Syllabi for Comprehensive Exams

graduate studies | YORK UNIVERSITÉ UNIVERSITY

Course information	
Title: Measure Theory	
Course number: 6280	Semester: Fall 2020

Outline of topics to be covered

Sigma-algebras; measures; Lebesgue measure; measurable functions; integration; convergence theorems; Lp spaces; signed measures; decomposition theorems; product measures; differentiation of measures.

The topics correspond to the parts of Cohn's book mentioned below.

Reading sources and textbooks

The course textbook is:

Donald L. Cohn, "Measure Theory", Second Edition, Birkhauser 2013. Chapters 1-6, except sections 2.6, 4.4, and 6.1. (This book is available for free download to all York students through York Libraries.)

The material also appears in:

H.L. Royden and P.M. Fitzpatrick, "Real Analysis", Fourth Edition, Prentice Hall 2010. Chapters 2-8 and 17-20 (but only parts of some chapters).

Evaluation method

1. 80%: Written 3-hour exam. It will be the same as the final exam for the course. It will be written remotely.
2. 20%: Oral component, up to 30 minutes. It will include some discussion of the student's responses on the written component.

Passing threshold: 60%

% of the comprehensive exam: 60%

Syllabi for Comprehensive Exams

graduate studies | YORK UNIVERSITÉ UNIVERSITY

Course information	
Title: Advanced Numerical Methods	
Course number: 6651	Semester: Fall 2020

Outline of topics to be covered

Chapter 1. Optimization Methods!
Chapter 2. The Preconditioned Conjugate Gradient Methods!
Chapter 3. Numerical Methods for Initial Value Problems of!
Ordinary Differential Equations!
Chapter 4. Approximation Theory!
Chapter 5. Numerical Methods for Boundary-Value Problems of ODEs!

Reading sources and textbooks

1. Numerical Analysis, by R. Kress, Springer-Verlag. (Chps 10 & 11; Section 8.2)
2. Numerical Analysis, by R. L. Burden, et al., 10th ed, CENGAGE Learning Publishing Company, (Section 7.6; Section 10.4; Chps 5, 9 & 11)
3. Numerical Optimization, by J. Nocedal and S.J. Wright, Springer-Verlag. (Chps 3 & 5)!

Evaluation method

Written Take-home Three-hours Examination. Examination will be posted on Crowdmark and students will submit their completed exam on Crowdmark.

Passing threshold: 60%

% of the comprehensive exam: 60%

Syllabi for Comprehensive Exams

Course information

Title: General Topology

Course number: 6540	Semester: Fall 2020

Outline of topics to be covered

The General Topology Comprehensive Examination during the Fall 2020 semester may cover the following topics:

1. Topological Spaces Topological spaces, open sets, metric spaces, basis for a topology, subspaces, product spaces, nets, Hausdorff space, closed sets, limit points, boundary points, closures of sets, interior of sets
2. Continuous Functions Continuous functions, homeomorphisms, quotient spaces, quotient maps, connected sets, Intermediate Value Theorem, path connected, locally connected
3. Compact Topological Spaces Compact space, Heine-Borel, Extreme Value Theorem, finite intersection property, Tychonoff's Theorem, local compactness, one-point compactification
4. Compact Metric Spaces Complete metric spaces, complete function spaces, sequential compactness, totally bounded sets, Borel-Lebesgue Theorem, Arezela-Ascoli's Theorem, Stone-Weierstrass Theorems
5. Separability Axioms and Theorems Separation axioms, normal spaces, Urysohn's Lemma, Tychonoff spaces, Stone-Cech Compactification, Tietze Extension Theorem
6. Metrizations Countability axioms, Baire Category Theorem, Urysohn's Metrization Theorem, Local Finiteness*, Nagata-Smirnov Metrization Theorem*, paracompactness*, Smirnov Metrization Theorem*
7. Ultrafilters* Filters, Ultrafilters, Stone-Cech Compactification of the Natural Numbers

1) (* = time permitting)

Reading sources and textbooks

The reference textbook for this examination is Topology by Munkres (2nd edition). Students attempting this comprehensive examination should be familiar with the topics listed above as presented in Chapters 1-8. Alternatively, students can view the course notes and assignments for MATH 6540 on the course webpage.

Evaluation method

The three-hour written examination and thirty-minute oral examination will consist of 8 written questions and follow-up oral questions based on the written questions. Each pair of written and oral questions is worth 10 points for a total of 80 points.

The written portion of the examination will be proctored via Zoom with students in individual breakout rooms to ensure privacy. The oral portion of the examination will be conducted one-on-one via Zoom as it will not be possible to monitor all students via Zoom all the time due to the breakout rooms.

Passing threshold: 48 out of 80
% of the comprehensive exam: 60%

Syllabi for Comprehensive Exams

graduate studies | YORK UNIVERSITÉ UNIVERSITY

Course information	
Title: Mathematical Statistics	
Course number: 6620	Semester: Fall 2020

Outline of topics to be covered

The topics of the course include:

probability theory fundamentals of statistical inference such as exponential families of distributions various methods of estimation with frequentists or Bayesian methods the principles of hypothesis testing and confidence regions.

Reading sources and textbooks

1. Mathematical Statistics by Jun Shao: Introduction to Mathematical Statistics by Hogg, Mckean & Craig
2. Lecture notes of the instructor

Evaluation method

Time-restricted open book exam (2 hours, 8 questions) held in zoom breakout rooms for each student.

Passing threshold: 60%

% of the comprehensive exam: 60%

Course information

Title: Mathematical Modelling

Course number: 6931	Semester: Fall 2020

Outline of topics to be covered

Philosophy of modelling, Scaling, ODE Models, Linear Stability, Law of mass action and enzyme kinetics, PDE Models, Method of characteristics, Shocks, Traffic flow, Riemann Invariants, Dam Breaking, Conservation Laws, Stefan problem for melting ice, Diffusive Instabilities, Stochastic models, Birth-death processes, Network Models, Graph Laplacian, Diseases on networks

Reading sources and textbooks

1. Eck, C. , Garcke, H. , and Knabner, P. (2017). Mathematical modeling. Springer.
2. Fowler, A. C. (1997). Mathematical models in the applied sciences (Vol. 17). Cambridge University Press.
3. Howison, S. (2005). Practical applied mathematics: modelling, analysis, approximation (No. 38). Cambridge university press.
4. Illner, R. A. , Bohun, C. S. , McCollum, S. , and Van Roode, T. (2005). Mathematical modelling: a case studies approach (Vol. 27). American Mathematical Soc.
5. Moghadas, S. M. , and Jaberi-Douraki, M. (2018). Mathematical Modelling: A Graduate Textbook. John Wiley & Sons.
6. Newman, M (2010). Networks-An Introduction. Oxford University Press.

Evaluation method

MATH 6931 has a written course exam worth 40%. Students who do the comprehensive exam will have the same written exam worth 30% plus one additional question worth 10%. They will not submit a written answer for this problem, but instead will be asked a series of questions about it in an oral exam.

The written exam will be through Crowdmark. There will be 5 questions released in half-hour intervals. There will be five minutes between each question to tidy up the solutions and 5 minutes at the end to assist with any upload issues (5*30+5*5+5=180 minutes). The written exam will include a preamble that details the rules and academic honesty. Students will have to sign an academic honesty statement that they upload with photo ID (student card preferred). They will have to write their name and sign the top of each page that they upload.

The oral exam will be conducted through zoom and will be scheduled over a two day period (I plan on doing them in one day, it depends on the number of comprehensives). I will provide students with a question a half-hour before the oral exam. For the exam they will walk me through their solution process and I will ask them questions about the problem and their work. The oral exam will not exceed 30 minutes.

Passing threshold: 65% (24/40)
% of the comprehensive exam: Threshold applied to cumulative exam

Syllabi for Comprehensive Exams

Course information	
Title: Applied Statistics I	
Course number: 6630	Semester: Fall 2020

Outline of topics to be covered

The exam will cover the topics in applied statistics including:

1. Maximum likelihood estimation using numeric method
2. EM algorithm for missing data
3. Monte Carlo simulation methods
4. Randomization tests
5. Markov Chain Monte Carlo methods
6. Bootstrap and Jackknife methods

Reading sources and textbooks

Chapters 1,2,4,6, 7, 9 of Computational statistics, Geof Givens and Jennifer Hoeting, Wiley

Evaluation method

There will be 12 problems with proofs, calculations and short answers. Each problem is worth 10 points.

As this is a course about computational statistics, the test will be conducted on crowdmark, some questions will require the students to use R programming. For invigilation, I will ask the students to stay on Zoom during the exam.

Passing threshold: 72%

% of the comprehensive exam: 72% of the exam

Course information

Title: Applied Algebra

Course number: 6121	Semester: Fall 2020

Outline of topics to be covered

1. Linear Algebra (Recall crash course, Graduate level): Direct sum and tensor product has corresponding operations on basis and linear transformations
2. Group Theory and representation Theory: Recall: Group, morphism, subgroup, G-sets (and G-morphisms), Isomorphisms Theorems and quotient groups.; Jordan-Holder Theorem; Sylow Theorem
3. Representation of finite groups and characters (over C): Maske's Theorem; Schur's lemma; Structure of the space of G-endomorphisms; Structure of the inner space of characters on G
4. Final Theorem: the number of irreducibles representations for G equal the number of conjugacy classes of G
5. Preliminary notions in ring: definitions; Euclidian domain; Principal ideal domain; Polynomial rings
6. Grobner basis with emphasis on algorithmic aspect and computational geometry solving polynomial system of equations (with some application to robotics and computational geometry)
7. Modules over PID (Advanced linear algebra); Chinese Remainder Theorem; Classification of finitely generated modules over PID; Classification of finitely generated abelian groups; rational canonical form; Jordan canonical form

Reading sources and textbooks

1. D. S. Dummit and R. M. Foote, "Abstract Algebra" Willey (2004). ISBN: 978-0-471-43334-7.
2. T. W. Hungerford, "Algebra", GTM Springer (2003). ISBN: 978-0-387-90518-1.
3. D. A. Cox, J. Little and D. O'shea, "An Introduction to Computational Algebraic Geometry and Commutative Algebra" UTM Springer (2007). ISBN: 978-0-387-35650-1.
4. B. Sagan, "The Symmetric Group", Springer-Verlag GTM (2001) ISBN: 978-1-4757-6804-6

Reference (1) and (2) are good for the general material. Reference (3) is for the Grobner basis, and the reference (4) is for the group representation only (chap 1).

Evaluation method

The comprehensive exam instructions are typically:

This is a 3 hours exam; Give detailed justifications and explanations where appropriate. Attention to detail and clarity of exposition are important.

Total: 6 problems of 10 points; required for passing: 32 points.

Exam will be invigilated through different zoom room, one for each student. Students will work on paper and upload their document at the end.
Passing threshold: 32/60
% of the comprehensive exam: 53%

Syllabi for Comprehensive Exams

Course information	
Title: Partial Differential Equations	
Course number: 6350	Semester: Fall 2020

Outline of topics to be covered

Schwartz class and tempered distributions, Fourier transform, weak solutions. 1D wave equation, general solution, energy, existence and uniqueness, discontinuous coefficient, changes of variables. Laplace and Helmholtz equations, harmonic functions and their properties. Heat equation, regularity of solutions. Wave equation in higher dimensions, Radon transform, energy methods, Green's functions. Schroedinger equation, Maxwell's equations. Scattering theory.

Reading sources and textbooks

Lawrence Evans, Partial Differential Equations, 2nd Ed.; Gerald Folland, Introduction to Partial Differential Equations, 2nd Ed.; David Colton, Partial Differential Equations, an Introduction; Gerald Folland, Fourier Analysis and its Applications.

Evaluation method

2-part exam.

Part I (60%): Written take-home exam, consisting of problems based on the course.

Part II (40%): One-on-one oral exam, conducted over zoom. Students will be required to answer general-knowledge questions and explain the solution to a problem chosen randomly from a set list.

Passing threshold: 60% of the overall exam grade

% of the comprehensive exam: 60%