 5-6.

4. *J. Hull: Options, Futures, and Other Derivatives. 10th Edition:*

Chapters 1, 3, 4, 5 (Sec. 1-11), 6, 7, 10, 11, 12, 13 (Sec. 1-9, 11), 14, 15, 19, 22, 26, 28, 29, 31, 32.