### Course information

<table>
<thead>
<tr>
<th>Title</th>
<th>Analytic Number Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course number</td>
<td>MATH 6110</td>
</tr>
<tr>
<td>Semester</td>
<td>winter 2022-2023</td>
</tr>
</tbody>
</table>

Exam is: [ ] Closed-book [ ] Open-Book

If open-book, provide a detailed rationale

Is Exam invigilated? [ ] Yes [ ] No

If No, provide a detailed rationale

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### Evaluation method

The exam will consist of a mix of definition questions, proofs of central results from analytic number theory (largely following Apostol’s presentation), and proofs of novel variations of these results.

The syllabus must be approved by the PhD Committee
Does the duration of exam exceed 3 hours?  □ Yes  ✔ No
If Yes, provide a detailed rationale

Outline of topics to be covered
- elementary number theory
- arithmetic functions, average values, and asymptotics
- Euler and Abel summation and related techniques
- equivalent forms of the prime number theorem, and related asymptotics
- Dirichlet characters and primes in arithmetic progressions
- the Riemann zeta function and Dirichlet L-functions (definitions, basic analytic properties)
- the analytic proof of the prime number theorem


Passing threshold (% of the exam): 65%

Faculty | Signature | Date
--- | --- | ---
Name Patrick Ingram |  | 10 Feb 2023, rev 6 Mar

This form must be submitted electronically by email to: gradmath@yorku.ca.
**Course information**

<table>
<thead>
<tr>
<th>Title</th>
<th>Algebra II</th>
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</thead>
<tbody>
<tr>
<td>Course number</td>
<td>Math 6122</td>
</tr>
<tr>
<td>Semester</td>
<td>Winter</td>
</tr>
</tbody>
</table>

Exam is:  ✔ Closed-book  ☐ Open-Book  
If open-book, provide a detailed rationale

Is Exam invigilated?  ✔ Yes  ☐ No  
If No, provide a detailed rationale

**Evaluation method**

In-person exam, two and half hours. There will be 10 problems (10% each). 55% is the minimal pass for the comprehensive exam.
Graduate Program in Mathematics and Statistics

Comprehensive Exam

Does the duration of exam exceed 3 hours? □ Yes  ✔ No
If Yes, provide a detailed rationale

Outline of topics to be covered

Further ring and module theory;
more on ideals (primes, irreducible, maximal, etc), UFD, injective and projective modules;
tensor products of modules;
Introduction to algebraic geometry: varieties, radical ideals, Hilbert’s nullstellensatz;

Fields theory and Galois theorems: field extensions, splitting fields, automorphism group of fields, Galois correspondence, Galois groups of polynomials, solving polynomials with radicals.

Introduction to category theory.

Textbook: Algebra, GTM 73, by Thomas W. Hungerford

Passing threshold (% of the exam): 55 %

Faculty  Signature  Date
Name     Yun Gao    02/10/2023

This form must be submitted electronically by email to: gradmath@yorku.ca.
# Comprehensive Exam

<table>
<thead>
<tr>
<th>Course information</th>
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<tbody>
<tr>
<td><strong>Title</strong></td>
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<tr>
<td><strong>Course number</strong></td>
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<tr>
<td><strong>Semester</strong></td>
</tr>
</tbody>
</table>

**Exam is:** [ ] Closed-book  [ ] Open-Book  
*If open-book, provide a detailed rationale*

**Is Exam invigilated?**  [ ] Yes  [ ] No  
*If No, provide a detailed rationale*

**Evaluation method**

This will be a written exam during the April exam period. It will be exactly the same as the final exam of the course 6280 that is being offered in the Winter term.
Does the duration of exam exceed 3 hours?  □ Yes  □ No
If Yes, provide a detailed rationale

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.

These topics correspond to the material in the course textbook:
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:
2-8 and 17-20 (but only parts of some chapters).

Passing threshold (% of the exam):  60 %

<table>
<thead>
<tr>
<th>Faculty</th>
<th>Signature</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
<td>Name</td>
<td>Neal Madras</td>
<td>1/29/23</td>
</tr>
</tbody>
</table>

This form must be submitted electronically by email to: gradmath@yorku.ca.

The syllabus must be approved by the PhD Committee
## Comprehensive Exam

<table>
<thead>
<tr>
<th>Course information</th>
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<tbody>
<tr>
<td><strong>Title</strong></td>
<td>Differential Equations</td>
</tr>
<tr>
<td><strong>Course number</strong></td>
<td>6340</td>
</tr>
<tr>
<td><strong>Semester</strong></td>
<td></td>
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</tbody>
</table>
| **Exam is:**        | ✔ Closed-book
|  |   |
| If open-book, provide a detailed rationale |  |
| **Is Exam invigilated?** | ✔ Yes
|  |   |
| If No, provide a detailed rationale |  |

### Evaluation method

There will be 6 questions to cover the selected topics from the syllabus.

The syllabus must be approved by the PhD Committee
**Comprehensive Exam**

<table>
<thead>
<tr>
<th>Does the duration of exam exceed 3 hours?</th>
<th>☑ Yes</th>
<th>No</th>
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</thead>
<tbody>
<tr>
<td>If Yes, provide a detailed rationale</td>
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</table>

**Outline of topics to be covered**

1. General properties of Differential Equations  
   Existence, uniqueness, dependence on initial data and parameters, extensibility.

2. Linear Systems and Stability  
   General theory of linear systems, Periodic coefficients and Floquet Theory, Stability of linear and nonlinear systems.

3. Nonlinear Systems: Local Theory  
   Linearization, Invariant manifolds, Hartman-Grobman Theorem, Normal form theory.

4. Nonlinear Systems: Global Theory  
   Limit sets and attractors, periodic sets and limit cycles; Poincare map, Poincare-Bendixson Theory, Lotka-Volterra system, Liénard systems.

5. Bifurcation theory of nonlinear systems  
   Saddle-node bifurcation, transcritical bifurcation, pitchfork bifurcation, Hopf bifurcation, homoclinic-bifurcations, co-dimension 2 and 3 bifurcations.


<table>
<thead>
<tr>
<th>Passing threshold (% of the exam): 60%</th>
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</table>

**Faculty**  
Name: Huaiping Zhu  
Signature: [Signature]  
Date: 1/27/23

This form must be submitted electronically by email to: gradmath@yorku.ca.

The syllabus must be approved by the PhD Committee
Math6340 Winter 2023

Differential Equations

Instructor: Huaiping Zhu

Topics

- General properties of Differential Equations
  Existence, uniqueness, dependence on initial data and parameters, extensibility.
- Linear Systems and Stability
  General theory of linear systems, Periodic coefficients and Floquet Theory, Stability of linear and nonlinear systems.
- Nonlinear Systems: Local Theory
  Linearization, Invariant manifolds, Hartman-Grobman Theorem, Normal form theory.
- Nonlinear Systems: Global Theory
  Limit sets and attractors, periodic sets and limit cycles; Poincare map, Poincare-Bendixson Theory, Lotka-Volterra system, Liénard systems.
- Bifurcation theory of nonlinear systems:
  Saddle-node bifurcation, transcritical bifurcation, pitchfork bifurcation, Hopf bifurcation, homoclinic-bifurcations, co-dimension 2 and 3 bifurcations.
- Nonlinear dynamics and applications in physics, biology and finance.

Textbook:
Lecture Notes (Book Draft).

References:

Grade Policy: Assignments (40%) + Final exam (60%)

Final Exam: 180 minutes. Invigilated in-person.

For Compressive Exam:
There will be 6 questions, total marks 120. I will consider 60%, or equivalently, 72 a pass.
<table>
<thead>
<tr>
<th>Course information</th>
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<tbody>
<tr>
<td>Title: Advanced Mathematical Statistics</td>
</tr>
<tr>
<td>Course number: 6621</td>
</tr>
<tr>
<td>Semester: W23</td>
</tr>
<tr>
<td>Exam is: [✓] Closed-book</td>
</tr>
<tr>
<td>Open-Book</td>
</tr>
<tr>
<td>If open-book, provide a detailed rationale</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Is Exam invigilated? [✓] Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>If No, provide a detailed rationale</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Evaluation method</td>
</tr>
<tr>
<td>A comprehensive exam</td>
</tr>
</tbody>
</table>
Does the duration of exam exceed 3 hours?  
Yes  
No

If Yes, provide a detailed rationale

Outline of topics to be covered

The topics of the course include:

Probability theory;

Limit theorems in mathematical statistics;

Asymptotic properties of the following statistics: (a) The usual statistics computed from a sample;  
(b) The statistics concocted as transformations of vectors of more basic statistics; (c) statistics  
arising in classical parametric inference and contingency table analysis; (d) U-statistics

References:


4) Lehmann, E.L., Elements of Large-Sample Theory, Springer; Corrected edition (August  
27, 2004).

Passing threshold (% of the exam): 60%

<table>
<thead>
<tr>
<th>Faculty</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Yuehua Wu</td>
<td></td>
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</tbody>
</table>

This form must be submitted electronically by email to: gradmath@yorku.ca.

The syllabus must be approved by the PhD Committee
## Comprehensive Exam

### Course information

<table>
<thead>
<tr>
<th>Title</th>
<th>Generalized linear models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course number</td>
<td>Math6622</td>
</tr>
<tr>
<td>Semester</td>
<td>Winter</td>
</tr>
</tbody>
</table>

**Exam is:**  
- [x] Closed-book  
- [ ] Open-Book  

If open-book, provide a detailed rationale

**Is Exam invigilated?**  
- [x] Yes  
- [ ] No  

If No, provide a detailed rationale

### Evaluation method

The Ph.D. students should obtain at least 60/100 to pass the comprehensive exam.
**Graduate Program in Mathematics and Statistics**

**Comprehensive Exam**

<table>
<thead>
<tr>
<th>Does the duration of exam exceed 3 hours?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>If Yes, provide a detailed rationale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math6622 final exam will last 3 hours. So the comprehensive exam with extra questions will last 4 hours.</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Outline of topics to be covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>review of linear models; formulation of GLMs; link functions; iterative least squares algorithms; deviance and asymptotic theory; model selection; residuals and quasi-likelihood; generalized linear mixed models.</td>
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</table>

<table>
<thead>
<tr>
<th>Passing threshold (% of the exam): 60%</th>
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<table>
<thead>
<tr>
<th>Faculty</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Wei Liu</td>
<td>Jan 27, 2023</td>
</tr>
</tbody>
</table>

This form must be submitted electronically by email to: gradmath@yorku.ca.
GS MATH 6622 3.0: Generalized Linear Models
(Winter, 2022 - 23)

Instructor: Wei Liu, office N601B, Ross Building, liuwei@yorku.ca
Lectures: 11:30am – 1:00pm on Tuesdays and Thursdays, MC 216 and LSB 101
Office hours: by appointment
Class Webpage: https://eclass.yorku.ca/ (please check it out frequently!)

- It is vital to be aware of course announcements, and adhere to dates and deadlines for
  the course. It is students’ responsibility to be aware of all in-class announcements and
  eClass announcements.

- Materials from the course are copyrighted and not to be distributed to individuals outside
  of the course whether as a physical or online copy at any time before the course has
  started, during the tenure of the course or after the course is completed. Individuals
  caught disobeying this will be charged.


References:
Faraway (2016). Extending the Linear Model with R: Generalized Linear, Mixed Effects, and
Hall/CRC Press.

Course description: Generalized Linear Models (GLMs) are an extension to linear models
where the response variable is not continuous. These models are commonly used for analysis
where the response variables are binary, categorical, proportions, or counts. GLMs play a
crucial role in statistics and can be widely applied in industry, government, and banks as well
as other areas. Tentative topics will include: review of linear models; formulation of GLMs; link
functions; iterative least squares algorithms; deviance and asymptotic theory; model selection;
residuals and quasi-likelihood; generalized linear mixed models.

Evaluation: Three assignments via Crowdmark (30%) , a group project and presentation
(25%), and a final exam (45%). The Ph.D. students should obtain at least 60/100 to pass the
comprehensive exam. It is the students’ responsibility to

1. be aware of the due time. NO extension for any submission. 0 grade for late submission.

2. make sure your assignment is uploaded fully and completely before the due time. Try to
make your picture a small size. Large files may cause uploading problem.

3. make sure the content you uploaded is clear, readable and markable. The unclear submis-
   sion will not be graded.
4. Missed final exam: A student who becomes ill, has a personal/family emergency or a religious observance may ask for a later date for their final exams. To do this, students must request deferred standing, no later than one week after the missed examination or the last day of classes. For details, please visit http://myacademicrecord.students.yorku.ca/deferred-standing.

5. A simple scientific calculator without statistical functions can be used for the final exam. Graphical or programmable calculators are NOT allowed.

6. It is expected that all students are aware of their individual responsibilities under the University Policies and Regulations (http://www.yorku.ca/univsec/policies) which will be strictly adhered to in this class. No form of academic dishonesty will be tolerated.

Email Policy:

i). It is strongly recommended that you use your York University email account.

ii). Please always put MATH 6622 on the subject line.

iii). Please identify yourself with your name and student number at the end of email.

Important Dates: check https://registrar.yorku.ca/enrol/dates
# Comprehensive Exam

**Course information**

<table>
<thead>
<tr>
<th>Title</th>
<th>Numerical Solutions to Differential Equations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course number</td>
<td>Math 6652</td>
</tr>
<tr>
<td>Semester</td>
<td>Winter 2022-23</td>
</tr>
<tr>
<td>Exam is:</td>
<td>☑ Closed-book ☐ Open-Book</td>
</tr>
<tr>
<td>If open-book, provide a detailed rationale</td>
<td></td>
</tr>
</tbody>
</table>

**Is Exam invigilated?** ☑ Yes ☐ No

If No, provide a detailed rationale

**Evaluation method**

Three hour written examination. The exam will have 6 questions; four questions will be evaluated out of 15 marks while two questions will be evaluated out of 20 marks (total 100 marks). The exam will be written in person at the University and invigilated by the course instructor.
# Comprehensive Exam

**Does the duration of exam exceed 3 hours?**
- [ ] Yes
- [x] No

**If Yes, provide a detailed rationale**

**Outline of topics to be covered**
- Section 1: Finite Difference Formulations
- Section 2: Parabolic Equations in One Space Dimension
- Section 3: Parabolic Equations in Two and Three Space Dimensions
- Section 4: Stability Analysis
- Section 5: Linear Second Order Elliptic Equations in One and Two Space Dimensions
- Section 6: Hyperbolic Equations in One Space Dimension

**Passing threshold (% of the exam): 60%**

<table>
<thead>
<tr>
<th>Faculty</th>
<th>Signature</th>
<th>Date</th>
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<tbody>
<tr>
<td>Name</td>
<td>Michael Haslam</td>
<td>10/20/22</td>
</tr>
<tr>
<td></td>
<td>Michael Haslam</td>
<td>Digitally signed by Michael Haslam Date: 2022.10.20 17:05:16 -04'00'</td>
</tr>
</tbody>
</table>

This form must be submitted electronically by email to: gradmath@yorku.ca.

The syllabus must be approved by the PhD Committee
MATH 6652 3.0  Numerical Solutions to Differential Equations: Syllabus for comprehensive exam, Winter 2022-23

Evaluation:

The final exam for Math 6652 is to serve as the comprehensive exam in numerical analysis. As per the course outline, the final exam is weighted as 60% of the course grade. The exam will have 6 questions; four questions will be evaluated out of 15 marks while two questions will be evaluated out of 20 marks (total 100 marks). A passing grade for the exam will be 60/100 marks. The exam will be written in person at the University and invigilated by the course instructor.

The main themes stressed in the exam problems are consistency, stability, and accuracy of numerical schemes applied to parabolic, elliptic and hyperbolic partial differential equations. One problem at the end of the exam is designed to ensure the students have learned basic skills in Matlab computing, reflecting the practical/lab component of the course.

Principal Text:


Other References:


COMPREHENSIVE EXAMINATION TOPICS:

Section 1: Finite Difference Formulations

1.1 Taylor series expansion
1.2 Mixed partial derivatives
1.3 Finite difference equations

Section 2: Parabolic Equations in One Space Dimension

2.1 Explicit methods: FTCS, Richardson, and Dufort-Frankel
2.2 Implicit methods: Laasonen, Crank-Nicolson, beta (theta) formulation
2.3 Truncation error, consistency, and convergence
Section 3: Parabolic Equations in Two and Three Space Dimensions

3.1 Standard finite difference methods
3.2 ADI method in two and three dimensions
3.3 Approximate factorization
3.4 Truncation error, consistency, and convergence
3.5 General problems

Section 4: Stability Analysis

4.1 Discrete perturbation stability analysis
4.2 Fourier stability analysis
4.3 Stability of explicit and implicit methods
4.4 Multi-dimensional problems

Section 5: Linear Second Order Elliptic Equations in One and Two Space Dimensions

5.1 Explicit iterative methods: Jacobi, point Gauss-Seidel, point successive over-relaxation.
5.2 Implicit iterative methods: Line Gauss-Seidel, Line successive over-relaxation, ADI method.
5.3 Stability, error analysis, and consistency.

Section 6: Hyperbolic Equations in One Space Dimension

6.2 Implicit methods for linear equations: BTCS, Crank-Nicolson.
6.5 Implicit methods for non-linear equations: Beam and Warming.
6.6 Linear damping.
6.7 Flux corrected transport.