SIMON FRASER UNIVERSITY

MEMORANDUM

TO: Senate

FROM: J. Munro
Chair, Senate
Cttee on Academic
Planning

SUBJECT: Graduate Curriculum Revisions - Faculty of Science

DATE: November 20, 1990

Action undertaken by the Senate Committee on Academic Planning and the Senate Graduate Studies Committee, gives rise to the following motion:

MOTION: "that Senate approve and recommend approval to the Board of Governors, as set forth in S.91-8 graduate curriculum revisions in the Faculty of Science as follows:

i)   S.91-8a   Department of Biological Sciences
ii) S.91-8b   Department of Mathematics & Statistics"

Department of Biological Sciences
Summary of Graduate Curriculum Revisions

SGSC Reference: Mtg. of April 9, 1990 and Mtg. of November 26, 1990

SCAP Reference: SCAP 90-67, SCAP 90-68

1.   New courses - BISC 880-3, BISC 881-3, BISC 883-3, BISC 884-3, BISC 885-3, BISC 886-3, BISC 887-3, BISC 889-3

2.   Deletion of BISC 802-3, BISC 840-3, BISC 853-3, BISC 854-3

SIMON FRASER UNIVERSITY

MEMORANDUM

To......... Dr. C.H.W. Jones

Dean of Science

Subject...... NEW GRADUATE COURSES

From...... Dr. B.A. McKeown, Chairman

Dept. of Biological Sciences

Date...... October 10, 1990

Our Department has proposed 8 new graduate courses in specific areas of Biological Sciences. These courses have been proposed due to Departmental initiatives over the last few months and in response to our latest External Review that stated there should be a greater variety of courses available to graduate students. These courses are labelled as Special Topics to allow flexibility. In succeeding semesters it will be possible to change the course content depending on the faculty member(s) giving the course and depending on what is more topical at the time.

In addition to these new courses the Department of Biological Sciences also wishes to retain its three graduate courses BISC 859, 869 and 879. The Biological Sciences Department is large and diversified. Many faculty are seconded to other positions (e.g. Killam Research Fellowship, University Research Fellowships, Indonesian Project) Thus, many limited-term and sessional appointments are made. Also, there are many Postdoctoral Fellows, Visiting Faculty and Adjunct Professors. In order for our graduate students to have access to the areas of expertise for these many visitors, the Department offers specialized graduate courses on an irregular basis. The present Special Topics courses (BISC 859, 869 and 879) serve this function extremely well and we therefore wish to retain them.

BAM/mc

CALENDAR INFORMATION:

Department: Biological Sciences _____ Course Number: 880-3

Title: Special Topics in Behavioural Ecology _____

Description: A consideration of advanced special topics in the field of behavioural

ecology

Credit Hours: 3 _____ Vector: 3-0-0 _____ Prerequisite(s) if any: -

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 10-15 _____ When will the course first be offered: ?

How often will the course be offered: as circumstances warrant (but no more than once

per year)

JUSTIFICATION:

This course would be useful in two general circumstances:

a) to try out a new course, prior to adding it to the regular curriculum;

b) to allow faculty, sabbatical visitors, or faculty from other institutions to

offer specialty courses on a one-time only basis

RESOURCES:

Which Faculty member will normally teach the course: Dill/Harestad/Roitberg/Verbeek/
                                                      Winston/ Ydenberg and visitors
What are the budgetary implications of mounting the course: None

Are there sufficient Library resources (append details): several additional journals
                    are required (see attached memo to Sharon Thomas)
Appended: a) Outline of the Course
          b) An indication of the competence of the Faculty member to give the course.
          c) Library resources

Approved: Departmental Graduate Studies Committee: _____ Date: 20 April 90
          Faculty Graduate Studies Committee: P. W. Percival Date: 13 Sept '90
          Faculty: _____ C.H.W. Jones Date: 11 Oct 90
          Senate Graduate Studies Committee: _____ Date: 27 Nov/96
          Senate: _____ Date:

SIM .. FRASER UNIVERSIT .

MEMORANDUM

To. SHARON THOMAS, HEAD
COLLECTIONS MANAGEMENT
LIBRARY

From .... L.M. DILL, DIRECTOR
BEHAVIOURAL ECOLOGY RESEARCH
GROUP, BIOSCIENCES

Subject... SERIALS NEEDED

Date.... JANUARY 31, 1990

The Behavioural Ecology Research Group (B.E.R.G.) was formed in February, 1989, under the terms of Policy AC-35, with the following objectives:

1. To pursue basic research in the field of behavioural ecology;
2. To maintain and further develop an internationally recognized training center for students in behavioural ecology, and related areas of inquiry;
3. To provide a service to government, industry and other organizations so that basic and applied problems in behavioural ecology can be tackled through collaborative research.

The group consists of 8 faculty members from BioSciences, Archaeology and Psychology, along with an active group of post-doctoral fellows and graduate students.

We have found our ability to meet our objectives somewhat limited by the unavailability in the SFU Library of several journals central to our discipline. The discipline is new, and so are many of its journals; presumably, they have not been added to the collection owing to the financial restraints of recent years.

A survey of BERG faculty has identified the following journals which should be added to the collection. Brochures describing some of them are attached (marked by *).

- American Journal of Primatology
- Behavior Processes
- Biotropica
- Ethology, Ecology and Evolution   *
- Ethology and Sociobiology
- Functional Ecology   *
- International Journal of Primatology
- J. Evolutionary Biology   *
- J. Field Ornithology
- J. Insect Behavior
- Trends in Ecology and Evolution   *

We hope that the current financial situation will allow upgrading of the Library's collection in our research area, and thank you for your attention to this joint request. Please let me know if you need any further information.

LMD/mc

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New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: BIOLOGICAL SCIENCES   **Course Number:** 881-3

Title: SPECIAL TOPICS IN CELL AND MOLECULAR BIOLOGY

Description: A student participation seminar course focusing on recent literature

on selected topics in cellular, developmental, and molecular biology

and genetics.

Credit Hours: 3   **Vector:** 3-0-0   **Prerequisite(s) if any:** Permission of instructor.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 12   **When will the course first be offered:** 1990-3

How often will the course be offered: Each semester, according to demand.

JUSTIFICATION:

The course will provide students with a structured, in-depth analytical approach

to the literature on selected topics. The capacity to present information and

to critically evaluate experiments will be emphasized as part of the development

of a student's professional competence.

RESOURCES:

Which Faculty member will normally teach the course: Various members of the IMBB

What are the budgetary implications of mounting the course: Photocopies of 20-30

pages per week will be provided to each student.

Are there sufficient Library resources (append details): Yes. IMBB journal room will be used for most assigned articles.

Appended: a) Outline of the Course
b) An indication of the competence of the Faculty member to give the course.
c) Library resources

Approved: Departmental Graduate Studies Committee: _____ Date: 20 April 90.

Faculty Graduate Studies Committee: P. W. Percival Date: 13 Sept 90

Faculty: _____ C.H.N. Jones Date: 11 oct 90

Senate Graduate Studies Committee: _____ Date: 27 Nov/90   *4*

Course Outline

Cell and Molecular Biology

The format and content of the course will depend on the
selected topics and the instructors responsible for the
course. In general, the course will require graduate
students to prepare a written summary and lecture on their
assigned topic. Each student will read assigned papers
before each lecture, and will be expected to participate in
discussions of the lecture material. Additional work (such
as a term paper or research grant proposal) may be assigned
as appropriate. During some semesters, the course will
consider a specific topic in depth, while during others it
will provide an overview of a number of areas of research
front activity.

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: BIOLOGICAL SCIENCES   Course Number: 883-3

Title: SPECIAL TOPICS IN ENVIRONMENTAL TOXICOLOGY

Description: Special topics course with emphasis on recent developments in environmental toxicology.

Credit Hours: 3   Vector: 3-0-0   Prerequisite(s) if any: None

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 5-10   When will the course first be offered: 1991

How often will the course be offered: Once every two years or more frequently with student demand.

JUSTIFICATION:

Although several advanced level courses in the environmental toxicology program could be used as graduate program (M.Sc. and Ph.D.) course requirements, there is no environmental toxicology graduate course per se in the Department. The proposed course will meet the demand of the graduate students in this area.

RESOURCES:

Which Faculty member will normally teach the course: Environmental toxicology faculty, visiting professors, and local experts outside of SFU.

What are the budgetary implications of mounting the course: Minor travel costs for outside experts.

Are there sufficient Library resources (append details): Yes

Appended: a) Outline of the Course
         b) An indication of the competence of the Faculty member to give the course.
         c) Library resources

Approved: Departmental Graduate Studies Committee: _Mujmek_ Date: 20 April 90
         Faculty Graduate Studies Committee: P.W. Percival Date: 13 Sept 90
         Faculty: CHW. Jones Date: 11 Oct 90
         Senate Graduate Studies Committee: _____ Date: 27 Nov/90

COURSE OUTLINE

883-3 - SPECIAL TOPICS IN ENVIRONMENTAL TOXICOLOGY

Environmental toxicology is a rapidly changing, multidisciplinary science. The objective of the course is to keep graduate students abreast of the most recent and innovative approaches and discoveries in this area. Topics such as toxic waste disposal industrial toxic waste abatement, health risk assessment, environmental legislation, biochemical toxicology, wildlife toxicology, toxicokinetics, inhalation toxicology, etc., could be included in the course.

The course will be co-ordinated by a faculty member. It will follow a lecture/seminar format. Lectures and seminars will be presented by a group of experts and scientists. Presentation of seminars by students is also encouraged.

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<u>New Graduate Course Proposal Form</u>

CALENDAR INFORMATION:

Department: <u>Biological Sciences</u>   Course Number: <u>884-3</u>

Title: <u>SPECIAL TOPICS IN PEST ECOLOGY AND MANAGEMENT I</u>

Description: <u>A specific topic in the field of pest ecology and management, not</u>

<u>otherwise covered in depth in regularly scheduled courses.</u>

Credit Hours: <u>3</u>   Vector: <u>3-0-0</u>   Prerequisite(s) if any:<u>____</u>

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: <u>5-20</u>   When will the course first be offered:<u>1990-3</u>

How often will the course be offered: <u>As required by student demand.</u>

JUSTIFICATION:

<u>The course will cover new and specialized topics that cannot be offered by faculty</u>

<u>on a regular basis.</u>

RESOURCES:

Which Faculty member will normally teach the course:<u>Faculty and Adjunct Professors in</u>
                                                Centre for Pest Management.
What are the budgetary implications of mounting the course: <u>None</u>

Are there sufficient Library resources (append details): <u>Yes</u>

Appended: a) Outline of the Course
          b) An indication of the competence of the Faculty member to give the course.
          c) Library resources

Approved: Departmental Graduate Studies Committee:_____ Date:_20 April 90_
           Faculty Graduate Studies Committee: _P.W./Percival_ Date: _13 Sept 90_
           Faculty:_____ C.H.W. Jones Date: _11 Oct 90_
           Senate Graduate Studies Committee:_____ Date:_27 Nov 90_

884-3 - SPECIAL TOPICS IN PEST ECOLOGY AND MANAGEMENT

Course objectives:

The objective of the course is to provide graduate students with an in-depth analysis of a topic in pest ecology and management. The course content will change from year to year to reflect student interests and topical research.

Course format:

This course will follow a lecture/seminar format. In general, the course will require graduate students to prepare a written summary and to give a seminar on their assigned topic. Each student will read assigned papers before each lecture, and will be expected to participate in discussions of the lecture material. Additional work (such as a term paper or research grant proposal) may be assigned as appropriate. During some semesters, the course will consider a specific topic in depth, while during others it will provide an overview of a number of areas of research front activity.

Student evaluation:

Seminar and essay.

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New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: Biological Sciences　　　　　　　Course Number: 885-3

Title: Special Topics in Animal Physiology

Description: Special topics in comparative vertebrate and invertebrate functional

mechanisms and adaptations.

Credit Hours: 3　　　　Vector: 3-0-0　　Prerequisite(s) if any: Undergrad.
course in animal physiology.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 5-10　　　　When will the course first be offered: 1990-3

How often will the course be offered: Once per year

JUSTIFICATION:

1. Large increases in physiologically oriented graduate students.

2. Very few physiological courses, all of which are specialized.

RESOURCES:

Which Faculty member will normally teach the course: Team taught: Dr. Belton, Dr. Burr,
Dr. Fankboner, Dr. Farrell, Dr. Haunerland, Dr. McKeown, Dr. Nair.
What are the budgetary implications of mounting the course: Faculty time and space.
Invited speakers.

Are there sufficient Library resources (append details): Yes - current SFU held journals
and interlibrary loan.
Appended: a) Outline of the Course
　　　　　b) An indication of the competence of the Faculty member to give the course.
　　　　　c) Library resources

Approved: Departmental Graduate Studies Committee: _____ Date: 20 April 90
　　　　　Faculty Graduate Studies Committee: P. W. Percival Date: 13 Sept 90
　　　　　Faculty: CHH. Jenss Date: 11 Oct 90
　　　　　Senate Graduate Studies Committee: _____ Date: 27 Nov 90

COURSE OUTLINE

885-3- SPECIAL TOPICS IN ANIMAL PHYSIOLOGY

Course objectives:
To bring a particular group of students to an understanding of the functional
mechanisms and adaptations in animals. The course content will change from
year to year as there will be an attempt to emphasize the interests of the
students enrolled in the course at any one particular time. Nevertheless,
from faculty input and the independent reading by the students, an effort
will be made to give the students an appreciation for general physiological
principles and their scope and position in many contemporary physiological
fields.

Course format:
This course will follow a lecture/seminar format. A number of faculty will
be involved with this course per offering and will introduce the topics for
that particular term with lectures in their field of expertise. The latter
half of the course will involve the enrolled students presenting seminars on
similar or related topics to the lectures. The students will also have to
write an essay on their seminar topics.

Student evaluation:
Seminar and essay.

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New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: BIOLOGICAL SCIENCES   **Course Number:** 886-3

Title: SPECIAL TOPICS IN MARINE AND AQUATIC BIOLOGY

Description: Special topics course emphasising recent developments in the area of aquatic and marine biology

Credit Hours: 3   **Vector:** 3-0-0   **Prerequisite(s) if any:** None

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 5-10   **When will the course first be offered:** 1991-1

How often will the course be offered: Once a year

JUSTIFICATION:

Biological Sciences has a large and expanding group of faculty involved in aquatic and marine research. Their graduate students require a continuing graduate course in this area.

RESOURCES:

Which Faculty member will normally teach the course: Faculty in marine and aquatic biology

What are the budgetary implications of mounting the course: Minor book purchases to keep current with literature. Invited speakers.

Are there sufficient Library resources (append details): Current reference material and interlibrary loans adequate. Textbooks seem adequate at this time.

Appended: a) Outline of the Course
           b) An indication of the competence of the Faculty member to give the course.
           c) Library resources

Approved: Departmental Graduate Studies Committee: _____ Date: 20 April 90

Faculty Graduate Studies Committee: P.W. Percival Date: 13 Sept 90

Faculty: Art. Jones Date: 11 Oct 90

Senate Graduate Studies Committee: _____ Date: 27 Nov /90

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COURSE OUTLINE

886-3 - SPECIAL TOPICS IN MARINE AND AQUATIC BIOLOGY

This course will provide the student with in-depth analyses of contemporary literature in specific research areas of marine and aquatic biology. The specific topics for a given semester will reflect the broad interests of faculty in marine and aquatic biology.

The special topics course will follow a lecture/seminar format. Faculty and invited speakers will introduce selected topics with lectures at the start of the course. Students will present a series of seminars on related topics and will perform independent literature research and submit an essay.

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CALENDAR INFORMATION:

Department: BIOLOGICAL SCIENCES   Course Number: 887-3

Title: SPECIAL TOPICS IN PLANT BIOLOGY

Description: Advanced treatment of selected topics or specialized areas in plant biology. The special topics which will be discussed will vary from semester to semester.

Credit Hours: 3   Vector: -   Prerequisite(s) if any: None

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 5-15   When will the course first be offered: 1991-1

How often will the course be offered: Two out of three semesters or as required.

JUSTIFICATION:

There are limited ways in the current calendar for Biological Sciences to offer

graduate level courses on contemporary issues and specialized areas in plant

biology. This course will enable the plant biologists to offer a range of

special topics from year to year to meet challenging interests in plant biology.

RESOURCES:

Which Faculty member will normally teach the course: Any/all plant biologists

What are the budgetary implications of mounting the course: None

Are there sufficient Library resources (append details): Yes

Appended: a) Outline of the Course
b) An indication of the competence of the Faculty member to give the course.
c) Library resources

Approved: Departmental Graduate Studies Committee: _____ Date: 20 April 90

Faculty Graduate Studies Committee: _____ Date: 13 Sept 90

Faculty: _____ Date: 11 oct 90

Senate Graduate Studies Committee: _____ Date: 27 Nov 60

COURSE OUTLINE

This course will develop and investigate specialized areas in plant biology of current significance. Instruction may consist of lectures, seminars and discussion, or laboratory/field projects which are appropriate to the particular course theme. Emphasis in the course will help students gain knowledge and expertise which will recognize their individual scholarly objectives.

/5

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: BIOLOGICAL SCIENCES   Course Number: 889-3

Title: DIRECTED READING

Description: Intended to cover the same ground as a normal graduate course, it may be given to one or two students where the lecture/seminar procedure is inappropriate.

Credit Hours: 3   Vector: 3-0-0   Prerequisite(s) if any:
Prior approval of the Department Graduate Studies Committee is required.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 1-3   When will the course first be offered: 1990

How often will the course be offered: When required

JUSTIFICATION:

A course is required to meet deficiencies in the background or the special needs of one or a few students.

RESOURCES:

Which Faculty member will normally teach the course: Any

What are the budgetary implications of mounting the course: Negligible, some photocopying may be needed.

Are there sufficient Library resources (append details): Yes, the course would not be taught unless faculty or library had material.
Appended: a) Outline of the Course
          b) An indication of the competence of the Faculty member to give the course.
          c) Library resources

Approved: Departmental Graduate Studies Committee: _[signature]_ Date: 20 April 90
           Faculty Graduate Studies Committee: P.W. Percival Date: 13 Sept 90
           Faculty: _[signature]_ CHW. John Date: 11 Oct 90
           Senate Graduate Studies Committee: _[signature]_ Date: 27 Nov/90

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COURSE OUTLINE

889-3 - DIRECTED READING

DGSC will maintain standards for directed reading courses.

Regular meetings would normally be required between instructor and students
to set up the reading assignments and monitor progress.

At least two essays or term papers would be required for evaluation and
copies would be retained by the Department.

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SIMON FRASER UNIVERSITY

MEMORANDUM

To.... Dr. Percival, Chairman, Faculty of Science, Department of Chemistry

From.. Dr. M.J. Smith, Chairman, Graduate Studies Committee

Subject. 800-level courses

Date. 19 January 1990
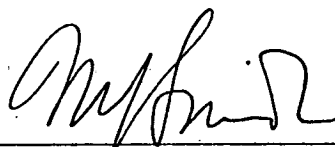
The Department at the 29 November 1990 meeting agreed to drop the following 800-level courses from the graduate calendar:

BISC 802 - Genetics

BISC 840 - Analyses of Insect Pest Situations

BISC 853 - Plant Disease Vectors

BISC 854 - Plant Pathosystems

Dr. M.J. Smith, Chairman,
Graduate Studies Committee

MJS:adj

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Department of Mathematics and Statistics
Summary of Graduate Curriculum Revisions

SGSC Reference: Mtg. of November 26, 1990

SCAP Reference: SCAP 90-69

1.   Revision to the Ph.D. Requirements

2.   Inclusion of a separate entry for Statistics in the graduate Calendar

3.   Change of course number -

MATH 850	renumbered	MATH 920
MATH 851	renumbered	MATH 921
MATH 852	renumbered	MATH 922
MATH 853	renumbered	MATH 923
MATH 855	renumbered	MATH 929
MATH 885	renumbered	MATH 960
MATH 886	renumbered	MATH 961
MATH 887	renumbered	MATH 964
MATH 888	renumbered	MATH 965

4.   Change of course number and title -

MATH 842	renumbered	MATH 910	Ordinary Differential Equations
MATH 845	renumbered	MATH 912	Partial Differential Equations
MATH 881	renumbered	MATH 948	Continuum Mechanics
MATH 889	renumbered	MATH 990	Selected Topics in Applied Mathematics
MATH 890	renumbered	MATH 945	Plasticity

5.   Deletion of MATH 838-4, MATH 843-4, MATH 846-4, MATH 882-4, MATH 883-4, MATH 884-4, MATH 891-4, MATH 892-4, MATH 893-4

6.   New Courses - MATH 900-4, MATH 901-4, MATH 902-4, MATH 905-4, MATH 930-4, MATH 934-4, MATH 935-4, MATH 939-4, MATH 940-4, MATH 950-4

7.   Change of title - MATH 833-4

8.   Revisions to the Applied and Computational Mathematics Program including the introduction of a project option at the Master's Level.

SIMON FRASER UNIVERSITY

MEMORANDUM

DEPARTMENT OF MATHEMATICS AND STATISTICS
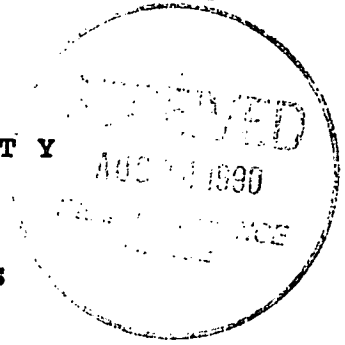
To:	Dr. Paul Percival Chairman, Faculty of Science Graduate Program Committee	:	From:	Dr. A.H. Lachlan Chairman, Graduate Program Committee Math & Stats Dept.
Re:	**GRADUATE PROGRAM REVISIONS**	:	Date:	August 24, 1990

I am hereby seeking approval for a number of changes to the graduate program of the Department of Mathematics and Statistics. In summary the changes proposed are:

(I) Revision of the regulations for the Ph.D., in particular, those concerning the General Examination.

(II) Inclusion of a separate entry for Statistics in the graduate calendar.

(III) Revision and renumbering of those graduate courses which have been grouped together under the heading "Applied and Computational Mathematics".

(IV) Substitution of: Math 833-4 Analysis: Selected Topics for Math 833-4 Real Analysis: Selected Topics.

(V) Identification of graduate programs in Applied and Computational Mathematics and separate entry for Applied and Computational Mathematics in the graduate calendar.

Details of the proposed changes are included in five separate sections below.

GUIDE TO REST OF THE DOCUMENT

I.   Changes to the Ph.D. Requirements.

It is proposed that the first two paragraphs under the heading Ph.D. Program on page 271 of the Calendar, namely

A candidate for the Ph.D. degree will generally be required to obtain at least 28 hours of credit for course work beyond courses taken for the Bachelor's degree. Of these 28 hours, at least 16 are to be in graduate courses or graduate seminars and the remaining 12 may be chosen from graduate courses or graduate seminars or 400 level undergraduate courses. Students who hold an M.Sc. in Mathematics or Statistics are deemed to have earned 12 of the 16 graduate hours and 8 of the 12 undergraduate or graduate hours required. The course work in all cases will involve study in at least four different areas of Mathematics, at least one of these areas being in Analysis (Applied, Complex or Real). Applied Analysis is understood to include Differential and Integral Equations and Methods of Applied Mathematics.

Candidates for the Ph.D. degree will normally be required to pass a general examination. At the option of the Candidate's Committee, this shall consist of either written papers in four areas of study, or written papers in three areas of study, and graduate course work in an approved fourth area in which a grade of B or higher is obtained. In either case, one of the written exam areas must be in Analysis (Applied, Complex or Real). A candidate ordinarily will not be allowed to take the general examination more than twice. Students will be interviewed and advised regarding appropriate courses and examination curricula. Course programs and examination programs require departmental approval.

be replaced by:

A candidate for the Ph.D. degree will generally be required to obtain at least 28 hours of credit for course work beyond courses taken for the Bachelor's degree. Of these 28 hours, at least 16 are to be in graduate courses or graduate seminars and the remaining 12 may be chosen from graduate courses or graduate seminars or 400 level undergraduate courses. Students who hold an M.Sc. in Mathematics or Statistics are deemed to have earned 12 of the 16 graduate hours and 8 of the 12 undergraduate or graduate hours required. The course work in all cases will involve study in at least 4 different areas of Mathematics and/or Statistics.

Candidates for the Ph.D. degree will normally be required to pass a General Examination. The General Examination will consist of examinations in three areas. The areas selected for a particular candidate are subject to approval by the Supervisory Committee and the Graduate Studies Committee. In a given area the examinations may be written or oral at the option of the Graduate Studies Committee. A candidate ordinarily will not be allowed to take the General Examination more than twice. Students will be interviewed and advised regarding appropriate courses and examination curricula.

Rationale.

(i) The requirement that each candidate study Applied, Complex, or Real Analysis is being dropped. The growing strength of subdisciplines for which the requirement seems inappropriate has made it a nuisance in recent years.

(ii) The fourth area requirement in the General Examination has been dropped since it could be satisfied by course work and has had negligible impact.

(iii) The format of the General Examination is being changed to allow oral examinations instead of written ones. This will allow us greater flexibility.

II. Statistics entry in the Graduate Calendar.

It is proposed that the following entry be placed in the graduate calendar to give more emphasis to the graduate program in Statistics.

Statistics Program*

Location: 10512 Shrum Science Centre

Telephone: 291-3331

Chair: A.R. Freedman, A.B. (Calif.),
            Ph.D. (Oregon State)

The program in Statistics is one of the graduate programs offered by the Department of Mathematics and Statistics.

FACULTY AND AREAS OF RESEARCH

C. Dean	Discrete and lifetime data, extra-Poisson variation.
D. Eaves	Biometrics, generalized linear modelling, theory of inference.
R. Lockhart	Goodness-of-fit testing, inference on stochastic processes, large sample theory.
R. Routledge	Biometrics, estimating the sizes of animal populations.
M. Stephens	Goodness-of-fit testing and directional data.
T. Swartz	Statistical computing, theory of inference.
C. Villegas	Foundations of Bayesian inference.
K.L. Weldon	Cross sectional sampling, statistical consulting.

Adjunct Professor

J. Cook	Applications to the forest industry.

*The formation of an Institute for Statistics and Probability has been proposed. Should the Institute be created appropriate changes would be made to the calendar entry which would then appear under the Institute.

Admission

For admission requirements, refer to the Graduate General Regulations.

Applicants are normally required to submit scores in the aptitude section of the Graduate Record Examinations of the Educational Testing Service. Applicants whose first language is not English will normally be asked to submit TOEFL results.

Applicants with degrees in areas other than statistics are encouraged to apply provided they have some formal training in statistical theory and practice.

Degree Requirements for M.Sc. and Ph.D.

M.Sc. Program

The program is intended to give students instruction in a wide range of statistical techniques and also to provide experience in the practical application of statistics. The program should be of interest to students who wish to acquire statistical expertise in preparation for a career in either theoretical or applied statistics.

Students in the program will be required:

- To complete at least 28 semester hours of credit for course work in Statistics and related fields beyond courses taken for the Bachelor's degree. Of these 28 hours, at least 20 are to be in graduate courses or graduate seminars, and the remaining 8 may be chosen from graduate or graduate seminars or 400 level undergraduate courses. Normally these courses will include STAT 801-4 (Mathematical Statistics) and at least four of STAT 802-4 (Multivariate Analysis), STAT 803-4 (Data Analysis), STAT 804-4 (Time Series Analysis), STAT 805-4 (Nonparametric Statistics and Discrete Data Analysis), and MATH 871-4 (Applied Probability Models).
- To complete satisfactorily STAT 811-0 (Statistical Consulting I) and STAT 812-0 (Statistical Consulting II).
- To submit and defend successfully a project (as outlined in the Graduate General Regulations) based on some problem of statistical analysis. This problem will ordinarily arise out of the statistical consulting service.

Students with backgrounds in other disciplines, or with an inadequate background in statistics, may be required to

take certain undergraduate courses in the department in addition to the above requirements.

Ph.D. Program

A candidate for the Ph.D. degree will generally be required to obtain at least 28 hours of credit for course work beyond courses taken for the Bachelor's degree. Of these 28 hours, at least 16 are to be in graduate courses or graduate seminars and the remaining 12 may be chosen from graduate courses or graduate seminars or 400 level undergraduate courses. Students who hold an M.Sc. in Statistics are deemed to have earned 12 of the 16 graduate hours and 8 of the 12 undergraduate or graduate hours required. The course work in all cases will involve study in at least 4 different areas of Statistics and Probability.

Candidates for the Ph.D. degree will normally be required to pass a General Examination. The General Examination will consist of examinations in three areas. The areas selected for a particular candidate are subject to approval by the Supervisory Committee and the Graduate Studies Committee. In a given area the examinations may be written or oral at the option of the Graduate Studies Committee. A candidate ordinarily will not be allowed to take the General Examination more than twice. Students will be interviewed and advised regarding appropriate courses and examination curricula.

Students who have completed a Master's degree will normally be required to attempt the general examination within one year of their initial registration in the Ph.D. program.

A candidate for the Ph.D. may be required by his/her Supervisory Committee to acquire proficiency in reading statistical papers in either French, German or Russian.

Students will be required to submit and successfully defend a thesis which will embody a significant contribution to statistical knowledge.

For further information and regulations refer to the Graduate General Regulations section.

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Graduate Courses

STAT 602-3 Generalized Linear and Non-linear Modelling

A methods-oriented unified approach to a broad array of nonlinear regression modelling methods including classical regression, logistic regression, probit analysis, dilution assay, frequency count analysis, ordinal-type responses, and survival data. A project will be assigned related to students' field of study. *Prerequisite: STAT 302 or 330 or permission of instructor. Open only to graduate students in departments other than Mathematics and Statistics.*

STAT 650-5 Quantitative Analysis In Resource Management and Field Biology

The use of statistical techniques and mathematical models in resource management with special emphasis on experimentation, survey techniques, and statistical model construction. (5-0-0) *Prerequisite: A course in parametric and non-parametric statistics. This course may not be used for the satisfaction of degree requirements in the Department of Mathematics and Statistics.*

STAT 801-4 Mathematical Statistics

Advanced mathematical statistics. A survey of basic concepts in point estimation, interval estimation and hypothesis testing. Principles of inference. *Students with credit for MATH 875-4 may not take STAT 801-4 for further credit.*

STAT 802-4 Multivariate Analysis

An advanced course in Multivariate Analysis. Factor analysis, discriminant analysis, principal components, canonical correlations. Multivariate regression and analysis of variance. *Students with credit for MATH 876-4 may not take STAT 802-4 for further credit.*

STAT 803-4 Data Analysis

A problem-based course emphasizing the exploratory aspects of statistical analysis with emphasis on modern computer-oriented methods. *Prerequisites: MATH 472 or equivalent or permission of the instructor.*

STAT 804-4 Time Series Analysis

An introduction to time series models and their analysis. Both time-domain and frequency-domain techniques will be studied. *Prerequisites: MATH 472 or equivalent or permission of the instructor.*

STAT 805-4 Non-Parametric Statistics and Discrete Data Analysis

Order statistics, rank statistics, procedures based on the empirical distribution function. Asymptotic efficiencies. Goodness-of-fit. Contingency tables, log-linear models. Further topics. *Prerequisites: MATH 372 and 473 or equivalent or permission of the instructor.*

STAT 811-0 Statistical Consulting I

Students will participate in the department statistical consulting service under the direction of faculty members. This course will be graded on a satisfactory/unsatisfactory basis. *Open to M.Sc. and Ph.D. students in Statistics.*

STAT 812-0 Statistical Consulting II

Students will participate in the department statistical consulting service under the direction of faculty members. This course is graded on a satisfactory/unsatisfactory basis. *Open to M.Sc. and Ph.D. students in Statistics.*

STAT 890-4 Statistics: Selected Topics

See also Math 800-899 listed under Department of Mathematics and Statistics on page xx and Math 900-990 listed under Applied and Computational Mathematics Program on page xx.

Rationale: In recent years the Statistics group within the Department of Mathematics and Statistics has grown and there has been a sharp increase in the number of graduate students working in Statistics. In many universities there are separate Departments of Statistics. The separate calendar entry is merited by the acknowledged status of Statistics as a separate discipline.

It should be noted that there is no question here of a new program being introduced. The calendar description corresponds exactly to what has been going on for a number of years as part of the graduate program of the Department of Mathematics and Statistics.

III. Revision of graduate course offerings in applied mathematics and numerical analysis.

(i) The courses numbered 850, 851, 852, 853, 855, 885, 886, 887, 888 are to be renumbered with the same title to 920, 921, 922, 923, 929, 960, 961, 964, 965 respectively.

(ii) The courses 842, 845, 881, 889, 890 are to be renumbered and retitled according to:

Math 842-4 Ordinary Differential Equations I
Math 845-4 Partial Differential Equations I
Math 881-4 Continuum Mechanics I
Math 889-4 Applied Mathematics: Selected Topics
Math 890-4 Plasticity I
become
Math 910-4 Ordinary Differential Equations
Math 912-4 Partial Differential Equations
Math 948-4 Continuum Mechanics
Math 990-4 Selected Topics in Applied Mathematics
Math 945-4 Plasticity

(iii) The courses

Math 838-4 Complex Analysis: Selected Topics
Math 843-4 Ordinary Differential Equations II
Math 846-4 Partial Differential Equations II
Math 882-4 Continuum Mechanics II
Math 883-4 Elasticity I
Math 884-4 Elasticity II
Math 891-4 Plasticity II
Math 892-4 Elasticity: Selected Topics
Math 893-4 General Relativity: Selected Topics
are to be deleted and the following new courses are to be introduced:
Math 900-4 Advanced Mathematical Methods I
Math 901-4 Advanced Mathematical Methods II
Math 902-4 Applied Complex Analysis
Math 905-4 Applied Functional Analysis
Math 930-4 Fluid Dynamics
Math 934-4 Selected Topics in Fluid Dynamics
Math 935-4 Mechanics of Solids
Math 939-4 Selected Topics in Mechanics of Solids
Math 940-4 Mathematical Elasticity
Math 950-4 Tensor Analysis on Differentiable Manifolds

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The calendar descriptions for the new courses and suggested texts are as follows:

Math 900-4   Advanced Mathematical Methods I
Hilbert spaces. Calculus of variations. Sturm-Liouville problems and special functions. Green's functions in one dimension. Integral equations. Prerequisite: Math 314-3 or equivalent. Math 419-3 is recommended.

[Based on Chapters 1-6 of Mathematical Methods in Physics & Engineering by J.W. Dettman (McGraw-Hill).]

Math 901-4   Advanced Mathematical Methods II
First order partial differential equations. Characteristics. Eigenfunction expansions and integral transforms. Discontinuities and singularities; weak solutions. Green's functions. Variational methods. Prerequisite: Math 314-3 or equivalent. Math 418-3 is recommended.

[Based on Chapters 2-8 of Partial Differential Equations of Applied Mathematics by E. Zauderer (Wiley) (Excluding Sections 4.7, 5.7, 8.5).]

Math 902-4   Applied Complex Analysis
Review of complex power series and contour integration. Conformal mapping, Schwartz-Christoffel transformation. Special functions. Asymptotic expansions. Integral transforms. Prerequisite: Math 322-3 or equivalent.

[Based on Chapters 1-7 of Functions of a Complex Variable: theory and technique by Carrier, Krook & Pearson.]

Math 905-4   Applied Functional Analysis
Infinite dimensional vector spaces, convergence, generalized Fourier series. Operator theory; the Fredholm alternative. Application to integral equations and Sturm-Liouville systems. Spectral theory. Prerequisite: Math 900-4 or permission of the instructor.

[Based on Chapters 4-7 of Greens functions and boundary-value problems by Stakgold.]

Math 930-4   Fluid Dynamics
Basic equations and theorems of fluid mechanics. Incompressible flow. Compressible flow. Effects of viscosity. Prerequisite: Math 361-3 or equivalent. Math 462-3 is recommended.

[Based on Chapters 1-7 of Fluid Mechanics by C.S. Yih, West River Press (1988).]

Math 934-4   Selected Topics in Fluid Dynamics
Study of a specialized area of fluid dynamics such as
hydrodynamic stability, multiphase flow, non-Newtonian
fluids, computational fluid dynamics, boundary-layer theory,
magnetic fluids and plasmas, bio-and geo- fluid mechanics,
gas dynamics. Prerequisite: Math 930-4 or permission of
the instructor.

Math 935-4   Mechanics of Solids
Analysis of stress and strain. Conservation laws. Elastic
and plastic material behaviour. Two- and three-dimensional
elasticity. Variational principles. Wave propagation.
Prerequisite: Math 361-3 or equivalent. Math 468-3 is
recommended. Students with credit for Math 883-4 may not
take Math 935-4 for further credit.

[Based on Chapters 1-11 of Solid Mechanics by Y.C. Fung,
Prentice-Hall.]

Math 939-4   Selected Topics in the Mechanics of Solids
Study of a specialized area of the mechanics of solids such
as composite materials, micromechanics, fracture, plate and
shell theory, creep, computational solid mechanics, wave
propagation, contact mechanics. Prerequisite: Math 935-4
or permission of the instructor.

Math 940-4   Mathematical Elasticity
Analysis of deformation and motion. Balance laws, stress
and field equations. Cauchy and Green elastic materials.
Boundary-value problems. Incremental elastic deformations.
Elastic properties of solid materials. Prerequisite: Math
935-4 or permission of the instructor.

[Based on Chapters 1-7 of Non-Linear Elastic Deformations by
R.W. Ogden.]

Math 950-4   Tensor Analysis on a Differentiable Manifold
A first graduate course dealing with the following topics:
Tensor Algebra, tensor fields on differentiable manifolds,
differential forms, invariant problems in the calculus of
variation, metric field theory and Einstein's equations.
Prerequisite: Math 466-4 or permission of the instructor.

[Based on: Tensors, Differential forms & Variational
Principles by D. Lovelock & H. Rund (J. Wiley) 1975 ISBN -
0 - 471 - 54840-5.]

The new course proposal forms will be found in Appendix A.

Rationale. The proposed course changes have been prompted by the desire of faculty members working in mechanics, numerical analysis, and related fields to offer a more coherent program for students wishing to complete graduate degrees with concentration in

Applied and Computational Mathematics

The subjects grouped under the heading include applied analysis, differential equations, numerical analysis, mechanics, fluid dynamics and mathematical physics.

The existing schedule of graduate courses was devised before the Department had any expertise in numerical analysis. Since the importance of numerical methods has been steadily increasing over the last two decades, revising our course offerings to take account of the new context is highly desirable.

The addition of Math 905-4 Applied Functional Analysis is also necessary to bring our course offerings up to date. We note that the External Review Committee which visited the Department in 1989 was of the opinion that our course offerings in Functional Analysis are not enough.

Another important element in the overall revision is the introduction of two courses in fluid dynamics. Until now courses in fluid dynamics have had to be offered under a selected topics number which hardly does the subject justice.

All the courses involved in the revision are being given 900-numbers so that collectively the courses will be more easily recognized.

(IV) Substitution of: Math 833-4 Analysis: Selected Topics for Math 833-4 Real Analysis: Selected Topics.

Rationale. As part of the revisions described in (III) above, Math 838-4 Complex Analysis: Selected Topics has been deleted. We would like to retain the option of mounting a selected topics course in Complex Analysis by changing the title of Math 833.

This change is contingent on the approval of the changes described in III.

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(V)   Graduate calendar entry for Applied and Computational Mathematics.

It is proposed that the following entry be placed in the graduate calendar to give an appropriate emphasis to what the Department has to offer M.Sc. and Ph.D. students interested in these areas:

Applied and Computational Mathematics Program*

Location: 10512 Shrum Science Centre

Telephone: 291-3331

Chair: A.R. Freedman, A.B. (Calif.),
               Ph.D. (Oregon State)

The Program in Applied and Computational Mathematics is one of the graduate programs offered by the Department of Mathematics and Statistics.

FACULTY AND AREAS OF RESEARCH

G.N. Bojadziev   Differential equations; population dynamics, controlled dynamics

A. Das   Variational techniques; interior solutions in general relativity

G.A.C. Graham   Analytical and computational methods in viscoelastic fracture and contact mechanics

R.W. Lardner   Computational fluid dynamics: oceanography, asymptotic methods, nonlinear waves

E. Pechlaner   Relativistic continuum mechanics: approximation methods, self-similar spinning rods

R.D. Russell   Numerical analysis: numerical solution of differential equations, dynamical systems

D.L. Sharma   Boundary value problems in elasticity and fluid dynamics

C.Y. Shen   Electromagnetic scattering; large-scale scientific computing

E.M. Shoemaker   Environmental mathematics: glaciology. Plasticity

M. Singh   Nonlinear fluid and solid mechanics: magnetohydrodynamics

T. Tang   Fluid dynamics; numerical analysis

M. Trummer   Numerical analysis: differential equations, integral equations

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*The formation of an Institute for Applied and Computational Mathematics has been proposed. Should the institute be created appropriate changes would be made to the calendar entry which would then appear under the Institute.

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Admission

For admission requirements, refer to the Graduate General Regulations.

Applicants are normally required to submit scores in the aptitude section and an appropriate advanced section of the Graduate Record Examinations of the Educational Testing Service.

Applicants with backgrounds in areas other than mathematics, for example, a Bachelor's degree or its equivalent in Engineering or Physics may be considered suitably prepared for these programs.

DEGREE REQUIREMENTS FOR M.SC. AND PH.D.

M.Sc. Program

A candidate for the M.Sc. degree will normally be required to obtain a total of 28 semester hours of credit for course work beyond courses taken for the Bachelor's degree. These 28 hours will consist of a core program containing the six courses listed below together with a further four hours of credit which may be at the graduate level or at the 400 undergraduate level. The six core courses are

    Math 900-4 Advanced Mathematical Methods I
    Math 901-4 Advanced Mathematical Methods II
    Math 920-4 Numerical Linear Algebra
    Math 922-4 Numerical Solution of Partial Differential
                Equations
    Math 930-4 Fluid Dynamics
    Math 935-4 Mechanics of Solids

In addition to this course requirement the student will be required to complete a project which will normally involve a significant computational component and to submit and successfully defend a report on that project. This project is intended to be completed within about one semester.

Ph.D. Program

A candidate for the Ph.D. degree will be required to obtain at least a further 8 semester hours of credit for course work in graduate level courses beyond the requirements for the M.Sc. degree. Candidates who are admitted to the Ph.D. program without completing an M.Sc. degree will be required to obtain credit or transfer credit for an amount of coursework equivalent to that obtained by students who first complete an M.Sc. degree.

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Candidates for the Ph.D. will normally be required to pass a General Examination which will cover the subjects treated in the six core courses listed in the M.Sc. requirements. A candidate ordinarily will not be allowed to take the General Examination more than twice. Students who have completed a Master's degree will normally be required to attempt the General Examination within one year of their initial registration in the Ph.D. program.

A candidate for the Ph.D. degree will be required to submit and defend a thesis based on his or her own original work and which will embody a significant contribution to mathematical knowledge.

Graduate Courses

Math 900-4   Advanced Mathematical Methods I
Hilbert spaces. Calculus of variations. Sturm-Liouville problems and special functions. Green's functions in one dimension. Integral equations. Prerequisite: Math 314-3 or equivalent. Math 419-3 is recommended.

Math 901-4   Advanced Mathematical Methods II
First order partial differential equations. Characteristics. Eigenfunction expansions and integral transforms. Discontinuities and singularities; weak solutions. Green's functions. Variational methods. Prerequisite: Math 314-3 or equivalent. Math 418-3 is recommended.

Math 902-4   Applied Complex Analysis
Review of complex power series and contour integration. Conformal mapping, Schwartz-Christoffel transformation. Special functions. Asymptotic expansions. Integral transforms. Prerequisite: Math 322-3 or equivalent. Students with credit for Math 836-4 may not take Math 902-4 for further credit.

Math 905-4   Applied Functional Analysis
Infinite dimensional vector spaces, convergence, generalized Fourier series. Operator theory; the Fredholm alternative. Application to integral equations and Sturm-Liouville systems. Spectral theory. Prerequisite: Math 900-4 or permission of the instructor.

Math 910-4   Ordinary Differential Equations
The solutions and properties of ordinary differential equations and systems of ordinary differential equations in the real and complex domains. Prerequisite: Math 415-3 or equivalent. Students with credit for Math 842-4 may not take Math 910-4 for further credit.

Math 912-4   Partial Differential Equations
An advanced course on partial differential equations.
Topics covered usually will include quasi-linear first order
systems and hyperbolic, parabolic and elliptic second-order
equations. Prerequisite: Math 901-4 or permission of the
instructor.   Students with credit for Math 845-4 may not
take Math 912-4 for further credit.

Math 920-4   Numerical Linear Algebra
Direct and iterative methods for the numerical solution of
linear systems, factorization techniques, linear least
squares problems, eigenvalue problems. Techniques for
parallel architectures. Prerequisite: Students with credit
for Math 850-4 may not take Math 920-4 for further credit.

Math 921-4   Numerical Solution of Ordinary Differential
                Equations
Study of the practical numerical methods for solving initial
and boundary value problems for ordinary differential
equations. Prerequisite: Students with credit for Math 851-4
may not take math 921-4 for further credit.

Math 922-4   Numerical Solution of Partial Differential
                Equations
Analysis and application of numerical methods for solving
partial differential equations. Finite difference methods,
spectral methods, multigrid methods. Prerequisite: Students
with credit for Math 852-4 may not take Math 922-4 for
further credit.

Math 923-4   Numerical Methods in Continuous Optimization
Numerical solution of systems of nonlinear equations, and
unconstrained optimization problems. Newton's method,
Quasi-Newton methods,secant methods, and conjugate gradient
algorithms. Prerequisite: Students with credit for Math
853-4 may not take Math 923-4 for further credit.

Math 929-4   Selected Topics in Numerical Analysis
Study of a specialized area of numerical analysis such as
computational fluid dynamics, approximation theory, integral
equations, integral transforms, computational complex
analysis, special functions, numerical quadrature and
multiple integrals, constrained optimization, finite element
methods, sparse matrix techniques, or parallel algorithms in
scientific computing.

Math 930-4   Fluid Dynamics
Basic equations and theorems of fluid mechanics.
Incompressible flow. Compressible flow. Effects of
viscosity. Prerequisite: Math 361-3 or equivalent. Math
462-3 is recommended.

Math 934-4 Selected Topics in Fluid Dynamics
Study of a specialized area of fluid dynamics such as
hydrodynamic stability, multiphase flow, non-Newtonian
fluids, computational fluid dynamics, boundary-layer theory,
magnetic fluids and plasmas, bio-and geo- fluid mechanics,
gas dynamics. Prerequisite: Math 930-4 or permission of the
instructor.

Math 935-4 Mechanics of Solids
Analysis of stress and strain. Conservation laws. Elastic
and plastic material behaviour. Two- and three-dimensional
elasticity. Variational principles. Wave propagation.
Prerequisite: Math 361-3 or equivalent. Math 468-4 is
recommended. Students with credit for Math 883-4 may not
take Math 935-4 for further credit.

Math 939-4 Selected Topics in Mechanics of Solids
Study of a specialized area of the mechanics of solids such
as composite materials, micromechanics, fracture, plate and
shell theory, creep, computational solid mechanics, wave
propagation, contact mechanics. Prerequisite: Math 935-4 or
permission of the instructor.

Math 940-4 Mathematical Elasticity
Analysis of deformation and motion. Balance laws, stress
and field equations. Cauchy and Green elastic materials.
Boundary-value problems. Incremental elastic deformations.
Elastic properties of solid materials. Prerequisite: Math
935-4 or permission of the instructor.

Math 945-4 Plasticity
An introduction to the mathematical theory of plasticity.
Topics normally will include yield criteria and flow rules,
torsion and bending, plane strain solutions and limit load
analysis. Prerequisite: Students with credit for Math 890-4
may not take Math 945-4 for further credit.

Math 948-4 Continuum Mechanics
General introduction to modern theories of the mechanics of
continuous media. Topics may include linear and non-linear
elasticity, viscoelasticity, Newtonian and non-Newtonian
fluids and multipolar materials. Prerequisite: Students with
credit for Math 881-4 may not take Math 948-4 for further
credit.

Math 950-4 Tensor Analysis on a Differentiable Manifold
A first graduate course dealing with the following topics:
Tensor Algebra, tensor fields on differentiable manifolds,
differential forms, invariant problems in the calculus of
variation, metric field theory and Einstein's equations.

Math 960-4   Mathematical Foundations of Quantum Mechanics I
Historical introduction; Minkowskian space-time and Lorentz-
group; brief review of multilinear algebra; representation
of Lorentz group in tensor spaces; representation of Lorentz
group in spinor spaces; irreducible representations of
Lorentz group; relativistic wave equations. Study of Lie
group generated by elements of Lorentz group in neighborhood
of identity. Prerequisite: Students with credit for Math
885-4 may not take Math 960-4 for further credit.

Math 961-4   Mathematical Foundations of Quantum Mechanics II
Hilbert space; closed linear manifolds; operators in Hilbert
space; eigenvalue problems; Hilbert space representation of
Lorentz group, quantized fields. Statistical
interpretation; uncertainty principle, measurement
processes. Prerequisite: Students with credit for Math 886-4
may not take Math 961-4 for further credit.

Math 964-4   General Relativity I
Historical introduction; review of tensor calculus in
pseudo-Riemannian space. The world function $w(X,X_1)$ and
chronometry; pseudo-Riemannian space-time; the material
continuum and Einstein's field equations. Differential and
integral conservation laws and equations of motion;
universes with spherical symmetry and application to
planetary systems; statical universes; stationary universes.
Prerequisite: Students with credit for Math 887-4 may not
take Math 964-4 for further credit.

Math 965-4   General Relativity II
Further studies of pseudo-Riemannian geometry; tetrad
formalism and Ricci rotation coefficients; Petrov's
classification of special Einstein spaces X_4. Gravitional
radiations; coupled electro-gravitional universes; combined
Klein-Gordon-Maxwell-Einstein field equations; comments on
geometrodynamics. Prerequisite: Students with credit for
Math 888-4 may not take Math 965-4 for further credit.

Math 990-4   Selected Topics in Applied Mathematics

See also MATH 800-899 listed under Department of Mathematics
and Statistics on page xx and STAT 801-890 listed under
Statistics Program on page xx.

Rationale. The new calendar entry reflects above all the Department's wish to give adequate exposure to what it can offer students interested in applied mathematics and numerical analysis. At the same time the proposed entry reflects the intention to give more structure to the program followed by students who select the option of Applied and Computational Mathematics. In the M.Sc. more emphasis will be placed on course work and less on the thesis which will now be called a "project". Another element which has been incorporated in the M.Sc. is the insistence that all students gain some experience in the application of numerical methods.

The Department believes that the change in format of the M.Sc. will provide a better training for students and will make better use of faculty.

The appropriateness of a separate graduate calendar entry for Applied and Computational Mathematics is supported by the existence of a corresponding entry for Applied Mathematics in the undergraduate section of the calendar. The inclusion of "Computational" is intended to underline the importance attached to integrating the application of numerical analysis with the study of other areas in applied mathematics.

The Ph.D. program described in the new calendar entry is virtually the same as that which has existed for many years. The main difference is that the syllabus for the General Examination will be based on the six core courses listed in the M.Sc. requirements.

The revision of the M.Sc. regulations for students in Applied and Computational Mathematics does not constitute the introduction of a new program. Given the course changes proposed in III above the changes to the M.Sc. for this stream of students could be implemented under our present calendar entry through the cooperation of Supervisory Committees. However, this remark should not be interpreted as diminishing the need for a separate calendar entry which is essential for the healthy operation and growth of this part of the Department's program.

SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

Appendix A

CALENDAR INFORMATION:

Department: _____Mathematics and Statistics_____ Course Number: __Math 833-4__

Title: _____Analysis: Selected Topics_____

Description: _____

_____

Credit Hours: ___4___   Vector: __4-0-0__   Prerequisite(s) if any: _____

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: ___12___ When will the course first be offered: When required

How often will the course be offered: _Irregular Intervals._

JUSTIFICATION:

This is a retitling of Math 833-4 whose present title is "Real Analysis: Selected

Topics". The revised title will allow it to be used for a selected topics course

in any part of Analysis.

RESOURCES:

Which Faculty member will normally teach the course: _Freedman, Thomson and others._

What are the budgetary implications of mounting the course: _____Nil_____

Are there sufficient Library resources (append details): _____Yes_____

Appended: a) Outline of the Course
          b) An indication of the competence of the Faculty member to give the course.
          c) Library resources

Approved: Departmental Graduate Studies Committee: _J. M. Lachlan_ Date: 24/08/90

          Faculty Graduate Studies Committee: _P. W. Percal_ Date: 13 Sept 90

          Faculty: _CHW Jones_ Date: 11 Oct 90

          Senate Graduate Studies Committee: _BRCla_ Date: 27 Nov 90

          Senate: _____ Date: _____

SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: _____Mathematics and Statistics_____ Course Number: Math 900-4

Title: Advanced Mathematical Methods I

Description: Hilbert spaces. Calculus of variations. Sturm-Liouville problems

and special functions. Green's functions in one dimension. Integral equations.

Credit Hours: 4   Vector: 4-0-0   Prerequisite(s) if any: Math 314-3

or equivalent. Math 419-3 is recommended.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 15-20   When will the course first be offered: 90-3 or 91-1

How often will the course be offered: Once every two years.

JUSTIFICATION: Every student for an M.Sc. or Ph.D. in *Applied and Computational*

Mathematics will be required to obtain credit for this course. It should also appeal

to students in Mathematics, Science and Applied Science. Math 900-4 is a replacement

for Math 843-4.

RESOURCES:

Which Faculty member will normally teach the course: Shen, Singh & others.

What are the budgetary implications of mounting the course: Nil

Are there sufficient Library resources (append details): Yes

Appended: a) Outline of the Course
b) An Indication of the competence of the Faculty member to give the course.
c) Library resources

Approved: Departmental Graduate Studies Committee: _A. M. Lachlan_ Date: 24/08/90

Faculty Graduate Studies Committee: _P. W. Percival_ Date: 13 Sept '90

Faculty: _CHM. Jones_ Date: 11 oct 90

Senate Graduate Studies Committee: _BPCla_ Date: 27 Nov /90

Senate: _____ Date: _____

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SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: Mathematics and Statistics   Course Number: Math 901-4

Title: Advanced Mathematical Methods II

Description: First order partial differential equations. Characteristics. Eigenfunction

expansions and integral transforms. Discontinuities and singularities; weak solutions.

Green's functions. Variational methods.

Credit Hours: 4   Vector: 4-0-0   Prerequisite(s) if any: Math 314-3

or equivalent. Math 418-3 is recommended.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 15-20   When will the course first be offered: 91-3

How often will the course be offered: Once every two years.

JUSTIFICATION: Every student for an M.Sc. or Ph.D. in *Applied and Computational Mathematics*

will be required to obtain credit for this course. It should also appeal to students

in Mathematics, Science and Applied Science. Math 901-4 is a replacement for Math 846

RESOURCES:

Which Faculty member will normally teach the course: Das, Pechlaner and others.

What are the budgetary implications of mounting the course: Nil

Are there sufficient Library resources (append details): Yes

Appended: a) Outline of the Course
b) An indication of the competence of the Faculty member to give the course.
c) Library resources

Approved: Departmental Graduate Studies Committee: _G. W. Lachlan_ Date: 24/08/90

Faculty Graduate Studies Committee: _P. W. Percival_ Date: 13 Sept '90

Faculty: _CHW. Jones_ Date: 11 Oct 90

Senate Graduate Studies Committee: _B. Clay_ Date: 27 Nov/90

Senate: _____ Date: _____

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: _Mathematics and Statistics_   Course Number: _Math 902-4_

Title: _Applied Complex Analysis_

Description: _Review of complex power series and contour integration. Conformal mapping, Schwartz-Christoffel transformation. Special functions. Asymptotic expansions. Integral transforms._

Credit Hours: _4_   Vector: _4-0-0_   Prerequisite(s) if any: _Math 322-0 or equivalent._

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: _12_   When will the course first be offered: _When required._

How often will the course be offered: _Irregular intervals._

JUSTIFICATION: This course will be available for elective credit to M.Sc. and Ph.D. students in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics Science and Applied Science. Math 902-4 is a replacement for Math 838-4.

RESOURCES:

Which Faculty member will normally teach the course: _Shoemaker, Trummer and others._

What are the budgetary implications of mounting the course: _Nil_

Are there sufficient Library resources (append details): _Yes_

Appended: a) Outline of the Course
         b) An indication of the competence of the Faculty member to give the course.
         c) Library resources

Approved: Departmental Graduate Studies Committee: _C. H. Lachlan_   Date: _24/08/90_

           Faculty Graduate Studies Committee: _P.W. Percival_   Date: _13 Sept 80_

           Faculty: _CHM. Jones_   Date: _11 Oct 90_

           Senate Graduate Studies Committee: _B. Clayman_   Date: _27 Nov/90_

           Senate: _____   Date: _____

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SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: Mathematics and Statistics   Course Number: Math 905-4

Title: Applied Functional Analysis

Description: Infinite dimensional vector spaces, convergence, generalized Fourier series. Operator theory; the Fredholm alternative. Application to integral equations and Sturm-Liouville systems. Spectral theory.

Credit Hours: 4   Vector: 4-0-0   Prerequisite(s) if any: Math 900-4 or permission of the instructor

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 12   When will the course first be offered: When required

How often will the course be offered: Irregular intervals.

JUSTIFICATION: This course will be available for elective credit to M.Sc. and Ph.D. students in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics, Science and Applied Science. "A Review of the Department of Mathematics and Statistics" performed in March 1989 noted the absence of a graduate level course Functional Analysis and stated that such a central area should be offered to graduate students. The proposed course will remedy this defect.

RESOURCES:

Which Faculty member will normally teach the course: Lardner, Shen & others

What are the budgetary implications of mounting the course: Nil

Are there sufficient Library resources (append details): Yes

Appended: a) Outline of the Course
b) An indication of the competence of the Faculty member to give the course.
c) Library resources

Approved: Departmental Graduate Studies Committee: _C.M. Lachlan_ Date: 24/08/90

Faculty Graduate Studies Committee: _P. W. Percal_ Date: 13 Sept '90

Faculty: _C.H.W. Jones_ Date: 11 oct 90

Senate Graduate Studies Committee: _B.P. Clayman_ Date: 27 Nov /90

Senate: _____ Date: _____

SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

<u>CALENDAR INFORMATION:</u>

Department: Mathematics and Statistics   Course Number: Math 910-4

Title: Ordinary Differential Equations

Description: The solutions and properties of ordinary differential equations and systems of ordinary differential equations in the real and complex domains.

Credit Hours: 4   Vector: 4-0-0   Prerequisite(s) if any: Math 415-3 or equivalent. Students with credit for Math 842-4 may not take Math 910-4 for further credit

<u>ENROLLMENT AND SCHEDULING:</u>

Estimated Enrollment: 12   When will the course first be offered: When required.

How often will the course be offered: Irregular intervals.

<u>JUSTIFICATION:</u> This course will be available for elective credit to M.Sc. and Ph.D. students in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics Science and Applied Science. Math 910-4 is a renumbering and retitling of Math 842-4.

<u>RESOURCES:</u>

Which Faculty member will normally teach the course: Bojadziev, Sharma and others.

What are the budgetary implications of mounting the course: Nil

Are there sufficient Library resources (append details): Yes

Appended: a) Outline of the Course
b) An indication of the competence of the Faculty member to give the course.
c) Library resources

Approved: Departmental Graduate Studies Committee: _C. M. Lachlan_ Date: 24/08/90

Faculty Graduate Studies Committee: _P. W. Percial_ Date: 13 Sept '90

Faculty: _CHW. Jones_ Date: 11 Oct 90

Senate Graduate Studies Committee: _____ Date: 27 Nov/90

Senate: _____ Date: _____

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SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department:___Mathematics and Statistics___   Course Number: Math 912-4

Title:__Partial Differential Equations_____

Description: An advanced course on partial differential equations. Topics covered usually
will include quasi-linear first order systems and hyperbolic, parabolic and elliptic second-
order equations.

Credit Hours:_____4_____ . Vector:__4-0-0___ Prerequisite(s) if any: Math 901-4 or
permission of the instructor. Students with credit for Math 845-4 may not take Math 912-4
for further credit.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment:_____12_____When will the course first be offered: When required

How often will the course be offered:___Irregular intervals._____

JUSTIFICATION: This course will be available for elective credit to M.Sc. and Ph.D. students
in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics,
Science and Applied Science. Math 912-4 is a renumbering and retitling of Math 845-4.

RESOURCES:

Which Faculty member will normally teach the course:____.Das, Sharma and others._____

What are the budgetary implications of mounting the course:_____Nil_____

Are there sufficient Library resources (append details):_____Yes___

Appended:. a) Outline of the Course
          b) An indication of the competence of the Faculty member to give the course.
          c) Library resources

Approved: Departmental Graduate Studies Committee: *A. H. Lachlan*   Date: 24/08/90

          Faculty Graduate Studies Committee:___*P. W. Percival*___ Date: 13 Sept '90

          Faculty:_____*C. H. W. Jones*___ Date: 11 Oct 90

          Senate Graduate Studies Committee: *B. P. Clayman*   Date: 27 Nov /90

          Senate:_____ Date:_____

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New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: Mathematics and Statistics   **Course Number:** Math 920-4

Title: Numerical Linear Algebra

Description: Direct and iterative methods for the numerical solution of linear systems, factorization techniques, linear least squares problems, eigenvalue problems. Techniques for parallel architectures.

Credit Hours: 4   **Vector:** 4-0-0   **Prerequisite(s) if any:** Students with credit for Math 850-4 may not take Math 920-4 for further credit.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 15-20   **When will the course first be offered:** 91-3 or 92-1

How often will the course be offered: Once every two years.

JUSTIFICATION: Every student for an M.Sc. or Ph.D. in *Applied and Computational Mathematics* will be required to obtain credit for this course. It should also appeal to students in Mathematics, Science and Applied Science. Math 920-4 is a renumbering of Math 850-4.

RESOURCES:

Which Faculty member will normally teach the course: Russell, Trummer and others.

What are the budgetary implications of mounting the course: Nil

Are there sufficient Library resources (append details): Yes

Appended: a) Outline of the Course
b) An indication of the competence of the Faculty member to give the course.
c) Library resources

Approved: Departmental Graduate Studies Committee: _C. H. Lachlan_ Date: 24/08/90

Faculty Graduate Studies Committee: _P. W. Percival_ Date: 13 Sept 90

Faculty: _C+H. Jones_ Date: 11 Oct 90

Senate Graduate Studies Committee: _B. Clay_ Date: 27 Nov/90

Senate: _____ Date: _____

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CALENDAR INFORMATION:

Department: __Mathematics and Statistics__   Course Number: __921-4__

Title: __Numerical Solution of Ordinary Differential Equations__

Description: __Study of the practical numerical methods for solving initial and boundary value problems for ordinary differential equations.__

Credit Hours: __4__   Vector: __4-0-0__   Prerequisite(s) if any: __Students with credit for Math 851-4 may not take Math 921-4 for further credit.__

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: __15-20__   When will the course first be offered: _____

How often will the course be offered: __Once every two years.__

JUSTIFICATION: This course will be available for elective credit to M.Sc. and Ph.D. students in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics, Science and Applied Science. Math 921-4 is a renumbering of Math 851-4.

RESOURCES:

Which Faculty member will normally teach the course: __Russell, Trummer and others.__

What are the budgetary implications of mounting the course: __Nil__

Are there sufficient Library resources (append details): __Yes__

Appended: a) Outline of the Course
      b) An indication of the competence of the Faculty member to give the course.
      c) Library resources

Approved: Departmental Graduate Studies Committee: _C. H. Lachlen_ Date: _24/08/90_

      Faculty Graduate Studies Committee: _P.W. Percival_ Date: _13 Sept '90_

      Faculty: _CHN Jones_ Date: _11 Oct 90_

      Senate Graduate Studies Committee: _BPCla_ Date: _2? Nov /90_

      Senate: _____ Date: _____

SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: Mathematics and Statistics   Course Number: Math 922-4

Title: Numerical Solution of Partial Differential Equations

Description: Analysis and application of numerical methods for solving partial differential equations. Finite difference methods, spectral methods, multigrid methods.

Credit Hours: 4   Vector: 4-0-0   Prerequisite(s) if any: Students with credit for Math 852-4 may not take Math 922-4 for further credit.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 15-20   When will the course first be offered: 90-3 or 91-1

How often will the course be offered: Once every two years.

JUSTIFICATION: Every student for an M.Sc. or Ph.D. in *Applied and Computational Mathematics* will be required to obtain credit for this course. It should also appeal to students in Mathematics, Science and Applied Science. Math 922-4 is a renumbering of Math 852-4.

RESOURCES:

Which Faculty member will normally teach the course: Lardner, Russell and others

What are the budgetary implications of mounting the course: Nil

Are there sufficient Library resources (append details): Yes

Appended: a) Outline of the Course
b) An indication of the competence of the Faculty member to give the course.
c) Library resources

Approved: Departmental Graduate Studies Committee: _G. H. Lachlan_ Date: 24/08/90

Faculty Graduate Studies Committee: _P. W. Percival_ Date: 13 Sept 90

Faculty: _C.H.W. Jones_ Date: 11 Oct 90

Senate Graduate Studies Committee: _____ Date: 27 Nov/90

Senate: _____ Date: _____

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SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: _____Mathematics and Statistics_____ Course Number: __Math 923-4__

Title: Numerical Methods in Continuous Optimization

Description: Numerical solution of systems of nonlinear equations, and unconstrained

optimization problems. Newton's method, Quasi-Newton methods, secant methods, and conjugate
gradient algorithms.

Credit Hours: _____4_____ Vector: _4-0-0_ Prerequisite(s) if any: Students with

credit for Math 853-4 may not take Math 923-4 for further credit.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: ___12___ When will the course first be offered: _____

How often will the course be offered: ____ Once every two years. _____

JUSTIFICATION: This course will be available for elective credit to M.Sc. and Ph.D. students

in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics,

Science and Applied Science. Math 923-4 is a renumbering of Math 853-4.

RESOURCES:

Which Faculty member will normally teach the course: . Russell, Trummer and others.

What are the budgetary implications of mounting the course: ____ Nil _____

Are there sufficient Library resources (append details): ____ Yes _____

Appended: a) Outline of the Course
b) An indication of the competence of the Faculty member to give the course.
c) Library resources

Approved: Departmental Graduate Studies Committee: _G·H·Lachlen_ Date: _24/08/90_

Faculty Graduate Studies Committee: _P.W. Percival_ Date: _13 Sept 90_

Faculty: _CHW. Jones_ Date: _11 Oct 90_

Senate Graduate Studies Committee: _BPClg_ Date: _27 No/60_

Senate: _____ Date: ____

SIMON FRASER UNIVERSITY

<u>New Graduate Course Proposal Form</u>

<u>CALENDAR INFORMATION</u>:

Department: Mathematics and Statistics   Course Number: Math 929-4

Title: Selected Topics in Numerical Analysis

Description: Study of a specialized area of numerical analysis such as computational fluid dynamics, approximation theory, integral equations, integral transforms, computational complex analysis, special functions, numerical quadrature and multiple integrals, constrained optimization, finite element methods, sparse matrix techniques, or parallel algorithms in scientific computing.

Credit Hours: 4   Vector: 4-0-0   Prerequisite(s) if any:

<u>ENROLLMENT AND SCHEDULING</u>:

Estimated Enrollment: 12   When will the course first be offered: When required

How often will the course be offered: Irregular intervals.

<u>JUSTIFICATION</u>: This course will be available for elective credit to M.Sc. and Ph.D. students in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics, Science and Applied Science. Math 929-4 is a renumbering of Math 855-4.

<u>RESOURCES</u>:

Which Faculty member will normally teach the course: Russell, Trummer and others.

What are the budgetary implications of mounting the course: Nil

Are there sufficient Library resources (append details): Yes

Appended: a) Outline of the Course
          b) An Indication of the competence of the Faculty member to give the course.
          c) Library resources

Approved: Departmental Graduate Studies Committee: _A.H. Lachlan_ Date: 24/08/90

Faculty Graduate Studies Committee: _P.W. Percival_ Date: 13 Sept 90

Faculty: _CHW. Jems_ Date: 11 Oct 90

Senate Graduate Studies Committee: _____ Date: 27 Nov/90

Senate: _____ Date: _____

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SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department:_____Mathematics and Statistics_____ Course Number:__Math 930-4__

Title:__Fluid Dynamics_____

Description:__Basic equations and theorems of fluid mechanics. Incompressible flow.__

Compressible flow. Effects of viscosity._____

Credit Hours:_____4_____Vector:____4-0-0_____Prerequisite(s) if any:_Math 361-3 or

equivalent. Math 462-3 is recommended.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment:___15-20_____When will the course first be offered:_____90-3_____

How often will the course be offered:___Once every two years._____

JUSTIFICATION: Every student for an M.Sc. or Ph.D. in *Applied and Computational Mathematics*

will be required to obtain credit for this course. It should also appeal to students in

Mathematics, Sciences and Applied Science. Math 930-4 is a replacement for Math 882-4.

RESOURCES:

Which Faculty member will normally teach the course:_Singh, Tao and others._____

What are the budgetary implications of mounting the course:_____Nil_____

Are there sufficient Library resources (append details):____Yes_____

Appended: a) Outline of the Course
           b) An indication of the competence of the Faculty member to give the course.
           c) Library resources

Approved: Departmental Graduate Studies Committee:_C. H. Lachlen___ Date:_24/08/90_

           Faculty Graduate Studies Committee:_____P. W. Percial__ Date:_13 Sept'90_

           Faculty:_____CHW. Jones_ Date: 11 Oct 90

           Senate Graduate Studies Committee:_BXCa____ Date:_27 Nov/90_

           Senate:_____ Date:_____

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SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: Mathematics and Statistics   Course Number: Math 934-4

Title: Selected Topics in Fluid Dynamics

Description: Study of a specialized area of fluid dynamics such as hydrodynamic stability, multiphase flow, non-Newtonian fluids, computational fluid dynamics, boundary-layer theory, magnetic fluids and plasmas, bio-and geo-fluid mechanics, gas dynamics.

Credit Hours: 4   Vector: 4-0-0   Prerequisite(s) if any: Math 930-4 or
                                                          permission of the instructor.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 12   When will the course first be offered: When required

How often will the course be offered: Irregular intervals.

JUSTIFICATION: This course will be available for elective credit to M.Sc. and Ph.D. students in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics, Science and Applied Science. Math 934-4 is a replacement for Math 891-4.

RESOURCES:

Which Faculty member will normally teach the course: Singh, Tao and others.

What are the budgetary implications of mounting the course: Nil

Are there sufficient Library resources (append details):   Yes

Appended: a) Outline of the Course
          b) An indication of the competence of the Faculty member to give the course.
          c) Library resources

Approved: Departmental Graduate Studies Committee: _Ce M. Lachlan_ Date: _24/C8/90_

          Faculty Graduate Studies Committee: ___P.W. Percival___ Date: _13 Sept 90_

          Faculty: _CHW. Jones_ Date: _11 Oct 90_

          Senate Graduate Studies Committee: _B.D. Clay_ Date: _27 Nov/90_

          Senate: _____ Date: _____

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SIMON FRASER UNIVERSITY

Ncw Graduate Course Proposal Form

CALENDAR INFORMATION:

Department:___Mathematics and Statistics_____ Course Number:____Math 935-4_____

Title:___Mechanics of Solids._____

Description: Analysis of stress and strain. Conservation laws. Elastic and plastic material

behaviour. Two- and three-dimensional elasticity. Variational principles. Wave propagation.

Credit Hours:_____4_____ Vector:____4-0-0_____ Prerequisite(s) if any: Math 361-3 or
equivalent. Math 468-4 is recommended. Students with credit for Math 883-4 may not take
Math 935-4 for further credit.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment:___15-20_____ When will the course first be offered:_____91-3_____

How often will the course be offered:____Once every two years._____

JUSTIFICATION: Every student for an M.Sc. or Ph.D. in *Applied and Computational Mathematics*
will be required to obtain credit for this course. It should also appeal to students in

Mathematics, Science and Applied Science. Math 935-4 is a replacement for Math 883-4.

RESOURCES:

Which Faculty member will normally teach the course:____Sharma, Singh and others._____

What are the budgetary implications of mounting the course:_____Nil_____

Are there sufficient Library resources (append details):_____Yes_____

Appended:. a) Outline of the Course
         b) An indication of the competence of the Faculty member to give the course.
         c) Library resources

Approved: Departmental Graduate Studies Committee:_*A.H. Lachlan*_____ Date:_24/08/90_

          Faculty Graduate Studies Committee:____*P.W. Percival*____ Date:_13 Sept '90_

          Faculty:_____*C.H.W. Jones*_____ Date:_11 Oct 90_

          Senate Graduate Studies Committee:_*B. Clayman*_____ Date:_27 Nov/90_

          Senate:_____ Date:_____

SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: Mathematics and Statistics   **Course Number:** Math 939-4

Title: Selected Topics in Mechanics and Solids.

Description: Study of a specialized area of the mechanics of solids such as composite materials, micromechanics, fracture, plate and shall theory, creep, computational solid mechanics, wave propagation, contact mechanics.

Credit Hours: 4   **Vector:** 4-0-0   **Prerequisite(s) if any:** Math 935-4 or permission of the instructor.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 12   **When will the course first be offered:** When required

How often will the course be offered: Irregular intervals.

JUSTIFICATION: This course will be available for elective credit to M.Sc. and Ph.D. students in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics, Science and Applied Science. Math 939-4 is a replacement for Math 892-4.

RESOURCES:

Which Faculty member will normally teach the course: Shoemaker, Lardner and others.

What are the budgetary implications of mounting the course: Nil

Are there sufficient Library resources (append details): Yes

Appended:
   a) Outline of the Course
   b) An indication of the competence of the Faculty member to give the course.
   c) Library resources

Approved: Departmental Graduate Studies Committee: _A.M. Lachlan_ Date: 24/08/90

       Faculty Graduate Studies Committee: _P. W. Percival_ Date: 13 Sept 90

       Faculty: _C.H.W. Jevos_ Date: 11 Oct 90

       Senate Graduate Studies Committee: _B.P.Clg_ Date: 27 Nov/90

       Senate: _____ Date: _____

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SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: _____ Mathematics and Statistics _____ Course Number: Math 940-4

Title: _____ Mathematical Elasticity _____

Description: Analysis of deformation and motion. Balance laws, stress and field equations. Cauchy and Green elastic materials. Boundary-value problems. Incremental elastic deformations. Elastic properties of solid materials.

Credit Hours: _____ 4 _____ Vector: 4-0-0 _____ Prerequisite(s) if any: Math 935-4 or permission of the instructor.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: _____ 12 _____ When will the course first be offered: When required

How often will the course be offered: _____ Irregular intervals.

JUSTIFICATION: This course is available for elective credit to M.Sc. and Ph.D. students in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics, Science and Applied Science. Math 940-4 is a replacement for Math 884-4.

RESOURCES:

Which Faculty member will normally teach the course: Lardner, Singh and others

What are the budgetary implications of mounting the course: _____ Nil

Are there sufficient Library resources (append details): Yes

Appended: a) Outline of the Course
b) An indication of the competence of the Faculty member to give the course.
c) Library resources

Approved: Departmental Graduate Studies Committee: _Ci H. Lachlan_ Date: 24/08/90

Faculty Graduate Studies Committee: _P.W. Percival_ Date: 13 Sept 90

Faculty: _CHW. Jones_ Date: 11 Oct 90

Senate Graduate Studies Committee: _BPClay_ Date: 27 Nov/90

Senate: _____ Date: _____

SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: Mathematics and Statistics   Course Number: Math945-4

Title: Plasticity

Description: An introduction to the mathematical theory of plasticity. Topics normally will include yield criteria and flow rules, torsion and bending, plane strain solutions and limit load analysis.

Credit Hours: 4   Vector: 4-0-0   Prerequisite(s) if any: Students with credit for Math 890-4 may not take Math 945-4 for further credit.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 12   When will the course first be offered: When required.

How often will the course be offered: Irregular intervals.

JUSTIFICATION: This course will be available for elective credit to M.Sc. and Ph.D. students in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics, Science and Applied Science. Math 945-4 is a renumbering and retitling of Math 890-4.

RESOURCES:

Which Faculty member will normally teach the course: Shoemaker, Singh and others.

What are the budgetary implications of mounting the course: Nil

Are there sufficient Library resources (append details):   Yes

Appended: a) Outline of the Course
          b) An indication of the competence of the Faculty member to give the course.
          c) Library resources

Approved: Departmental Graduate Studies Committee: _C. H. Lachlan_ Date: 24/05/90

          Faculty Graduate Studies Committee: _P. W. Percival_ Date: 13 Sept 90

          Faculty: _A. W. Jones_ Date: 11 Oct 90

          Senate Graduate Studies Committee: _B. P. Clay_ Date: 27 Nov /90

          Senate: _____ Date: _____

SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: __Mathematics and Statistics__   Course Number: __Math 948-4__

Title: __Continuum Mechanics__

Description: __General introduction to modern theories of the mechanics of continuous media.__
__Topics may include linear and non-linear elasticity, viscoelasticity, Newtonian and non-__
__Newtonian fluids and multipolar materials.__

Credit Hours: __4__   Vector: __4-0-0__   Prerequisite(s) if any: __Students with__
__credit for Math 881-4 may not take Math 948-4 for further credit.__

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: __12__ When will the course first be offered: __When required__

How often will the course be offered: __Irregular intervals__

JUSTIFICATION: This course will be available for elective credit to M.Sc. and Ph.D. students

in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics,

Science and Applied Science. Math 948-4 is a renumbering and retitling of Math 881-4.

RESOURCES:

Which Faculty member will normally teach the course: __Lardner, Singh and others__

What are the budgetary implications of mounting the course: __Nil__

Are there sufficient Library resources (append details): __Yes__

Appended:. a) Outline of the Course
    b) An indication of the competence of the Faculty member to give the course.
    c) Library resources

Approved: Departmental Graduate Studies Committee: _C. H. Lachlan_ Date: _24/08/90_

    Faculty Graduate Studies Committee: _P. W. Percival_ Date: _13 Sept 90_

    Faculty: _CHW. Jones_ Date: _11 Oct 90_

    Senate Graduate Studies Committee: _BRCe_ Date: _27 Nov/90_

    Senate: _____ Date: _____

SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: _____ Mathematics and Statistics _____ Course Number: _Math 950-4_

Title: _Tensor Analysis on a Differentiable Manifold._

Description: _A first graduate course dealing with the following topics: Tensor Algebra, tensor fields on differentiable manifolds, differential forms, invariant problems in the calculus of variation, metric field theory and Einstein's equations._

Credit Hours: _____4_____ Vector: _4-0-0_ Prerequisite(s) if any:_____

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: _____12_____ When will the course first be offered: _When required_

How often will the course be offered:_____ Irregular intervals

JUSTIFICATION: This course will be available for elective credit to M.Sc. and Ph.D. students

in Applied and Computational Mathematics. It should also appeal to students in Mathematics

Science and Applied Science. Math 950-4 is a replacement for Math 893-4.

RESOURCES:

Which Faculty member will normally teach the course:_ Das, Pechlaner and others._

What are the budgetary implications of mounting the course:_____ Nil _____

Are there sufficient Library resources (append details):_____ Yes _____

Appended: a) Outline of the Course
b) An indication of the competence of the Faculty member to give the course.
c) Library resources

Approved: Departmental Graduate Studies Committee: _C. M. Lachlan_ Date: _24/08/90_

Faculty Graduate Studies Committee: _P. W. Percal_ Date: _13 Sept '90_

Faculty:_____ _CHW. Jones_ Date: _11 Oct 90_

Senate Graduate Studies Committee: _BPClay_ Date: _27 Nov/96_

Senate:_____ Date:_____

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SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department:_____Mathematics and Statistics_____ Course Number:__Math 960-4__

Title:__Mathematical Foundations of Quantum Mechanics I_____

Description:___Historical introduction; Minkowskian space-time and Lorentz-group; brief review
of multilinear algebra; representation of Lorentz group in tensor spaces;
representation of Lorentz group in spinor spaces; irreducible representations of Lorentz
group; relativistic wave equations. Study of Lie group generated by elements of Lorentz
group in neighborhood of identity.

Credit Hours:_____4_____ Vector:__4-0-0_____ Prerequisite(s) if any:_Students with
credit for Math 885-4 may not take Math 960-4 for further credit.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment:____12_____ When will the course first be offered: When required

How often will the course be offered:____Irregular intervals.

JUSTIFICATION: This course will be available for elective credit to M.Sc. and Ph.D. students

in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics,

Science and Applied Science. Math 960-4 is a renumbering of Math 885-4.

RESOURCES:

Which Faculty member will normally teach the course:____. Das and others.

What are the budgetary implications of mounting the course:_____Nil

Are there sufficient Library resources (append details):____Yes

Appended:. a) Outline of the Course
          b) An Indication of the competence of the Faculty member to give the course.
          c) Library resources

Approved: Departmental Graduate Studies Committee:_C.H. Lachlan____ Date:_24/08/90_

           Faculty Graduate Studies Committee:____P.W. Percival__ Date: 13 Sept '90

           Faculty:_____ A.W. Jones Date: 11 Oct 90

           Senate Graduate Studies Committee:_____ Date: 27 Nov/6

           Senate:_____ Date:_____

CALENDAR INFORMATION:

Department: Mathematics and Statistics   **Course Number:** Math 961-4

Title: Mathematical Foundations of Quantum Mechanics II

Description: Hilbert space; closed linear manifolds; operators in Hilbert space; eigenvalue problems; Hilbert space representation of Lorentz group, quantized fields. Statistical interpretation; uncertainty principle, measurement processes.

Credit Hours: 4   **Vector:** 4-0-0   **Prerequisite(s) if any:** Students with credit for Math 886-4 may not take Math 961-4 for further credit.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 12   **When will the course first be offered:** When required

How often will the course be offered: Irregular intervals.

JUSTIFICATION: This course will be available for elective credit to M.Sc. and Ph.D. students in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics, Science and Applied Science. Math 961-4 is a renumbering of Math 886-4.

RESOURCES:

Which Faculty member will normally teach the course: Das and others.

What are the budgetary implications of mounting the course: Nil

Are there sufficient Library resources (append details): Yes

Appended: a) Outline of the Course
b) An indication of the competence of the Faculty member to give the course.
c) Library resources

Approved: Departmental Graduate Studies Committee: *G.A.C. Lachlan* Date: 24/08/90

Faculty Graduate Studies Committee: *P.D. Percival* Date: 13 Sept 90

Faculty: *C.H.W. Jones* Date: 11 Oct 90

Senate Graduate Studies Committee: *BPCC* Date: 22 Nov/90

Senate: _____ Date: _____

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SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department:___Mathematics and Statistics_____ Course Number:__Math 964-4__

Title:__General Relativity I__

Description:__Historical introduction; review of tensor calculus in pseudo-Riemannian space.
The world function $w(X,X_1)$ and chronometry; pseudo-Riemannian space-time;
the material continuum and Einstein's field equations. Differential and integral con-
servation laws and equations of motion; universes with spherical symmetry and application
to planetary systems; statical universes; stationary universes.

Credit Hours:_____4_____ Vector:__4-0-0_____ Prerequisite(s) if any:_Students with
credit for Math 887-4 may not take Math 964-4 for further credit.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment:____12____ When will the course first be offered:_When required_

How often will the course be offered:_____Irregular intervals.__

JUSTIFICATION: This course will be available for elective credit to M.Sc. and Ph.D. students

in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics,

Science and Applied Science. Math 964-4 is a renumbering of Math 887-4.

RESOURCES:

Which Faculty member will normally teach the course:____.____Das, Pechlaner and others.

What are the budgetary implications of mounting the course:____Nil__

Are there sufficient Library resources (append details):____Yes__

Appended: a) Outline of the Course
          b) An indication of the competence of the Faculty member to give the course.
          c) Library resources

Approved: Departmental Graduate Studies Committee:_*A.M. Lachlan*_Date:_24/08/90_

           Faculty Graduate Studies Committee:____P.W. Percival____Date:_13 Sept'90_

           Faculty:_____C.H.W. Jones____Date:_11 Oct 90_

           Senate Graduate Studies Committee:__BRC_____Date:_27 Nov/90_

           Senate:_____Date:_____

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: Mathematics and Statistics   **Course Number:** Math 965-4

Title: General Relativity II

Description: Further studies of pseudo-Riemannian geometry; tetrad formalism and Ricci rotation coefficients; Petrov's classification of special Einstein spaces X_4. Gravitational radiations; coupled electro-gravitational universes; combined Klein-Gordon-Maxwell-Einstein field equations; comments on geometrodynamics.

Credit Hours: 4   **Vector:** 4-0-0   **Prerequisite(s) if any:** Students with credit for Math 888-4 may not take Math 965-4 for further credit.

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 12   **When will the course first be offered:** When required

How often will the course be offered: Irregular intervals

JUSTIFICATION: This course will be available for elective credit to M.Sc. and Ph.D. students in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics, Science and Applied Science. Math 965-4 is a renumbering of Math 888-4.

RESOURCES:

Which Faculty member will normally teach the course: Das, Pechlaner and others.

What are the budgetary implications of mounting the course: Nil

Are there sufficient Library resources (append details): Yes

Appended: a) Outline of the Course
b) An indication of the competence of the Faculty member to give the course.
c) Library resources

Approved: Departmental Graduate Studies Committee: _A. H. Lachlan_ Date: 24/08/90

Faculty Graduate Studies Committee: _P.W. Percival_ Date: 13 Sept/90

Faculty: _C.H.W. Jones_ Date: 14 Oct 90

Senate Graduate Studies Committee: _B. Clayman_ Date: 2> Nov/90

Senate: _____ Date: _____

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SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

CALENDAR INFORMATION:

Department: Mathematics and Statistics   Course Number: Math 990-4

Title: Selected Topics in Applied Mathematics

Description:

Credit Hours: 4   Vector: 4-0-0   Prerequisite(s) if any:

ENROLLMENT AND SCHEDULING:

Estimated Enrollment: 12   When will the course first be offered: When required

How often will the course be offered: Irregular intervals.

JUSTIFICATION: This course will be available for elective credit to M.Sc. and Ph.D. students in *Applied and Computational Mathematics*. It should also appeal to students in Mathematics, Science and Applied Science. Math 990-4 is a renumbering and retitling of Math 889-4.

RESOURCES:

Which Faculty member will normally teach the course: Applied Mathematics Faculty and others.

What are the budgetary implications of mounting the course: Nil

Are there sufficient Library resources (append details): Yes

Appended: a) Outline of the Course
          b) An indication of the competence of the Faculty member to give the course.
          c) Library resources

Approved: Departmental Graduate Studies Committee: _A H Lachlan_ Date: 24/08/90

          Faculty Graduate Studies Committee: _P.W. Percival_ Date: 13 Sept '90

          Faculty: _C+W. Jones_ Date: 11 Oct 90

          Senate Graduate Studies Committee: _B.P. Clay_ Date: 27 Nov/90

          Senate: _____ Date: _____

Appendix B. Graduate calendar entry for the Department of Mathematics and Statistics.

If the changes proposed in I-IV are approved, a revision of the calendar entry for the Department of Mathematics and Statistics will be required. The revised calendar entry is set out below:

Department of Mathematics and Statistics

Location: 10512 Shrum Science Centre

Telephone: 291-3331

Chair: A.R. Freedman, A.B. (Calif.),
            Ph.D. (Oregon State)

FACULTY AND AREAS OF RESEARCH

B.R. Alspach	Graph Theory, discrete mathematics
J.L. Berggren	History of Mathematics, algebra
G.N. Bojadziev	Applied Mathematics
T.C. Brown	Algebra, combinatorics
A. Das	Applied Mathematics
C. Dean	Statistics
D.M. Eaves	Statistics
A.R. Freedman	Number theory, analysis, automata theory
H. Gerber	Mathematical Logic
G.A.C. Graham	Applied Mathematics mechanics
L. Goddyn	Combinatorics
R. Harrop	Medical computing, mathematical logic
K. Heinrich	Combinatorics
P. Hell	Computational discrete mathematics
C.W. Kim	Analysis, probability
A.H. Lachlan	Mathematical Logic
R.W. Lardner	Applied Mathematics
R. Lockhart	Statistics
A. Mekler	Mathematical Logic
E. Pechlaner	Applied Mathematics
N.R. Reilly	Algebra
R.D. Routledge	Statistics, population biology
R.D. Russell	Applied Mathematics
D. Ryeburn	General Topology
J.J. Sember	Functional Analysis
D.L. Sharma	Applied Mathematics
C.Y. Shen	Applied Mathematics
E.M. Shoemaker	Applied Mathematics
M. Singh	Applied Mathematics
M.A. Stephens	Statistics
T.B. Swartz	Statistics
T. Tang	Applied Mathematics
S.K. Thomason	Mathematical Logic
B.S. Thomson	Analysis

M. Trummer	Applied Mathematics
C. Villegas	Statistics
K.L. Weldon	Statistics

Admission

For admission requirements, refer to the Graduate General Regulations.

Applicants are normally required to submit scores in the aptitude section and an appropriate advanced section of the Graduate Record Examinations of the Educational Testing Service. Applicants whose first language is not English will normally be asked to submit TOEFL results.

Students interested in <u>Applied and Computational Mathematics</u> or <u>Statistics</u> should consult the entries under Institute for Applied and Computational Mathematics and Institute for Statistics.

Degree Requirements for M.Sc. and Ph.D.

M.Sc. Program

A candidate for the M.Sc. degree will normally be required to obtain a total of at least 20 semester hours of credit for course work beyond courses taken for the Bachelor's degree. of these 20 hours, at least 12 are to be in graduate courses or graduate seminars, and the remaining 8 may be chosen from graduate courses or graduate seminars or 400 division undergraduate courses. The student will also be required to submit a satisfactory thesis and to attend an oral examination based on that thesis and related topics.

Ph.D. Program

A candidate for the Ph.D. degree will generally be required to obtain at least 28 hours of credit for course work beyond courses taken for the Bachelor's degree. Of these 28 hours, at least 16 are to be in graduate courses or graduate seminars and the remaining 12 may be chosen from graduate courses or graduate seminars or 400 level undergraduate courses. Students who hold an M.Sc. in Mathematics or Statistics are deemed to have earned 12 of the 16 graduate hours and 8 of the 12 undergraduate or graduate hours required. The course work in all cases will involve study in at least 4 different areas of Mathematics and/or Statistics.

Candidates for the Ph.D. degree will normally be required to pass a General Examination. The General Examination will consist of examinations in three areas.

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The areas selected for a particular candidate are subject to approval by the Supervisory Committee and the Graduate Studies Committee. In a given area the examinations may be written or oral at the option of the Graduate Studies Committee. A candidate ordinarily will not be allowed to take the General Examination more than twice. Students will be interviewed and advised regarding appropriate courses and examination curricula.

Students who have completed a Master's degree will normally be required to attempt the general examination within one year of their initial registration in the Ph.D. program.

A candidate for the Ph.D. may be required by his/her Supervisory Committee to acquire proficiency in reading mathematical papers in either French, German or Russian.

Students will be required to submit and successfully defend a thesis which will embody a significant contribution to mathematical knowledge.

For further information and regulations refer to the Graduate General Regulations section.

Graduate Courses

The following three courses are offered by the Department of Mathematics as part of the Graduate Program in Mathematical Education, M.Sc. (Education). These three courses are not available for credit towards the M.Sc. or the Ph.D. degrees in the Faculty of Science.

MATH 603-4   Foundations of Mathematics
Topics in mathematics, their historical and philosophical background and their evolution. *Prerequisite: Acceptance into the M.Sc. program in Mathematics education or permission of the department. Graduate students in the Department of Mathematics and Statistics cannot take this course to satisfy their degree requirements.*

MATH 604-4   Geometry
Euclidean and non-Euclidean Geometries. Klein's Erlangen program. *Prerequisite. Entrance into the M.Sc. in Mathematics Education program or permission of the department. Graduate students in the Department of Mathematics and Statistics cannot take this course to satisfy their degree requirements.*

MATH 605-4   Mathematical Modeling
Introduction to Mathematical modeling using algebraic, geometric techniques along with techniques using calculus. *Prerequisite: acceptance into the M.Sc. program in Mathematics Education and one year of university level calculus. Graduate students in the Department of Mathematics and Statistics cannot take this course to satisfy their degree requirements.*

MATH 800-4   Pure Mathematics: Selected Topics

MATH 806-4   Mathematical Logic II
First-order theories. Some syntactical theorems concerning provability, such as the equivalence and equality theorems; the completeness theorem and some of its consequences for equivalence of syntactical and semantical notions, and introduction to model theory, incompleteness of formal arithmetic.

MATH 807-4   Mathematical Logic: Selected Topics

MATH 808-4   Mathematical Logic III
Introduction to recursion theory. Church's Thesis, Godel-Rosser incompleteness theorem, undecidability. Kleen's normal form theorem and enumerations theorem, the recursion theorem. The arithmetic hierarchy, the analytical hierarchy. Degrees of unsolvability. Basic theorems. Additional topics, if time permits. *Prerequisite. MATH 806.*

MATH 812-4   Algebra I
Theory of fields. Topics covered will include separable, normal, Galois, and transcendental extensions; finite fields and algebraically closed fields. Additional topics may include infinite Galois groups, valuation, Kummer extensions and Galois cohomology, further material in algebraic number theory.

MATH 813-4   Algebra II
Group theory. Generators and relations, normalizers and centralizers, composition series. Permutation groups, Sylow theory, abelian groups. Other topics covered will be the theory of p-groups, nilpotent and solvable groups, and some aspects of simple groups.

MATH 814-4   Algebra: Selected Topics

MATH 815-4   Algebra III
Rings and modules. Commutative and noncommutative associate rings with ascending or descending chain condition. Jacobson radical Chevalley-Jacobson density theorem, Wedderburn-Artin theorems, Goldie theorems, with applications to matrix groups and group algebras. As time permits, homological and local methods.

MATH 816-4   Algebra IV
Homology. Categories, functors, adjoint functors, homology, and cohomology of a complex. Universal coefficient theorem; Extn cohomology of groups; Schurs theorem, Tensor and torsion products. Global dimension of rings.

MATH 820-4   Graph Theory
A first graduate course in graph theory dealing with some of the following algebraic graph theory, extremal graph theory, coloring problems, applications of graphs, hypergraphs, and current research topics.

MATH 821-4   Combinatorics
An introduction to the theory of block designs, finite geometries and related topics.

MATH 825-4   Enumeration
Enumeration problems concerned with permutations, sequences, partitions, lattice walks and graphs, algebraic and analytic properties of generating functions, asymptotic analysis.

MATH 826-4   Posets and Matroids
An introduction to the theory of posets, geometric lattices and matroids.

MATH 827-4   Discrete Mathematics: Selected Topics

MATH 831-4   Real Analysis I
An intensive study of Lebesgue measure, integration and the Lebesgue convergence theorems together with the treatment of such topics as absolute continuity, the fundamental theorem of calculus, the Lp-spaces, comparison of types of convergence in function spaces, the Baire category theorem.

MATH 832-4   Real Analysis II
This course normally covers abstract measure and integration, and material which collectively might be called an introduction to functional analysis (e.g. complete metric spaces, normal spaces, the Stone-Weierstrass theorem, near functionals and the Hahn-Banach theorem). Other specialized topics in modern analysis. *Prerequisite: MATH 831.*

MATH 833-4   Real Analysis: Selected Topics

MATH 836-4   Complex Analysis I
Topics covered normally will include: Riemann surfaces, complex conjugate coordinates; the maximum principle, boundary value problems; conformal mappings. Schwartz-Christoffel formula; the symmetry principle, analytic continuation.

MATH 837-4   Complex Analysis II
Topics covered will include some of the following: entire functions, normal families, Hilbert space of analytic functions; conformal mappings of special functions; Picard's theorem. *Prerequisite: MATH 836.*

MATH 839-4   Topology I
First graduate course in general topology, dealing with some of the following topics: set-theoretic preliminaries, topological spaces, filters and nets, connectedness notions, separation properties, countability properties, compactness properties, paracompactness, metrization, uniform spaces, function spaces.

MATH 840-4   Topology II
Second graduate course in general topology dealing with additional topics among those listed for MATH 839-4. *Prerequisite: MATH 839.*

MATH 841-4   Topology: Selected Topics

MATH 871-4   Applied Probability Models
Applications of stochastic processes: Queues, inventories, counters, etc. reliability and life testing. Point processes. Simulation. *Prerequisites: MATH 837 or equivalent.*

MATH 872-4   Probability I
Fundamental probability concepts and related measure theory, series of independent random variables, the central limit theorem. Introduction to stochastic processes.

MATH 873-4   Probability II
Stochastic processes, construction of probability measures on function spaces. Survey in one or more of the following areas: construction and convergence of probability measures on metric spaces, on spaces of continuous functions, on Hilbert space, on spaces of generalized functions.

MATH 874-4   Probability: Selected Topics

MATH	894-2	Reading
MATH	895-4	Reading
MATH	896-2	Introductory Seminar
MATH	897-2	Advanced Seminar
MATH	898	M.Sc. Thesis
MATH	899	Ph.D. Thesis

See also MATH 900 to MATH 990 listed under Applied and Computational Mathematics Program, page xxx, and STAT 800 to STAT 890 listed under Statistics Program, page yyy. These courses may also be used to satisfy the course requirements for the M.Sc. and Ph.D.