SFU GRADUATE STUDIES AND POSTDOCTORAL FELLOWS

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**MEMORANDUM**

| | | | |
|---|---|---|---|
| ATTENTION | Senate | DATE | June 13, 2016 |
| FROM | Wade Parkhouse, Chair of Senate<br>Graduate Studies Committee (SGSC) | No. | GS2016.20 |
| RE: | Faculty of Science | | |

**For information:**
Acting under delegated authority at its meeting of June 6, 2016, SGSC approved the following curriculum revisions **effective Spring 2017:**

Department of Biological Sciences
Course change (title, description): BISC 827

Department of Earth Science
New course: EASC 628 Advanced Mineral Deposits

Department of Mathematics
a) Program change: Master of Science in Mathematics
b) Program change: Doctor of Philosophy in Mathematics
c) New courses:
- MATH 801 Computer Algebra
- MATH 846 Cryptography
- MATH 875 PhD Preliminary Examination
- MATH 876 PhD Comprehensive Examination

d) Course change (description): MATH 701

SFU

MEMO

Faculty of Science

ATTENTION Wade Parkhouse, Dean, Graduate Studies

FROM Peter Ruben, Associate Dean, Research and Graduate Studies, Faculty of Science

RE Faculty of Science, New Courses and Major Program Changes

DATE May 12, 2016

TIME 2:07 PM

The following curriculum changes have been approved by the Faculty of Science and are forwarded to the Senate Graduate Studies Committee for approval. These curriculum items should be effective for Spring 2017. Please include them on the next SGSC agenda.

**Department of Biological Sciences**
Course change (title, description, perquisite): BISC 827

**Department of Earth Science**
New course: EASC 628 Advanced mineral deposits

NOT SUBMITTED TO SENATE

~~**Department of Statistics and Actuarial Science**~~
~~New course: STAT 641 Introduction to Statistical Computing and Exploratory Data Analysis—R~~
~~New course: STAT 642 Introduction to Statistical Computing and Exploratory Data Analysis—SAS~~

NOT SUBMITTED TO SENATE

~~**Department of Physics**~~
~~New course: PHYS 890: General Relativity and Gravitation~~
~~New course: PHYS 891: Cosmology~~

**Department of Mathematics**
Program change: MSc Mathematics, PhD in Mathematics
New course: MATH 801 Computer Algebra
New course: MATH 846 Cryptography
New course: MATH 875 PhD Preliminary Examination
New course: MATH 876 PhD Comprehensive Examination
COURSE CHANGE, MATH 701 Computer Algebra

SIMON FRASER UNIVERSITY
GRADUATE STUDIES & POSTDOCTORAL FELLOWS

# Graduate Course Change

**Attach a separate document if more space is required.**

| Course Subject/Number | Units | Effective Term and Year |
|---|---|---|
| BISC 827 | 1 | Spring 2017 |

Course Title: Seminar in Ecology, Evolution, and Conservation

Rationale for Change:
The new title and description will better reflect the range of topics covered in the Ecology, Evolution, and Conservation stream of the department.

**Proposed Changes (Check all that apply)**

☐ Course number ☐ Units* ☑ Title ☑ Description ☐ Prerequisite ☐ Other _____

**Complete only the fields to be changed**

| FROM | TO |
|---|---|
| Course Subject/Number | Course Subject/Number |
| Units | Units* |
| Course Title<br>Seminar in Ecology, Evolution, and Conservation | Course Title (max 100 characters)<br>Seminar in Evolutionary, Behavioural, and Conservation Ecology |
| Course Short Title | Course Short Title (max 30 characters) |
| Description<br>An introduction to the important issues, methods, and philosophy of ecology, evolution, and conservation biology as represented by faculty in the Department of Biological Sciences, and discussion of current topics. | Description<br>Interactive discussions of current issues and cutting-edge methods in evolutionary, behavioural, and conservation ecology. |
| Prerequisite | Prerequisite |
| Other | Other |

* Program requirements may need to be revised when course units are changed. Please review the calendar and submit any relevant program revisions resulting from this course change.

**REMINDER:** All course changes must be identified on a cover memo and confirmed as approved when submitted to FGSC and SGSC.

## CONTACT PERSON

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| Biological Sciences | Isabelle Cote | imcote@sfu.ca |

## DEPARTMENTAL APPROVAL

| | | |
|---|---|---|
| Department Graduate Program Committee<br>Isabelle Cote | Signature<br>I Cote | Date<br>18 April 2016 |
| Department Chair<br>Elizabeth Elle | Signature | Date<br>18 Apr 2016 |

## FACULTY APPROVAL

| | | |
|---|---|---|
| Faculty Graduate Studies Committee (FGSC)<br>Peter Cuban | Signature | Date<br>19 Apr 16 |

## SENATE GRADUATE STUDIES COMMITTEE APPROVAL

| | | |
|---|---|---|
| Senate Graduate Studies Committee (SGSC)<br>Wade Parkhouse | Signature | Date<br>JUN 15 2016 |

**ADMINISTRATIVE SECTION (for DGS office only)**
**Course Attribute:** _____
**Course Attribute Value:** _____
**Instruction Mode:** _____
**Attendance Type:** _____

**If different from regular units:**
**Academic Progress Units:** _____
**Financial Aid Progress Units:** _____

SFU SIMON FRASER UNIVERSITY
GRADUATE STUDIES & POSTDOCTORAL FELLOWS

# New Graduate Course Proposal

**Please save the form before filling it out to ensure that the information will be saved properly.**

| Course Subject (eg. PSYC) | Number (eg. 810) | Units (eg. 4) |
|---|---|---|
| EASC | 628 | 3 |

Course title (max 100 characters including spaces and punctuation)
Advanced Mineral Deposits

Short title (for enrollment/transcript - max 30 characters)
Advanced Mineral Deposits

Course description for SFU Calendar *
A graduate-level overview of the role tectonics and fluid-rock interaction play in the genesis and spatial distribution of ore deposits. Basic skills used to aid the understanding of, and exploration for, ore deposits will be reviewed, including aspects of geophysics, geochemistry, petrography, and field methods. The focus of the course will be tailored to the technical background of the students, and the concepts and skills most relevant to their research interests and needs.

Rationale for introduction of this course
EASC 628 will be taught in conjunction with EASC 401 with the same faculty member teaching both so the additional workload would not be the same as a stand-alone course as student numbers for 628 are expected to be modest. Students enrolled in EASC 628 will be required to attend EASC 401 lectures (2h/wk) and labs (3h/wk) in addition to biweekly seminars with the instructor. Students will also complete an independent project during the semester. The course will provide a basic foundation through the undergraduate content while allowing exploration of the topic in more detail and at a higher level during seminars, and experience relevant to research interests will be acquired through the project.

| Effective term and year | Course delivery (eg 3 hrs/week for 13 weeks) |
|---|---|
| Spring 2017 | 5 hrs/week for 13 weeks (2 hrs lecture, 3 hrs lab) |
| Frequency of offerings/year: once/2 yrs | Estimated enrollment/offering: 2-5 |

Equivalent courses (These are previously approved courses that replicate the content of this course to such an extent that students should not receive credit for both courses.)
EASC 401

Prerequisite and/or Corequisite **
Undergraduate geology degree or permission of the instructor

Criminal record check required? ☐ Yes ☑ No If yes, then add this requirement as a prerequisite.

Campus where course will be taught ☑ Burnaby ☐ Surrey ☐ Vancouver ☐ Great Northern Way ☐ Off campus

Course Components ☑ Lecture ☐ Seminar ☑ Lab ☐ Research ☐ Practicum ☐ Online ☐ _____

| | | |
|---|---|---|
| Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | | Capstone course? ☐ Yes ☑ No |
| Repeat for credit? *** ☐ Yes ☑ No | Total completions allowed? 1 | Repeat within a term? ☐ Yes ☑ No |
| Required course? ☐ Yes ☑ No | Final exam required? ☑ Yes ☐ No | Additional course fees? ☐ Yes ☑ No |

Combined with an undergrad course? ☑ Yes ☐ No If yes, identify which undergraduate course and what the additional course requirements are for graduate students:
EASC 401 - graduate students must submit a research paper and attend extra bi-weekly seminars.

* Course descriptions should be brief and should never begin with phrases such as "This course will..." or "The purpose of this course is..." If the grading basis is satisfactory/unsatisfactory include this in the description.
** If a course is only available to students in a particular program, that should be stated in the prerequisite.
*** This mainly applies to a Special Topics or Directed Readings course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

| Faculty member(s) who will normally teach this course |
|---|
| Professor Dan Marshall |
| **Additional faculty members, space, and/or specialized equipment required in order to offer this course** |
| None |

## CONTACT PERSON

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| EASC | Dan Marshall | marshall@sfu.ca |

## DEPARTMENTAL APPROVAL

**REMINDER:** New courses must be identified on a cover memo and confirmed as approved when submitted to FGSC/SGSC. Remember to also include the course outline.

Non-departmentalized faculties need not sign

| | | |
|---|---|---|
| Department Graduate Program Committee<br>Gwenn Flowers | Signature | Date<br>26 April 2016 |
| Department Chair<br>Brent Ward | Signature Dr. Brent Ward, P.Geo. Digitally signed by Dr. Brent Ward, P.Geo. DN: cn=Dr. Brent Ward, P.Geo., o=SFU, ou=EArth Sciences, email=bcward@sfu.ca, c=US Date: 2016.04.26 13:46:32 -08'00' | Date<br>26 April 2016 |

## LIBRARY REVIEW

**Library review done?** ☑ YES

Course form, outline, and reading list must be sent by FGSC to lib-courseassessment@sfu.ca for a review of library resources.

## OVERLAP CHECK

**Overlap check done?** ☑ YES ☐ N/A

The course form and outline must be sent by FGSC to the chairs of each FGSC (fgsc-list@sfu.ca) to check for an overlap in content. An overlap check is not required for some courses (ie. Special Topics, Capstone, etc.)

## FACULTY APPROVAL

This approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| Faculty Graduate Studies Committee (FGSC) | Signature | Date |
|---|---|---|
| Peter Ruben | | 9 May 2016 |

## SENATE GRADUATE STUDIES COMMITTEE APPROVAL

| Senate Graduate Studies Committee (SGSC) | Signature | Date |
|---|---|---|
| Wade Parkhouse | | JUN 15 2016 |

**ADMINISTRATIVE SECTION (for DGS office only)**

**Course Attribute:** _____
**Course Attribute Value:** _____
**Instruction Mode:** _____
**Attendance Type:** _____

**If different from regular units:**
**Academic Progress Units:** _____
**Financial Aid Progress Units:** _____

**D. Marshall**
**(778) 782-5474**
**Rm: TASC 7321**
marshall@sfu.ca

**TA: TBA**

# EASC 628

# ADVANCED MINERAL DEPOSITS

## COURSE OUTLINE

**General:**
The course will be a combination of: (i) seminar-style classes with readings and student presentations; (ii) lab style exercises; and (iii) a term paper. All students will be expected to be able to lead the discussion of assigned readings. Students will develop skills related to asking and assessing scientific questions, synthesizing and presenting the results of scientific studies, and debating the assumptions and validity of conclusions outlined in published papers.

**Recommended courses:** An undergraduate degree in earth sciences including an undergraduate course in ore deposits, sedimentology, igneous or metamorphic petrology and permission of the instructor.

**Course Topics**
- Introduction to mineral resourses
- Geochemical and geophysical exploration techniques
- Fluid-mineral interactions
- Igneous ore-forming processes
- Magmatic hydrothermal ore-forming processes
- Metamorphic hydrothermal ore-forming processes
- Surficial and supergene ore-forming processes
- Sedimentary ore-forming processes
- Ore deposits in a global tectonic context

**Course Organization:**
Two 1 hour lectures and a 3 hour microscope- and specimen-based laboratory per week with a mixture of weekly and biweekly assignments, short presentations and a term research paper.

**Course Materials:**
Course text: Selected Readings. The course will be **partially seminar based**. Participation marks will be based on students' abilities to assimilate, ask questions on, make presentations on, and discuss the assigned readings.

**Online materials:**
The materials for reading assignments will be provided. Powerpoint lecture materials and laboratory instructions will be posted online.

**Additional Resources:**
Ridley, J. (2013): Ore deposit geology. Cambridge University Press.
Robb, L. (2005): Introduction to ore-forming processes. Blackwell Science Ltd.

**Course Grading:**

| | |
|---|---|
| • Midterm examination | 10% |
| • Laboratory assignments | 15% |
| • Microscopy exam | 10% |
| • Final lab examination | 15% |
| • Research paper | 15% |
| • Oral presentations | 10% |
| • Final exam | 25% |
| | 100% |

**Letter Grades**

| | |
|---|---|
| A+: 90-100 % | B+: 77-79.99 % |
| A : 85-89.99 % | B : 73-76.99 % |
| A- : 80-84.99 % | B- : 70-72.99 % |
| C+ : 67-69.99 % | |
| C : 63-66.99 % | D: 50 – 59.99 % |
| C- : 60-62.99 % | |

**Calendar Entry Change for Mathematics Master of Science**

| |
|---|
| Summary of change:<br>Introduction of an explicit breadth requirement - coursework involves at least 3 groups of courses from the list of 5 groups. Removal of MATH 882 from Project Course Option. |
| Rationale for change:<br>Department of Mathematics approved the Action Plan as a response to recommendations from an external review of the department. The Action Plan involves a review of course offerings and degree requirements for the Mathematics graduate programs.<br><br>The breadth requirement ensures that students acquire a broader knowledge of mathematics and they become prepared for a wider range of career choices including teaching mathematics at the postsecondary level. |
| Effective term and year:<br>Spring 2017 |
| Will this change impact current students? If yes, what is the plan for current students?<br>Students admitted in Fall 2016 or earlier will have the option of satisfying either the current degree requirements or the new degree requirements. |

| FROM | TO |
|---|---|
| ~~Mathematics~~<br><br>MASTER OF SCIENCE<br><br>Program Requirements<br><br>~~See Graduate General Regulations for further information and regulations.~~<br><br>~~Thesis Option~~<br><br>~~Students who choose the thesis option within the master of science (MSc) program will normally complete at least 18 graduate units beyond courses completed for the bachelor's degree.~~<br><br>~~Of these, at least 12 should be numbered 800 or above. The course work should involve at~~ | **Department of Mathematics**<br>Master of Science<br><br>Program Requirements<br><br>MATHEMATICS STREAM<br><br>The Master of Science degree requires a minimum of 30 graduate units consisting of a thesis (12 units) with 18 units of coursework or a project (6 units) with 24 units of coursework. All coursework is subject to supervisory committee and departmental graduate studies committee approval.<br><br>Thesis Option<br><br>Students must complete a minimum of 12 units of coursework from the courses listed in |

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| ~~least two different mathematics areas subject to supervisory committee and department graduate studies committee approval.~~ | Groups 1-5 below. The coursework must involve at least three different groups.<br><br>Group 1<br>MATH 817 - Groups and Rings (4)<br>MATH 818 - Algebra and Geometry (4)<br>MATH 819 - Algebra: Selected Topics (4)<br><br>Group 2<br>MATH 820 - Graph Theory (4)<br>MATH 821 - Combinatorics (4)<br>MATH 827 - Discrete Mathematics: Selected Topics (4)<br><br>Group 3<br>MATH 842 - Algebraic Number Theory (4)<br>MATH 843 - Analytic and Diophantine Number Theory (4)<br>MATH 845 - Number Theory: Selected Topics (4)<br>MATH 846 - Cryptography (4)<br><br>Group 4<br>MATH 801 - Computer Algebra (4)<br>MATH 808 - Advanced Linear Programming (4)<br>APMA 923 - Numerical Methods in Continuous Optimization (4)<br><br>Group 5<br>MATH 831 - Real Analysis I (4)<br>APMA 905 - Applied Functional Analysis (4)<br>MATH 833 - Analysis: Selected Topics (4) |
| ~~The candidate also submits a satisfactory thesis and defends it at an oral exam based on the thesis and related topics (MATH 898). See graduate general regulations for regulations.~~ | and<br>6 units of any graduate course |
| ~~Project Course Option~~ | and a thesis<br>MATH 898 –MSc Thesis (12) |
| ~~Students who choose the project option within the master of science (MSc) program will normally complete at least 30 graduate units beyond courses completed for the applicant's bachelor's degree. Of these, at least 18 units should be from courses numbered 800 or above. The course work should normally~~ | **Project Course Option**<br><br>Students must complete a minimum of 12 units of coursework from the courses listed in Groups 1-5 above. The coursework must involve at least three different groups. |

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| ~~involve at least three different mathematics areas subject to the approval of the student's supervisory committee and the department's graduate studies committee.~~<br><br>~~The candidate is required to complete and pass the project course~~<br><br>~~MATH 880 – MSc Project (6)~~<br><br>~~and the examination course~~<br><br>~~MATH 882 – MSc Final Examination (0)~~<br><br>~~At most, one unsuccessful attempt of each course is allowed.~~<br><br>Operations Research Stream<br><br>~~MSc candidates normally complete at least~~ 18 ~~graduate~~ units ~~beyond courses completed for the bachelor's degree. Of these, at least~~ 12 ~~should be~~ numbered 800 or above, ~~and must include all of the operations research core courses as follows.~~<br><br>APMA 923 - Numerical Methods in Continuous Optimization (4)<br>MATH 708 - Discrete Optimization (3)<br>MATH 808 - Advanced Linear Programming (4)<br><br>~~The additional courses may be graduate courses from the Department of Mathematics and will frequently include relevant courses from related disciplines such as business, engineering or statistics, subject to approval by the student's supervisory committee. At least one course is from an area of mathematics or operations research outside the operations research core courses. The candidate also submits a satisfactory thesis and defends it at an oral exam based on the thesis and related topics (MATH 898). See graduate general regulations for more information.~~ | and<br>12 units of any graduate course<br><br>and a project<br>MATH 880 – MSc Project (6)<br><br>MATH 880 can be attempted at most twice.<br><br>OPERATIONS RESEARCH STREAM<br><br>The Master of Science degree requires a minimum of 30 graduate units consisting of a thesis (12 units) with 18 units of coursework.<br><br>Students must complete all of<br>APMA 923 - Numerical Methods in Continuous Optimization (4)<br>MATH 708 - Discrete Optimization (3)<br>MATH 808 - Advanced Linear Programming (4)<br><br>and<br>4 units of graduate courses numbered 800 or above<br><br>and<br>3 units of any graduate course.<br><br>At least one course must be from an area of mathematics or operations research outside the operations research core courses. All coursework is subject to supervisory committee and departmental graduate studies committee approval.<br><br>and a thesis<br>MATH 898 –MSc Thesis (12)<br><br>Program Length<br><br>The estimated completion time for a Master of Science in Mathematics is two years.<br><br>Academic Requirements within the |

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| Academic Requirements within the Graduate General Regulations<br><br>All graduate students must satisfy the academic requirements that are specified in the graduate general regulations, as well as the specific requirements for the program in which they are enrolled, as listed above. | Graduate General Regulations<br>All graduate students must satisfy the academic requirements that are specified in the graduate general regulations, as well as the specific requirements for the program in which they are enrolled. |

**Calendar Entry Change for Mathematics Doctor of Philosophy**

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|---|
| Summary of change:<br>Change of the format of the comprehensive examination: the examination is divided into two parts (MATH 875 and MATH 876) which will be co-requisites. Adjustment and clarification of the breadth requirement. Editorial changes. |
| Rationale for change:<br>Department of Mathematics approved the Action Plan as a response to recommendations from an external review of the department. The Action Plan involves a review of course offerings and degree requirements for the Mathematics graduate programs, as well as a review of the format of the comprehensive exam.<br><br>The current version of the comprehensive examination (MATH 878) is offered as a six-hour examination that covers senior undergraduate level material as well as graduate level material. It is perceived that the exam is too long. Due to the large scope of the exam, it is hard to manage it and questions vary too much in difficulty and in style. It is proposed that the candidacy exam is divided into two shorter exams: MATH 875 (senior undergraduate level material) and MATH 876 (graduate level material). It is proposed that these two exams will be co-requisites so students have to take them in the same semester in order to understand and appreciate the connections between the various areas of mathematics that are examined.<br><br>Fulfillment of the breadth requirement to take courses from at least three areas of mathematics will be determined by the departmental graduate studies committee and student's supervisory committee. The first assessment of the extent to which the student has fulfilled this requirement will take place in the first semester of student's enrolment in the program. |
| Effective term and year:<br>Spring 2017 |
| Will this change impact current students? If yes, what is the plan for current students?<br>Students admitted in Fall 2016 or earlier will have the option of satisfying either the current degree requirements or the new degree requirements. |

| FROM | TO |
|---|---|
| Mathematics<br>DOCTOR OF PHILOSOPHY<br><br>~~Program Requirements~~<br><br>~~A doctor of philosophy (PhD) candidate is~~ | Mathematics<br>DOCTOR OF PHILOSOPHY<br><br>**Admission Requirements**<br>Applicants must satisfy the University admission requirements as stated in the |

~~normally required to complete the master of science (MSc) requirements (either the thesis or the project option) and at least 12 further graduate units.~~

~~Of these, at least eight units should be from courses numbered 800 or above. Subject to the approval of the department's graduate studies committee, a PhD candidate with an MSc degree is deemed to have completed the MSc requirements for the purpose of the PhD program requirements.~~

~~The graduate course work should normally involve at least four different areas of mathematics subject to the approval of the student's supervisory committee and the department's graduate studies committee.~~

~~Courses~~

~~Seven hundred division courses may be offered in conjunction with a 400 division course. Students may not complete a 700 division course if it is offered in conjunction with a 400 division course which they have completed previously.~~

## ~~Examination and Thesis Proposal~~

~~Candidates normally pass a two stage general exam. The first stage consists of successful completion of a comprehensive exam by enrolling in~~

~~MATH 878 - PhD Comprehensive Examination (0)~~

~~In the second stage, students present their supervisory committee with a written thesis proposal and then the student defends it at an open oral defence by enrolling in~~

~~MATH 879 - PhD Thesis Proposal (0)~~

Graduate General Regulations 1.3. Normally, candidates should have a Master of Science (MSc) degree in mathematics or a related discipline to enter the program.

## Mathematics Stream Program Requirements

This program consists of required and elective courses (12 units), and a thesis (12 units) for a minimum of 24 units. Students who did not complete a MSc degree may be asked to complete additional course work. The graduate course work, across degrees, should demonstrate a breadth of mathematical knowledge. This can be achieved by completing coursework in three of the five groups of courses listed in the Mathematics MSc program; similar breadth from coursework in other major areas of mathematics can satisfy this requirement. All course work is subject to supervisory committee and departmental graduate studies committee approval.

Students must complete a minimum of 24 units, including all of
MATH 875 - PhD Preliminary Examination (0)
MATH 876 - PhD Comprehensive Examination (0)
MATH 879 - PhD Thesis Proposal (0)

and
8 units of course work from courses numbered 800 or above

and
4 units of any graduate course

and a thesis
MATH 899 - PhD Thesis (12)

## Examinations

A student cannot attempt to complete MATH

~~The supervisory committee evaluates the thesis proposal and defence, and passes or fails the student. A candidate cannot complete either the general exam or the second stage more than twice. Both stages must be completed within six full-time terms of initial enrolment in the program.~~

~~Thesis Defence~~

~~Students must submit and successfully defend a thesis which embodies a significant contribution to mathematical knowledge by enrolling in~~

~~MATH 899 - PhD Thesis (12)~~

~~The supervisory committee evaluates the thesis proposal and defence, and passes or fails the student. A candidate cannot complete either the general exam or the second stage more than twice. Both stages must be completed within six full-time terms of initial enrolment in the program.~~

## ~~Operations Research Stream~~

~~A PhD candidate is normally required to complete the MSc requirements and at least 12 further graduate units. Of these, at least eight units must be from courses numbered 800 or above. Subject to the approval of the department's graduate studies committee, a PhD candidate with an MSc degree is deemed to have completed the MSc requirements for the purpose of the PhD program requirements.~~

~~Candidates normally pass a two-stage general exam. The first stage consists of successful completion of~~

~~MATH 888 - Ph.D. Comprehensive Exam: Operations Research (0)~~

~~In the second stage, students present to their~~

875, MATH 876 or MATH 879 more than twice. Normally, these examinations must be completed within six terms of initial enrolment in the program.

The program requires the submission and successful examination of a thesis. The thesis embodies a significant contribution to mathematical knowledge. The completed thesis is assessed by the student's examining committee at an oral examination.

## Operations Research Stream Program Requirements

This program consists of required and elective courses (12 units), and a thesis (12 units) for a minimum of 24 units. Students with who did not complete a MSc degree may be asked to complete additional course work. All course work is subject to supervisory committee and departmental graduate studies committee approval.

Students must complete a minimum of 24 units, including all of
MATH 888 - PhD Comprehensive Examination: Operations Research (0)
MATH 879 - PhD Thesis Proposal (0)

and
8 units of course work from courses numbered 800 or above

and
4 units of any graduate course

and a thesis
MATH 899 - PhD Thesis (12)

## Examinations

A student cannot attempt to complete MATH 888 or MATH 879 more than twice. Normally, these examinations must be completed within six terms of initial enrolment in the program.

| | |
|---|---|
| ~~supervisory committee a written thesis proposal and then defend it at an open oral defence by enroling in~><br><br>~~MATH 879 - PhD Thesis Proposal (0)~><br><br>~~The supervisory committee evaluates the thesis proposal and defence, and passes or fails the student. A candidate cannot attempt either general exam stage more than twice. Both stages must be completed within six full-time terms of initial enrolment in the program.~><br><br>~~Students must submit and successfully defend a thesis which embodies a significant contribution to mathematical knowledge, by completing~><br><br>~~MATH 899 - PhD Thesis (12)~><br><br>~~See the graduate general regulations for further information.~><br><br>## ~~Academic Requirements within the Graduate General Regulations~><br><br>~~All graduate students must satisfy the academic requirements that are specified in the graduate general regulations, as well as the specific requirements for the program in which they are enrolled, as listed above.~> | <u>The program requires the submission and successful examination of a thesis. The thesis embodies a significant contribution to mathematical knowledge. The completed thesis is assessed by the student's examining committee at an oral examination.</u> |

SIMON FRASER UNIVERSITY
GRADUATE STUDIES & POSTDOCTORAL FELLOWS

# New Graduate Course Proposal

**Please save the form before filling it out to ensure that the information will be saved properly.**

| Course Subject (eg. PSYC) | Number (eg. 810) | Units (eg. 4) |
|---|---|---|
| MATH | 801 | 4 |

Course title (max 100 characters including spaces and punctuation)
Computer Algebra

Short title (for enrollment/transcript - max 30 characters)
Computer Algebra

Course description for SFU Calendar *
Computing with long integers, polynomials, and mathematical formulae. Topics include computing polynomial greatest common divisors, the Fast Fourier Transform, Hensel's Lemma and p-adic methods, differentiation and simplification of formulae, polynomial factorization. Integration of rational functions and elementary functions, Liouville's principle, the Risch algorithm. Students will use a computer algebra system such as Maple for calculations and programming.

Rationale for introduction of this course
To provide graduate students in Mathematics and Computer Science a first course in computer algebra and to equip them with a tool (computer algebra system) for use in their studies. Computer Algebra is a modern discipline whose products are widely used in Sciences, Engineering and other disciplines.

| Effective term and year | Course delivery (eg 3 hrs/week for 13 weeks) |
|---|---|
| Spring 2017 | 4 hours/week for 13 weeks |
| Frequency of offerings/year: 1 offering / 2 years | Estimated enrollment/offering: 5 |

Equivalent courses (These are previously approved courses that replicate the content of this course to such an extent that students should not receive credit for both courses.)
MACM 401, MATH 701

Prerequisite and/or Corequisite **
none

Criminal record check required? ☐ Yes ☑ No If yes, then add this requirement as a prerequisite.

Campus where course will be taught ☑ Burnaby ☐ Surrey ☐ Vancouver ☐ Great Northern Way ☐ Off campus

Course Components ☑ Lecture ☐ Seminar ☐ Lab ☐ Research ☐ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete — Capstone course? ☐ Yes ☑ No

Repeat for credit? *** ☐ Yes ☑ No — Total completions allowed? _____ — Repeat within a term? ☐ Yes ☑ No

Required course? ☐ Yes ☑ No — Final exam required? ☑ Yes ☐ No — Additional course fees? ☐ Yes ☑ No

Combined with an undergrad course? ☑ Yes ☐ No If yes, identify which undergraduate course and what the additional course requirements are for graduate students:
Offered jointly with MACM 401. Additional requirements for MATH 801 are one extra lecture hour per week, extra homework assignments and a course project.

* Course descriptions should be brief and should never begin with phrases such as "This course will..." or "The purpose of this course is..." If the grading basis is satisfactory/unsatisfactory include this in the description.
** If a course is only available to students in a particular program, that should be stated in the prerequisite.
*** This mainly applies to a Special Topics or Directed Readings course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

| Faculty member(s) who will normally teach this course |
|---|
| Michael Monagan, Nils Bruin |
| **Additional faculty members, space, and/or specialized equipment required in order to offer this course** |
| none |

## CONTACT PERSON

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| Mathematics | Michael Monagan | mmonagan@cecm.sfu.ca |

## DEPARTMENTAL APPROVAL

**REMINDER:** New courses must be identified on a cover memo and confirmed as approved when submitted to FGSC/SGSC. Remember to also include the course outline.

Non-departmentalized faculties need not sign

| | | |
|---|---|---|
| Department Graduate Program Committee: Petr LISONEK | Signature | Date: 10 May 2016 |
| Department Chair: Manfred TRUMMER | Signature | Date: MAY 10 2016 |

## LIBRARY REVIEW

**Library review done?** ☒ YES

Course form, outline, and reading list must be sent by FGSC to lib-courseassessment@sfu.ca for a review of library resources.

## OVERLAP CHECK

**Overlap check done?** ☒ YES ☐ N/A

The course form and outline must be sent by FGSC to the chairs of each FGSC (fgsc-list@sfu.ca) to check for an overlap in content. An overlap check is not required for some courses (ie. Special Topics, Capstone, etc.)

## FACULTY APPROVAL

This approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| | | |
|---|---|---|
| Faculty Graduate Studies Committee (FGSC): PETER RUBEN | Signature | Date: 12 May 2016 |

## SENATE GRADUATE STUDIES COMMITTEE APPROVAL

| | | |
|---|---|---|
| Senate Graduate Studies Committee (SGSC): Wade Parkhouse | Signature | Date: JUN 15 2016 |

**ADMINISTRATIVE SECTION (for DGS office only)**

**Course Attribute:** _____
**Course Attribute Value:** _____
**Instruction Mode:** _____
**Attendance Type:** _____

**If different from regular units:**
**Academic Progress Units:** _____
**Financial Aid Progress Units:** _____

# MATH 801 Computer Algebra

## Outline

Offered jointly with MACM 401. MATH 801 has one additional lecture hour per week. Additional topics are covered in MATH 801. Additional assignment problems and a course project are required for MATH 801.

**Calendar description:**

Computing with long integers, polynomials, and mathematical formulae. Topics include computing polynomial greatest common divisors, the Fast Fourier Transform, Hensel's Lemma and p-adic methods, differentiation and simplification of formulae, polynomial factorization. Integration of rational functions and elementary functions, Liouville's principle, the Risch algorithm. Students will use a computer algebra system such as Maple for calculations and programming.

**Course details:**

- Algorithms for long integers and their analysis.
- Unique factorization and Euclidean rings.
- Polynomial representations, term orderings, and division.
- The Chinese remainder theorem and polynomial GCD computation.
- Polynomial interpolation and the Fast Fourier Transform.
- Hensel's lemma, the p-adic Newton iteration, and applications.
- Factoring polynomials over finite fields and the integers.
- Differentiation of mathematical formulae on a computer.
- Resultants and algorithms for rational function integration.
- The Risch decision procedure for elementary function integration.

**Text:** K.O. Geddes, S.R. Czapor, G. Labahn, *Algorithms for computer algebra.* Kluwer Academic Publishers 1992.

**Alternative text:** J. von zur Gathen, J. Gerhard, *Modern computer algebra.* Third edition. Cambridge University Press 2013.

**Grading:**

- Assignments 50%

- Course project 15%
- Final exam 35%

# MACM 401 Introduction to Computer Algebra

## Outline

**Prerequisite:** CMPT 307 or MATH 332 or MATH 340.

**Calendar description:**

Computer algebra, also called symbolic computation, covers data structures and algorithms for mathematical objects, including long integers, polynomials, and general mathematical formulae. Topics include computing polynomial greatest common divisors, the fast Fourier transform, Hensel's lemma and p-adic methods, differentiation and simplification of formulae, and polynomial factorization. Students will use a computer algebra system such as Maple for calculations and programming.

**Course details:**

- Algorithms for long integers and their analysis.
- Unique factorization and Euclidean rings.
- Polynomial representations, term orderings, and division.
- The Chinese remainder theorem and polynomial GCD computation.
- Polynomial interpolation and the Fast Fourier Transform.
- Hensel's lemma, the p-adic Newton iteration, and applications.
- Factoring polynomials over finite fields and the integers.
- Differentiation of mathematical formulae on a computer.

**Text:** *Algorithms for Computer Algebra* by Geddes, Czapor and Labahn.

**Alternative text:** *Modern Computer Algebra* by von zur Gathen and Gerhard.

**Grading:**

- Assignments 60%
- Final exam 40%

SIMON FRASER UNIVERSITY
GRADUATE STUDIES & POSTDOCTORAL FELLOWS

# New Graduate Course Proposal

**Please save the form before filling it out to ensure that the information will be saved properly.**

| Course Subject (eg. PSYC) | MATH | Number (eg. 810) | 846 | Units (eg. 4) | 4 |
|---|---|---|---|---|---|

Course title (max 100 characters including spaces and punctuation)
Cryptography

Short title (for enrollment/transcript - max 30 characters)
Cryptography

Course description for SFU Calendar *
An introduction to the subject of modern cryptography. Classical methods for cryptography and how to break them, the data encryption standard (DES), the advanced encryption standard (AES), differential and linear cryptanalysis. RSA and ElGamal public key cryptosystems, digital signatures, secure hash functions and pseudo-random number generation. Algorithms for computing with long integers including the use of probabilistic algorithms. Elliptic curve cryptography. Post-quantum cryptography.

Rationale for introduction of this course
Cryptography has become an essential part of modern digital communications. Knowledge of cryptography is a marketable skill for graduate students pursuing careers in academia, industry and government.

| Effective term and year | Spring 2017 | Course delivery (eg 3 hrs/week for 13 weeks) | 4 hrs/week for 13 weeks |
|---|---|---|---|
| Frequency of offerings/year | 1 offering / 2 years | Estimated enrollment/offering | 5 |

Equivalent courses (These are previously approved courses that replicate the content of this course to such an extent that students should not receive credit for both courses.)
MACM 442, MATH 742

Prerequisite and/or Corequisite **

Criminal record check required? ☐ Yes ☑ No If yes, then add this requirement as a prerequisite.

Campus where course will be taught ☑ Burnaby ☐ Surrey ☐ Vancouver ☐ Great Northern Way ☐ Off campus

Course Components ☑ Lecture ☐ Seminar ☐ Lab ☐ Research ☐ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | Capstone course? ☐ Yes ☑ No

Repeat for credit? *** ☐ Yes ☑ No | Total completions allowed? _____ | Repeat within a term? ☐ Yes ☑ No

Required course? ☐ Yes ☑ No | Final exam required? ☑ Yes ☐ No | Additional course fees? ☐ Yes ☑ No

Combined with an undergrad course? ☑ Yes ☐ No If yes, identify which undergraduate course and what the additional course requirements are for graduate students:
Offered jointly with MACM 442. Additional topics covered in the extra lecture hour. Additional homework problems and additional exam questions required for MATH 846.

* Course descriptions should be brief and should never begin with phrases such as "This course will..." or "The purpose of this course is..." If the grading basis is satisfactory/unsatisfactory include this in the description.
** If a course is only available to students in a particular program, that should be stated in the prerequisite.
*** This mainly applies to a Special Topics or Directed Readings course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

| Faculty member(s) who will normally teach this course |
|---|
| Petr Lisonek, Michael Monagan |
| **Additional faculty members, space, and/or specialized equipment required in order to offer this course** |
| none |

## CONTACT PERSON

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| Mathematics | Petr Lisonek | plisonek@sfu.ca |

## DEPARTMENTAL APPROVAL

**REMINDER:** New courses must be identified on a cover memo and confirmed as approved when submitted to FGSC/SGSC. Remember to also include the course outline.

Non-departmentalized faculties need not sign

| | | |
|---|---|---|
| Department Graduate Program Committee: Petr LISONEK | Signature | Date: 10 May 2016 |
| Department Chair: Manfred TRUMMER | Signature | Date: MAY 10 2016 |

## LIBRARY REVIEW

**Library review done?** ☒ YES

Course form, outline, and reading list must be sent by FGSC to lib-courseassessment@sfu.ca for a review of library resources.

## OVERLAP CHECK

**Overlap check done?** ☒ YES ☐ N/A

The course form and outline must be sent by FGSC to the chairs of each FGSC (fgsc-list@sfu.ca) to check for an overlap in content. An overlap check is not required for some courses (ie. Special Topics, Capstone, etc.)

## FACULTY APPROVAL

This approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| | | |
|---|---|---|
| Faculty Graduate Studies Committee (FGSC): PETER RUBEN | Signature | Date: 12 May 2016 |

## SENATE GRADUATE STUDIES COMMITTEE APPROVAL

| | | |
|---|---|---|
| Senate Graduate Studies Committee (SGSC): Wade Parkhouse | Signature | Date: JUN 15 2016 |

**ADMINISTRATIVE SECTION (for DGS office only)**

**Course Attribute:** _____
**Course Attribute Value:** _____
**Instruction Mode:** _____
**Attendance Type:** _____

**If different from regular units:**
**Academic Progress Units:** _____
**Financial Aid Progress Units:** _____

# MATH 846 Cryptography

## Outline

Offered jointly with MACM 442. MATH 846 has one additional lecture hour per week. Additional topics are covered in MATH 846. Additional assignment problems and exam questions are required for MATH 846.

**Calendar description:**

An introduction to the subject of modern cryptography. Classical methods for cryptography and how to break them, the data encryption standard (DES), the advanced encryption standard (AES), differential and linear cryptanalysis. RSA and ElGamal public key cryptosystems, digital signatures, secure hash functions and pseudo-random number generation. Algorithms for computing with long integers including the use of probabilistic algorithms. Elliptic curve cryptography. Post-quantum cryptography.

**Course details:**

- Classical Cryptography.
- The Data Encryption Standard and Advanced Encryption Standard.
- Differential Cryptanalysis, Linear Cryptanalysis.
- Basic Integer Algorithms and their Time Complexity.
- The RSA Public Key Cryptosystem and Attacks on RSA.
- Algorithms for Integer Primality Testing and Integer Factorization.
- Finite Fields and the ElGamal Cryptosystem.
- Algorithms for the Discrete Logarithm Problem.
- Elliptic Curve Cryptography.
- Key Distribution and Key Agreement Protocols.
- Digital Signature Schemes and Secure Hash Functions.
- Pseudo-Random Number Generation.
- The Quadratic Residue Problem and the Jacobi Symbol.
- Post-quantum Cryptography, McEliece Cryptosystem.

**Text:** D.R. Stinson, *Cryptography. Theory and practice.* Third edition. Chapman & Hall/CRC, 2006.

**Grading:**

- Assignments 60%
- Exams 40%

# MACM 442 Cryptography

## Outline

**Prerequisites:** (CMPT 201 or 225) and one of (MATH 340 or 332 or 342); or CMPT 405.

**Calendar description:**

An introduction to the subject of modern cryptography. Classical methods for cryptography and how to break them, the data encryption standard (DES), the advanced encryption standard (AES), the RSA and ElGamal public key cryptosystems, digital signatures, secure hash functions and pseudo-random number generation. Algorithms for computing with long integers including the use of probabilistic algorithms. Students with credit for MACM 498 between Fall 2003 and Spring 2006 may not take this course for further credit. Quantitative.

**Course details:**

- Classical Cryptography.
- The Data Encryption Standard and Advanced Encryption Standard.
- Basic Integer Algorithms and their Time Complexity.
- The RSA Public Key Cryptosystem and Attacks on RSA.
- Algorithms for Integer Primality Testing and Integer Factorization.
- Finite Fields and the ElGamal Cryptosystem.
- Algorithms for the Discrete Logarithm Problem.
- Key Distribution and Key Agreement Protocols.
- Digital Signature Schemes and Secure Hash Functions.
- Pseudo-Random Number Generation.
- The Quadratic Residue Problem and the Jacobi Symbol.

**Grading:**

- Assignments 60%
- Exams 40%

SIMON FRASER UNIVERSITY
GRADUATE STUDIES & POSTDOCTORAL FELLOWS

# New Graduate Course Proposal

**Please save the form before filling it out to ensure that the information will be saved properly.**

| Course Subject (eg. PSYC) | Number (eg. 810) | Units (eg. 4) |
|---|---|---|
| MATH | 875 | 0 |

Course title (max 100 characters including spaces and punctuation)
PhD Preliminary Examination

Short title (for enrollment/transcript - max 30 characters)
PhD Preliminary Examination

Course description for SFU Calendar *
A preliminary written examination covering a broad range of senior undergraduate material. Graded on a satisfactory/unsatisfactory basis.

Rationale for introduction of this course
In response to its external review, Department of Mathematics proposes to restructure the graduate comprehensive exam. The new format of the comprehensive exam will consist of two parts. MATH 875 will be the first part of the new exam.

| Effective term and year | Course delivery (eg 3 hrs/week for 13 weeks) |
|---|---|
| Spring 2017 | 3 hrs examination |
| **Frequency of offerings/year** | **Estimated enrollment/offering** |
| every other semester | 3 |

Equivalent courses (These are previously approved courses that replicate the content of this course to such an extent that students should not receive credit for both courses.)
MATH 878

Prerequisite and/or Corequisite **
Corequisite MATH 876. Only available to students in Mathematics PhD program.

Criminal record check required? ☐ Yes ☑ No If yes, then add this requirement as a prerequisite.

Campus where course will be taught ☑ Burnaby ☐ Surrey ☐ Vancouver ☐ Great Northern Way ☐ Off campus

Course Components ☐ Lecture ☐ Seminar ☐ Lab ☐ Research ☐ Practicum ☐ Online ☑ Examination

| | | |
|---|---|---|
| Grading Basis ☐ Letter grades ☑ Satisfactory/Unsatisfactory ☐ In Progress/Complete | | Capstone course? ☐ Yes ☑ No |
| Repeat for credit? *** ☐ Yes ☑ No | Total completions allowed? _____ | Repeat within a term? ☐ Yes ☑ No |
| Required course? ☑ Yes ☐ No | Final exam required? ☑ Yes ☐ No | Additional course fees? ☐ Yes ☑ No |

Combined with an undergrad course? ☐ Yes ☑ No If yes, identify which undergraduate course and what the additional course requirements are for graduate students:

* Course descriptions should be brief and should never begin with phrases such as "This course will..." or "The purpose of this course is..." If the grading basis is satisfactory/unsatisfactory include this in the description.
** If a course is only available to students in a particular program, that should be stated in the prerequisite.
*** This mainly applies to a Special Topics or Directed Readings course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

| Faculty member(s) who will normally teach this course |
|---|
| Graduate Studies Committee |
| **Additional faculty members, space, and/or specialized equipment required in order to offer this course** |
| none |

## CONTACT PERSON

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| Mathematics | Petr Lisonek | plisonek@sfu.ca |

## DEPARTMENTAL APPROVAL

**REMINDER:** New courses must be identified on a cover memo and confirmed as approved when submitted to FGSC/SGSC. Remember to also include the course outline.

Non-departmentalized faculties need not sign

| | | |
|---|---|---|
| Department Graduate Program Committee: Petr LISONEK | Signature | Date: 10 May 2016 |
| Department Chair: Manfred TRUMMER | Signature | Date: MAY 10 2016 |

## LIBRARY REVIEW

**Library review done?** ☒ YES

Course form, outline, and reading list must be sent by FGSC to lib-courseassessment@sfu.ca for a review of library resources.

## OVERLAP CHECK

**Overlap check done?** ☒ YES ☐ N/A

The course form and outline must be sent by FGSC to the chairs of each FGSC (fgsc-list@sfu.ca) to check for an overlap in content. An overlap check is not required for some courses (ie. Special Topics, Capstone, etc.)

## FACULTY APPROVAL

This approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| | | |
|---|---|---|
| Faculty Graduate Studies Committee (FGSC): PETER ROWLEY | Signature | Date: 12 May 2016 |

## SENATE GRADUATE STUDIES COMMITTEE APPROVAL

| | | |
|---|---|---|
| Senate Graduate Studies Committee (SGSC): Wade Parkhouse | Signature | Date: JUN 15 2016 |

**ADMINISTRATIVE SECTION (for DGS office only)**

**Course Attribute:** _____
**Course Attribute Value:** _____
**Instruction Mode:** _____
**Attendance Type:** _____

**If different from regular units:**
**Academic Progress Units:** _____
**Financial Aid Progress Units:** _____

# MATH 875 PhD Preliminary Examination

## Outline

A preliminary written examination covering a broad range of senior undergraduate material. Graded on a satisfactory/unsatisfactory basis.

MATH 875 can be attempted at most twice.

Corequisite: MATH 876 PhD Comprehensive Examination.

Format: The length of the examination is 3 hours. The examination consists of 12 questions. To pass the exam the student has to completely answer 9 questions.

Examinable material is defined by a reading list (books, chapters). The level of the examinable material is third year undergraduate Mathematics courses. Assessment is based on correctness of answers as well as quality of writing and style of presentation.

**Reading:**


M. Anderson, T. Feil, *A first course in abstract algebra. Rings, groups and fields.* Third edition. CRC Press 2015.

J.W. Brown, R.V. Churchill, *Complex variables and applications.* Ninth edition. McGraw-Hill 2013.

V. Chvátal, *Linear programming.* W.H. Freeman 1983.

J.A. Gallian, *Contemporary abstract algebra.* Eight edition. Brooks Cole 2012.

K. Hoffman, R. Kunze, *Linear algebra.* Second edition. Prentice-Hall 1971.

S. Lang, *Linear algebra.* Third edition. Springer-Verlag 1989.

J. Matoušek, J. Nešetřil, *Invitation to discrete mathematics.* Oxford University Press 2009.

I. Niven, H.S. Zuckerman, H.L. Montgomery, *An introduction to the theory of numbers.* Fifth edition. John Wiley & Sons 1991.

W. Rudin, *Principles of mathematical analysis.* Third edition. McGraw-Hill 2013.

D.B. West, *Introduction to graph theory.* Second edition. Prentice Hall 2001.

SIMON FRASER UNIVERSITY
GRADUATE STUDIES & POSTDOCTORAL FELLOWS

# New Graduate Course Proposal

**Please save the form before filling it out to ensure that the information will be saved properly.**

| Course Subject (eg. PSYC) | Number (eg. 810) | Units (eg. 4) |
|---|---|---|
| MATH | 876 | 0 |

Course title (max 100 characters including spaces and punctuation)
PhD Comprehensive Examination

Short title (for enrollment/transcript - max 30 characters)
PhD Comprehensive Examination

Course description for SFU Calendar *
A comprehensive written examination covering a broad range of graduate material. Graded on a satisfactory/unsatisfactory basis.

Rationale for introduction of this course
In response to its external review, Department of Mathematics proposes to restructure the graduate comprehensive exam. The new format of the comprehensive exam will consist of two parts. MATH 876 will be the second part of the new comprehensive exam.

| Effective term and year | Course delivery (eg 3 hrs/week for 13 weeks) |
|---|---|
| Spring 2017 | 4 hrs examination |
| Frequency of offerings/year: every other semester | Estimated enrollment/offering: 3 |

Equivalent courses (These are previously approved courses that replicate the content of this course to such an extent that students should not receive credit for both courses.)
MATH 878

Prerequisite and/or Corequisite **
Corequisite MATH 875. Only available to students in Mathematics PhD program.

Criminal record check required? ☐ Yes ☑ No If yes, then add this requirement as a prerequisite.

Campus where course will be taught ☑ Burnaby ☐ Surrey ☐ Vancouver ☐ Great Northern Way ☐ Off campus

Course Components ☐ Lecture ☐ Seminar ☐ Lab ☐ Research ☐ Practicum ☐ Online ☑ Examination

| | | |
|---|---|---|
| Grading Basis ☐ Letter grades ☑ Satisfactory/Unsatisfactory ☐ In Progress/Complete | | Capstone course? ☐ Yes ☑ No |
| Repeat for credit? *** ☐ Yes ☑ No | Total completions allowed? _____ | Repeat within a term? ☐ Yes ☑ No |
| Required course? ☑ Yes ☐ No | Final exam required? ☑ Yes ☐ No | Additional course fees? ☐ Yes ☑ No |

Combined with an undergrad course? ☐ Yes ☑ No If yes, identify which undergraduate course and what the additional course requirements are for graduate students:

* Course descriptions should be brief and should never begin with phrases such as "This course will..." or "The purpose of this course is..." If the grading basis is satisfactory/unsatisfactory include this in the description.
** If a course is only available to students in a particular program, that should be stated in the prerequisite.
*** This mainly applies to a Special Topics or Directed Readings course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

| Faculty member(s) who will normally teach this course |
|---|
| Graduate Studies Committee |
| **Additional faculty members, space, and/or specialized equipment required in order to offer this course** |
| none |

## CONTACT PERSON

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| Mathematics | Petr Lisonek | plisonek@sfu.ca |

## DEPARTMENTAL APPROVAL

**REMINDER:** New courses must be identified on a cover memo and confirmed as approved when submitted to FGSC/SGSC. Remember to also include the course outline.

Non-departmentalized faculties need not sign

| | | |
|---|---|---|
| Department Graduate Program Committee: Petr LISONEK | Signature | Date: 10 May 2016 |
| Department Chair: Manfred TRUMMER | Signature | Date: MAY 10 2016 |

## LIBRARY REVIEW

**Library review done?** ☒ YES

Course form, outline, and reading list must be sent by FGSC to lib-courseassessment@sfu.ca for a review of library resources.

## OVERLAP CHECK

**Overlap check done?** ☒ YES ☐ N/A

The course form and outline must be sent by FGSC to the chairs of each FGSC (fgsc-list@sfu.ca) to check for an overlap in content. An overlap check is not required for some courses (ie. Special Topics, Capstone, etc.)

## FACULTY APPROVAL

This approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| | | |
|---|---|---|
| Faculty Graduate Studies Committee (FGSC): PETER RUBEN | Signature | Date: 12 May 2016 |

## SENATE GRADUATE STUDIES COMMITTEE APPROVAL

| | | |
|---|---|---|
| Senate Graduate Studies Committee (SGSC): Wade Parkhouse | Signature | Date: JUN 15 2016 |

**ADMINISTRATIVE SECTION (for DGS office only)**

**Course Attribute:** _____
**Course Attribute Value:** _____
**Instruction Mode:** _____
**Attendance Type:** _____

**If different from regular units:**
**Academic Progress Units:** _____
**Financial Aid Progress Units:** _____

# MATH 876 PhD Comprehensive Examination

## Outline

A comprehensive written examination covering a broad range of graduate material. Graded on a satisfactory/unsatisfactory basis.

MATH 876 can be attempted at most twice.

Corequisite: MATH 875 PhD Preliminary Examination

Format: The length of the examination is 4 hours. The examination consists of 6 questions. To pass the exam the student has to completely answer 4 questions.

Examinable material is defined by a list of questions. The list of questions is made available to the student at the start of the semester upon registration in MATH 876. Each question on the list is accompanied by recommended reading. The list of questions is updated after each offering. Assessment is based on correctness of answers as well as quality of writing and style of presentation.

**Reading:**


N. Alon, J.H. Spencer, *The probabilistic method.* Third edition. John Wiley & Sons 2008.

T.M. Apostol, *Introduction to analytic number theory.* Springer-Verlag 1976.

M.F. Atiyah, I.G. Macdonald, *Introduction to commutative algebra.* Addison-Wesley 1969.

J. Bak, D.J. Newman, *Complex analysis.* Third edition. Springer 2010.

J. Bierbrauer, *Introduction to coding theory.* Chapman & Hall/CRC 2005.

J.A. Bondy, U.S.R. Murty, *Graph theory.* Springer 2008.

J.B. Conway, *Functions of one complex variable.* Springer-Verlag 1978.

J.B. Conway, *Functions of one complex variable II.* Springer-Verlag 1995.

D.A. Cox, J. Little, D. O'Shea, *Ideals, varieties and algorithms. An introduction to computational algebraic geometry and commutative algebra.* Fourth edition. Springer 2015.

R. Diestel, *Graph theory.* Fourth edition. Springer 2010.

R.L. Graham, D.E. Knuth, O. Patashnik, *Concrete mathematics.* Second edition. Addison-Wesley 1994.

R. Hartshorne, *Algebraic geometry.* Springer-Verlag 1977.

D.A. Marcus, *Number fields.* Springer-Verlag 1977.

J.R. Munkres, *Topology: a first course.* Prentice-Hall 1975.

W. Rudin, *Real and complex analysis.* Third edition. McGraw-Hill 1987.

A. Schrijver, *Theory of linear and integer programming.* Wiley 1986.

I.R. Shafarevich, *Basic algebraic geometry.* Third edition. Springer 2013.

R.P. Stanley, *Enumerative combinatorics. Vol. 1.* Second edition. Cambridge University Press 2012.

R.P. Stanley, *Enumerative combinatorics. Vol. 2.* Cambridge University Press 1999.

D.R. Stinson, *Cryptography. Theory and practice.* Third edition. Chapman & Hall/CRC, 2006.

J.H. van Lint, R.M. Wilson, *A course in combinatorics.* Second edition. Cambridge University Press 2001.

SIMON FRASER UNIVERSITY
GRADUATE STUDIES & POSTDOCTORAL FELLOWS

# Graduate Course Change

**Attach a separate document if more space is required.**

| Course Subject/Number | MATH 701 | Units | 3 | Effective Term and Year | Spring 2017 |
|---|---|---|---|---|---|
| Course Title | Computer Algebra | | | | |
| Rationale for Change: This course is offered jointly with MACM 401. The changes proposed on this form for MATH 701 are the same as the changes for MACM 401 which were approved by Department of Mathematics at its meeting on 12 April 2016. The changes reflect recent developments in the subject and in department's teaching practices. | | | | | |

**Proposed Changes (Check all that apply)**

☐ Course number ☐ Units* ☐ Title ☑ Description ☐ Prerequisite ☐ Other _____

**Complete only the fields to be changed**

| FROM | TO |
|---|---|
| Course Subject/Number | Course Subject/Number |
| Units | Units* |
| Course Title | Course Title (max 100 characters) |
| Course Short Title | Course Short Title (max 30 characters) |
| Description<br>Data-structures and algorithms for mathematical objects, including polynomials, general mathematical formulae, long integer arithmetic, polynomial greatest common divisors, the Risch integration algorithm. Other topics include symbolic differentiation, simplification of formulae, and polynomial factorization. Students will learn Maple for use on assignments. Students may not take a 700 division course if it is being offered in conjunction with a 400 division course which they have taken previously. | Description<br>Data structures and algorithms for mathematical objects, including long integers, polynomials, and general mathematical formulae. Topics include computing polynomial greatest common divisors, the Fast Fourier transform, Hensel's lemma and p-adic methods, differentiation and simplification of formulae, and polynomial factorization. Students will use a computer algebra system such as Maple for calculations and programming. Students may not take a 700 division course if it is being offered in conjunction with a 400 division course which they have taken previously. |
| Prerequisite | Prerequisite |
| Other | Other |

* Program requirements may need to be revised when course units are changed. Please review the calendar and submit any relevant program revisions resulting from this course change.

**REMINDER:** All course changes must be identified on a cover memo and confirmed as approved when submitted to FGSC and SGSC.

## CONTACT PERSON

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| Mathematics | Michael Monagan | mmonagan@cecm.sfu.ca |

## DEPARTMENTAL APPROVAL

| | | |
|---|---|---|
| Department Graduate Program Committee: Petr LISONEK | Signature | Date: 10 May 2016 |
| Department Chair: Manfred TRUMMER | Signature | Date: MAY 10 2016 |

## FACULTY APPROVAL

| | | |
|---|---|---|
| Faculty Graduate Studies Committee (FGSC): Peter RUBEN | Signature | Date: 12 May 2016 |

## SENATE GRADUATE STUDIES COMMITTEE APPROVAL

| | | |
|---|---|---|
| Senate Graduate Studies Committee (SGSC): Wade Parkhouse | Signature | Date: JUN 15 2016 |

**ADMINISTRATIVE SECTION (for DGS office only)**
**Course Attribute:** _____
**Course Attribute Value:** _____
**Instruction Mode:** _____
**Attendance Type:** _____

**If different from regular units:**
**Academic Progress Units:** _____
**Financial Aid Progress Units:** _____