

## 47 Mechanical Engineering

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Chair — S.J. Price

Chair of Graduate Program — N. Hori

### 47.1 Staff

#### Emeritus Professors

D.R. Axelrad; M.Eng.Sc.(Sydney), D.Sc.Eng.(Vienna), M.N.A.Sc.,  
F.I.A.S.(Berlin), M.G.A.M.M.(Germany), Eng.  
R. Knystautas; B.Eng., M.Eng., Ph.D.(McG.), Eng.  
W. Bruce; B.A.Sc., M.A.Sc.(Tor.), Eng.  
J. Cherna; Dipl.Eng.(Swiss Fed. Inst.), Eng., F.E.I.C.  
B.G. Newman; M.A.(Cantab.), Ph.D.(Syd.), Eng., F.C.A.S.I.,  
F.R.Ae.S., F.C.A.E., F.R.S.C.

#### Professors

A.M. Ahmed; B.Sc.(Dhaka), Ph.D.(McG.), Eng.  
J. Angeles; B.Sc., M.Sc.(Unam Mexico), Ph.D.(Stan.), Eng.  
F.A.S.M.E., F.C.S.M.E.  
B.R. Baliga; B.Tech.(I.I.T. Kanpur), M.Sc.(Case), Ph.D.(Minn.)  
J.H.S. Lee; B.Eng.(McG.), M.Sc.(M.I.T.), Ph.D.(McG.), Eng.  
A.K. Misra; B.Tech.(I.I.T. Kgp.), Ph.D.(Br.Col.), P.Eng.  
M.P. Paidoussis; M.P., B.Eng.(McG.), Ph.D.(Cantab.), F.A.A.M.,  
F.I.Mech.E., F.A.S.M.E., F.C.S.M.E., F.R.S.C., Eng.  
S.J. Price; B.Sc., Ph.D.(Brist.), P.Eng.

#### Associate Professors

M. Buehler; M.Sc., Ph.D.(Yale)  
L. Cortezzi; M.Sc., Ph.D.(Caltech)  
D.L. Frost; B.A.Sc.(Br.Col.), M.S., Ph.D.(Caltech.), P.Eng.  
N. Hori; B.Sc.(NDA, Japan), M.Sc., Ph.D.(Sask.), P. Eng.  
L. Lessard; B.Eng.(McG.), M.Sc., Ph.D.(Stan.), P.Eng.  
D.F. Mateescu; M.Eng.(Poli. Univ. Buch.), Ph.D.(Rom. Acad. Sci.),  
Doctor Honoris Causa (Poli. Univ. Buch.), AFAIAA, AFCASI  
A. Post; B.S.(Ariz.), M.I.M.(AGSIM), M.S.(Stan.), Ph.D.(Hawaii)  
V. Thomson; B.Sc.(Windsor), Ph.D.(McM.)  
P.J. Zsombor-Murray; B.Eng., M.Eng., Ph.D.(McG.), Eng.

#### Assistant Professors

V.N. Krovi; B.Tech.(I.I.T. Madras), Ph.D.(Pennsylvania)  
T. Lee; M.S.(Portland St.), Ph.D.(Idaho)  
L. Mydlarski; B.Sc.(Wat.), Ph.D.(C'Nell)  
J.A. Nemes; B.Sc.(Maryland), M.Sc., D.Sc.(GWU)

#### Adjunct Professors

H. Alighanbari, G.G. Bach, R. Edwards, S. Kalaycioglu, L. Kops,  
K. MacKenzie, W.D. May, H. Moustapha, T. Yee, D. Zorbas

#### Associate Members

R.E. Kearney; B.Eng, Ph.D.(McG.), Biomedical Engineering Unit  
B.H.K. Lee; B.Eng, M.Eng, Ph.D.(McG.)  
M. Tanzer; M.D., Orthopaedic Surgery

### 47.2 Programs Offered

M.Eng., M.Sc. and Ph.D. degrees in Mechanical Engineering.

Advanced courses and laboratory facilities are available for graduate study leading to the M.Eng. and Ph.D. degrees in Mechanical Engineering. Some of the specific areas of research are as follows:

**Aerodynamics:** experimental and computational studies in subsonic, transonic and supersonic, steady and unsteady flows.

**Bioengineering:** mechanics of the human musculoskeletal system and design of joint prostheses.

**Combustion, shock wave physics and vapour explosions:** dust combustion, solid and liquid propellants, explosion hazard, and nuclear reactor safety.

**Computational fluid dynamics and heat transfer:** turbulent, reacting and multiphase flows in engineering equipment and in the environment.

**Fluid-structure interactions and dynamics:** vibrations and instabilities of cylindrical bodies, fluidelasticity, aeroelasticity, dynamics of shells containing axial and annular flows.

**Manufacturing and Industrial engineering:** thermoelastic effects in machine tools, functional behaviour of machined surfaces, optimization in production systems.

**Robotics and automation:** artificial intelligence based simulation of industrial processes, design optimization of manipulators, finite automata, geometric modeling and control systems.

**Solid mechanics:** composite materials, fracture, fatigue and reliability, microscopic and macroscopic approaches.

**Space dynamics:** orbital analysis, large space structures, space manipulators and tethered satellites.

### 47.3 Admission Requirements

The general rules of the Faculty of Graduate Studies apply. Candidates who come from other institutions are expected to have an academic background equivalent to the undergraduate curriculum in mechanical engineering at McGill or to make up any deficiencies in a qualifying year. Applicants are requested to state in as much detail as possible their particular field of interest for graduate study.

Students who do not hold an undergraduate engineering (or equivalent) degree and who are accepted into a Master's program will register for the M.Sc. degree in Mechanical Engineering. This applies particularly to students engaged in interdisciplinary research.

#### M.Eng. Aerospace Degree

Applicants would normally hold a B.Eng. in Mechanical Engineering, however students with an undergraduate degree in engineering other than Mechanical Engineering are also eligible to apply.

### 47.4 Application Procedures

Applications will be considered upon receipt of:

1. application form;
2. transcripts;
3. letters of Reference;
4. \$60 application fee;
5. test results (TOEFL).

All information is to be submitted directly to the Graduate Program Secretary in the Mechanical Engineering Department

Deadlines:

- February 1st for Fall admission;
- May 15th for Winter admission.

### 47.5 Program Requirements

The minimum residence requirement for the M.Eng. degree is three terms of full-time study, one of which may be a summer term. In the case of M.Eng. (Project) a part-time program is available.

#### M.Eng. (Thesis) Degree (minimum 45 credits)

##### Thesis Component – Required (29 credits)

305-609	(1) Seminar
305-691	(3) M.Eng. Thesis Literature Review
305-692	(4) M.Eng. Thesis Research Proposal
305-693	(3) M.Eng. Thesis Progress Report I
305-694	(6) M.Eng. Thesis Progress Report II
305-695	(12) M.Eng. Thesis

305-691 is to be completed in the first semester of the student's program.

**Complementary Courses** (16 credits)

a set of courses to be selected from the list below, or approved courses offered by other engineering departments, to a minimum of 16 credits.

Students who do not hold an undergraduate engineering (or equivalent) degree and who are accepted into this option will register for the M.Sc. degree in Mechanical Engineering. This applies particularly to students engaged in interdisciplinary research. A thesis describing the candidate's research is to be submitted in accordance with the rules of the Faculty and is the major requirement for the degree.

**M.Eng. (Project) Degree** (minimum 45 credits)

This is a course-type Master's degree which requires 12 graduate courses for completion. All candidates are required to take the following courses:

**Required Courses** (29 credits)

305-605A	(4)	Applied Mathematics I
305-610B	(4)	Fundamentals of Fluid Mechanics
305-632A	(4)	Stress Analysis
305-642B	(4)	Advanced Dynamics
305-603*	(6)	Design Project I
305-604*	(6)	Design Project II
305-609*	(1)	Seminar

\* these three courses are taken near the end of the program. In these courses, industrial liaison is encouraged.

**Complementary Courses** (16 credits)

The five remaining courses (minimum 16 credits) may be selected individually by the student (based on interest and the choice of the area of specialization) from the following groups of courses, although it is not necessary that students confine their choice to one of these groups

- Thermo-fluids
- Solid Mechanics and Stress Analysis
- System Dynamics and Control
- Industrial and Production Engineering

**M.Eng. Aerospace Degree** (minimum 45 credits)

The M.Eng. Aerospace Degree is offered to the students who wish to specialize in the general area of aerospace engineering. This degree is given in conjunction with Concordia University, Ecole Polytechnique, Université Laval and Université de Sherbrooke. Students registered at McGill are required to take two courses from two other institutions.

Students holding an undergraduate degree in engineering other than Mechanical Engineering are also eligible to apply for this degree. Depending on their background, students would specialize in one of the three areas:

1. Aeronautics and Space Engineering;
2. Avionics;
3. Aerospace Materials and Structures.

**Required Courses** (9 credits)

305-687	(3)	Aerospace Case Studies
305-688	(6)	Industrial Stage

**Complementary Courses** (36 credits)

The other courses, depending on the area of concentration, will be chosen in consultation with an Aerospace Engineering Advisor.

**Master of Management (Manufacturing)** (56 credits)

The Master of Management (Manufacturing) program (M.M.M.) is offered to students who wish to have a career as manufacturing managers. The program sets a curriculum in manufacturing and management subjects as well as providing exposure to industry through case studies, seminars and a paid industry internship.

The M.M.M. program is a 12-month academic program starting in September followed by a 4-month industrial internship. The program is offered in collaboration with the Faculty of Management, and the Master in Management (Manufacturing) degree is granted jointly by the Faculties of Engineering and Management.

Students should hold an undergraduate degree in engineering or science. Two to five years industrial experience is preferred, but not mandatory. Students with other academic backgrounds and appropriate industrial experience will be considered. The program is intended for full time as well as part time students. Enrollment is limited.

The M.M.M. program is a self-funded program and special tuition fees apply.

**Management Segment – Required Courses** (17 credits)

277-608	(3)	Data, Decisions and Models
272-632	(3)	Group, Dynamics and Interpersonal Behaviour
279-603	(3)	Industrial Relations
280-611	(2)	Financial Accounting
280-612	(2)	Organizational Behaviour
280-615	(2)	Finance
280-616	(2)	Marketing

A background in statistics is a prerequisite for the program; otherwise 277-671 Statistics for Business Decisions is required.

**Manufacturing Segment – Required Courses** (21 credits)

277-601	(3)	Management of Technology in Manufacturing
277-602	(3)	Manufacturing Strategies
277-603	(3)	Logistics Management
277-605	(3)	Total Quality Management
277-631	(3)	Analysis of Manufacturing Systems
305-524	(3)	Computer Integrated Manufacturing
305-526	(3)	Manufacturing and the Environment

**Manufacturing Segment – Complementary Courses** (6 credits)

one of the following two options:

*Discrete Manufacturing Option*

305-528	(3)	Product Design
305-529	(3)	Discrete Manufacturing Systems

*Process Manufacturing Option*

302-572	(3)	Process Dynamics and Control
302-653	(3)	Advanced Process Design

**Industrial Segment – Required Courses** (12 credits)

305-627	(9)	Manufacturing Industrial Stage
305-628	(2)	Manufacturing Case Studies
305-629	(1)	Manufacturing Industrial Seminar

**Ph.D. Degree**

Candidates normally register for the M.Eng. degree in the first instance. However, in exceptional cases where the research work is proceeding very satisfactorily, or where the equivalent of the M.Eng. degree has been completed at another university, candidates may be permitted to proceed directly to the Ph.D. degree without submitting a master's thesis as long as they have satisfied the course requirements for the M.Eng. degree.

Courses of study selected for a Ph.D. program will depend upon the existing academic qualifications of the candidate and those needed for effective research.

Candidates are required to pass a preliminary oral examination within twelve months of their initial registration for the Ph.D. degree.

The residence requirement for Ph.D. candidates is outlined in the General Calendar of the Faculty.

**47.6 Courses**

- Denotes not offered in 1999-2000.
- Denotes limited enrolment.

The course credit weight is given in parentheses (#) after the course title.

**UNDERGRADUATE COURSES APPROVED FOR HIGHER DEGREES**

The following courses, available in the undergraduate curriculum of the Mechanical Engineering Department, may be selected for graduate credit provided that both of the following conditions are

met: the course is recommended by the candidate's supervisor, and no equivalent course was taken during the candidate's undergraduate program.

**305-413A CONTROL SYSTEMS. (3)**

**305-432A AIRCRAFT STRUCTURES. (3)**

**COURSES OPEN TO GRADUATE AND TO QUALIFIED UNDERGRADUATE STUDENTS**

**305-500A,B SELECTED TOPICS IN MECHANICAL ENGINEERING. (3)** A course to allow the introduction of new topics in Mechanical Engineering as needs arise, by regular and visiting staff. **Staff**

**305-501A,B SELECTED TOPICS IN MECHANICAL ENGINEERING. (3)** A course to allow the introduction of new topics in Mechanical Engineering as needs arise, by regular and visiting staff. **Staff**

**305-522B PRODUCTION SYSTEMS. (3)** Characteristics of production systems. System boundaries, input-output, feedback time-lag effects, dynamics of production systems. Design for manufacturability. Process planning, process/machine tool selection, break-even analysis, CAPP. Production planning, scheduling and control of operations; quality management. Competitive strategies; FMS, CIM. Hands-on experience with industrial factory simulation software. **Professor Kops**

**305-524B COMPUTER INTEGRATED MANUFACTURING. (3)** A study of the present impact of computers and automation on manufacturing. Computer aided systems. Information modelling. Information system structures. Study of several types of production systems. Integration issues: inter-and intra-enterprise. Laboratory experience with manufacturing software systems. **Professor Thomson**

**305-526C MANUFACTURING AND THE ENVIRONMENT. (3)** Course topics include: clean manufacturing, product and process design for minimizing materials and energy use, the product life cycle, impact of technology on the environment, environmental impact assessment, regulatory process, and managing the "political" process. **Staff**

□ **305-528A PRODUCT DESIGN. (3)** A study of the design issues present in product life cycle demands. Computer aided systems. Rapid prototyping. Design for manufacturability. Integration of mechanics, electronics and software in products. Effect on design of product cost, maintainability, recycling, marketability. **Staff**

□ **305-529C DISCRETE MANUFACTURING SYSTEMS. (3)** An overview of present day production machines and systems with special emphasis on automation, computer control and integration techniques. Material handling, automatic inspection, process monitoring, maintenance. Socio-economic and environmental issues. Laboratory experience with factory simulation. **Staff**

**305-530B MECHANICS OF COMPOSITE MATERIALS. (3)** (Instructor's permission) Fiber reinforced composites. Stress, strain, and strength of composite laminates and honeycomb structures. Failure modes and failure criteria. Environmental effects. Manufacturing processes. Design of composite structures. Computer modeling of composites. Computer techniques are utilized throughout the course. **Professor Lessard**

**305-531B AEROELASTICITY. (3)** (Prerequisite: 305-533A) Wing divergence using strip theory aerodynamics. The effect of aircraft flexibility on the control and stability. Flutter calculations for two dimensional wings with discussion of three dimensional effects. Examples of aeroelastic instability and the relevant analysis of non-aeronautical structures. **Professor Price and Dr Alighanbari**

**305-532B AIRCRAFT PERFORMANCE, STABILITY AND CONTROL. (3)** (Prerequisite: 305-533A) Aircraft performance criteria such as range, endurance, rate of climb, maximum ceiling for steady and accelerated flight. Landing and take-off distances. Static and dynamic stability in the longitudinal (stick-fixed and stick-free) and coupled lateral and directional modes. Control response for all three modes. **Professor Price and Mr. Asselin**

**305-533A SUBSONIC AERODYNAMICS 3. (3)** Kinematics; equations of motion; vorticity and circulation; conformal mapping and flow around simple bodies. Two dimensional flow around aerofoils. Three dimensional flows; high and low aspect-ratio wings; air-screws. Wind tunnel interference. Similarity rules for subsonic irrotational flow. **Professor Mateescu**

● **305-534B AIR POLLUTION ENGINEERING. (3)** (Consent of instructor)

**305-537B HIGH SPEED AERODYNAMICS. (3)** Equations of compressible flows. Planar and conical shock waves. Expansion and shock wave interference; shock tubes. Method of characteristics. Supersonic nozzle design. Aerofoil theory in high subsonic, supersonic and hypersonic flows. Conical flows. Yawed, delta and polygonal wings; rolling and pitching rotations. Wing-body systems. Elements of transonic flows. **Professor Mateescu**

● **305-538B UNSTEADY AERODYNAMICS. (3)** (Prerequisite: 305-533A)

**305-539A COMPUTATIONAL AERODYNAMICS. (3)** (Pre-or Co-requisite: 305-533A or equivalent.) Fundamental equations. Basic flow singularities. Boundary element methods. Source, doublet and vortex panel methods for 2D and 3D incompressible and compressible flows. Method of characteristics. Euler equations for inviscid rotational flows. Finite-difference and finite-volume methods. Explicit and implicit time-integration methods. Quasi 1D solutions. Nozzle and confined aerofoil applications. **Professor Mateescu**

**305-540B DESIGN: MODELLING AND DECISION. (3)** 3-D geometric modelling for design; principles and practice. Selected topics/case studies requiring use of: 3-D CAD; component selection and integration; use of machine element design analysis software; practice in developing simple directions. Use of modern software for design decision making. Introduction to mechanism animation. Introduction to design for NC production. **Mr. T. Yee**

● **305-541B KINEMATIC SYNTHESIS. (3)**

**305-542B SPACECRAFT DYNAMICS. (3)** Review of central force motion; Hohmann and other coplanar transfers, rotation of the orbital plane, patched conic methods. Orbital perturbations due to the earth's oblateness, solar-lunar attraction, solar radiation pressure and atmospheric drag. Attitude dynamics of a rigid spacecraft; attitude stabilization and control; attitude manoeuvres; large space structures. **Professor Misra**

**305-543A DESIGN WITH COMPOSITE MATERIALS. (3)** (Prerequisite: 305-530) Material systems/selection process. Cost vs performance. Laminate layup procedures. Theory and application of filament winding of composite cylinders. Regular oven and autoclave oven curing, analysis of resulting material performance. Practical design considerations and tooling. Analysis of environmental considerations. Joining techniques. Analysis of test methods. Theory of repair techniques. **Professor Lessard**

**305-545A ADVANCED STRESS ANALYSIS. (3)** (Not open to students who are taking or have taken 305-632.) Tensor Analysis: Review of continuum mechanics. Equilibrium and constitutive equations in tensor form. Finite elements methods. Torsion of non-circular cross-sections; spherical problems; advanced airy stress function problems. Introduction to plates and shells. Thermal deformations and stresses. Introduction to plasticity and viscoelasticity. **Professors Nemes and Lessard**

**305-552B ADVANCED APPLIED MATHEMATICS. (3)** (Permission of instructor.) Solutions of ordinary differential equations using integral methods; asymptotic series, Stirling's approximation. Bessel and Laguerre functions. Green's functions. Laplace, Helmholtz, diffusion, wave, telegraph partial differential equations. Variational methods. Numerical solutions to partial differential equations. **Professor Bach**

**305-554A PROCESS AUTOMATION. (3)** Introduction to digital logic and microprocessor assembler. Logic and programming laboratory exercises pertaining to simple combinatorial, sequential and

analogue elements and their applications to control and signal conditioning. **Professor Zsombor-Murray**

● **305-555B APPLIED PROCESS CONTROL.** (3) (Prerequisite: 305-554)

● **305-557B ELECTROMECHANICAL DESIGN.** (3)

**305-561B BIOMECHANICS OF MUSCULO-SKELETAL SYSTEMS.** (3)  
The musculoskeletal system; general characteristics and classification of tissues and joints. Biomechanics and clinical problems in orthopaedics. Modelling and force analysis of musculoskeletal systems. Passive and active kinematics. Load-deformation properties of passive connective tissue, passive and stimulated muscle response. Experimental approaches, case studies.

**Professor Ahmed**

● **305-562A ADVANCED FLUID MECHANICS.** (3)

**305-565B FLUID FLOW AND HEAT TRANSFER EQUIP.** (3) Fluid flow machinery and systems. Metering devices and control system. Heat exchange systems. Boilers and condensers. Fouling, corrosion and vibration problems. Air conditioning and refrigeration. Humidifiers and dehumidifiers. Space heating and ventilation system. Monitoring and control units. Building materials and insulation.

**Professor Baliga**

**305-572A MECHANICS OF ROBOTIC SYSTEMS I.** (3) (Prerequisite: Permission of the instructor. Not open to students who have taken 305-573.) Manipulator hardware structure, kinematics, statics, dynamics planning and control. Rigid-body, three-dimensional statics, kinematics and dynamics. Direct and inverse kinematics and dynamics. Trajectory planning subject to constraints. Manipulator control. In depth study of serial manipulators with extension to more complex robotic devices.

**Professor Angeles**

● **305-573B MECHANICS OF ROBOTIC SYSTEMS II.** (3) (Prerequisite: Consent of the instructor.)

**305-576A COMPUTER GRAPHICS AND GEOMETRIC MODELLING.** (3)  
Review of pertinent linear algebra. Explicit, implicit and parametric polynomial forms. Splines: curves and surfaces. Properties: curvature, twist, continuity. Ruled surfaces and other quad patches. Constructive solid models; Octree/Voxel, sweep wire frame, Boolean, boundary representation. Mechanical Engineering applications.

**Professor Zsombor-Murray**

● **305-577A OPTIMUM DESIGN.** (3)

● **305-578B ADVANCED THERMODYNAMICS.** (3)

● **305-581A NONLINEAR DYNAMICS AND CHAOS.** (3)

#### COURSES FOR GRADUATE STUDENTS ONLY

**305-602A,B SPECIAL TOPICS IN MECHANICAL ENGINEERING.** (4)  
New developments related to Mechanical Engineering will be presented either by staff or by visiting professors.

**305-603A,B OR C DESIGN PROJECT I.** (6) A design project undertaken under the direct supervision of at least one staff member. Examination entails the writing of a report which is examined internally by the supervisor and another staff member appointed by the Mechanical Engineering Department. **Staff**

**305-604A,B OR C DESIGN PROJECT II.** (6) A continuation of 305-603A,B or C. **Staff**

**305-605A APPLIED MATHEMATICS I.** (4) A brief treatment of tensor analysis. A review of complex variables. Analytical methods of solution for partial differential equations occurring with great frequency in engineering. Perturbation methods, integral methods, asymptotic methods and variational techniques. Numerical methods of solution. **Professor Bach**

● **305-606B APPLIED MATHEMATICS II.** (4) (Prerequisite: 305-605A)

● **305-608B NUMERICAL ANALYSIS FOR COMPUTER USERS II.** (4)

**305-609A,B,C SEMINAR.** (1) All candidates for a Master's degree are required to participate and to deliver one paper dealing with their particular area of research or interest. **Staff**

**305-610B FUNDAMENTALS OF FLUID DYNAMICS.** (4) Conservation laws control volume analysis, Navier Stokes Equations and some exact solutions, dimensional analysis and limiting forms of Navier Stokes Equations. Vorticity, Potential flow and lift, boundary layer theory, drag, turbulence. **Professors J. Lee and L. Cortelezzi**

● **305-615A,B GASDYNAMICS I.** (4)

● **305-617A,B GASDYNAMICS II.** (4)

● **305-620A,B ADVANCED COMPUTATIONAL AERODYNAMICS.** (4) (Evening course)

● **305-626B ADVANCED CONCEPTS OF ENGINEERING DESIGN.** (4) (Evening course)

**305-627A,B MANUFACTURING INDUSTRIAL STAGE.** (9) (Restricted to students in the M.M.M. Program) An industrial work term is an integral component of the M.M.M. program which is to be completed under the supervision of an experienced engineer in the facilities of a sponsoring company. **Staff**

**305-628A,B,C MANUFACTURING CASE STUDIES.** (2) (Restricted to students in the M.M.M. Program) Case studies on a variety of manufacturing topics are given by industry experts. To be attended by all students in the M.M.M. program. **Staff**

**305-629A,B,C MANUFACTURING INDUSTRIAL SEMINAR.** (1) (Restricted to students in the M.M.M. Program) A series of presentations by industry experts and manufacturing managers. To be attended by all students in the M.M.M. program. **Staff**

**305-632A STRESS ANALYSIS.** (4) (Evening course) The continuum concepts of stress, stress boundary conditions, principal stresses and the equations of equilibrium. Small strain theory and principal strains. The elastic constitutive relations. The extension, torsion and flexure of mechanical components. Plane stress and plane strain. Variational principals and the finite element method. Computer techniques are utilized. **Professor Nemes**

● **305-634B NONLINEAR CONTINUUM MECHANICS.** (4)

**305-635B FRACTURE AND FATIGUE.** (4) (Evening course) (Prerequisite: 305-632A) An introduction to the design aspects of fracture and fatigue, standard specimen fatigue, stress concentrations, crack initiation, linear elastic fracture mechanics, developments in non-linear fracture mechanics and low-cycle fatigue. Where appropriate, fractographic and probabilistic aspects of fatigue failure are discussed. **Professor Nemes**

**305-642B ADVANCED DYNAMICS.** (4) (Evening course) Variational methods. Hamilton's principle and equations of motion of engineering systems. Lagrangian formulations for discrete systems. Methods of discretizing continuous systems. Rigid body dynamics. Dynamic behaviour of linear and nonlinear systems. Response of engineering systems to deterministic inputs by classical methods. Stability of linear and nonlinear systems. **Professor Paidoussis**

● **305-643B VIBRATIONS IN ENGINEERING SYSTEMS.** (4) (Evening course) (Prerequisite: 305-642B)

● **305-645B FINITE ELEMENTS IN DYNAMIC SYSTEMS.** (4) (Evening course) (Prerequisite: 305-642B)

● **305-650A,B HEAT TRANSFER.** (4) (Evening course)

**305-652A DYNAMICS OF COMBUSTION.** (4) Chemical thermodynamics and chemical kinetics, Hugoniot analysis of reacting flows, conservation equation for reactive mixtures, Reacting Couette flows, boundary layers and shear layers. Laminar premixed flames, Detonation theory and ZND structure. Stability of flames and detonations, limits, ignition energies and quenching distance, dynamic parameters of detonations. **Professors Lee and Frost**

**305-654B COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER.** (4) (Evening course) A study of numerical methods for solving complex problems involving fluid flow and heat and mass transfer. Control-volume-based finite-difference and finite-element methods. Methods for solving large systems of coupled nonlinear algebraic discretized equations. Mathematical models for turbulence, radiation, and dilute gas-particle flows. **Professor Baliga**

**305-681 A,B,C AERONAUTICS PROJECT I.** (3) (Open to students in the Aeronautical Option only.) The project is undertaken under the direct supervision of at least one staff member. Examination entails the writing of a report which is examined internally within the Mechanical Engineering Department.

**305-682 A,B,C AERONAUTICS PROJECT II.** (3) (Open to students in the Aeronautical Option only.) A continuation of 305-681.

**305-683 A,B,C AERONAUTICS PROJECT III.** (3) (Open to students in the Aeronautical Option only.) A continuation of 305-682.

**305-687A,B,C AEROSPACE CASE STUDIES.** (3) (Restricted to students in the Aerospace Engineering Option/Programs at McGill, Concordia or Ecole Polytechnique.) This course covers topical case studies drawn from aerospace industrial experience. It is conducted in a modular form by experienced engineers from industry. It is given in collaboration with the other two institutions participating in this joint option/program, and may be conducted at any of the three locations in the language of convenience to the instructors. **Staff**

**305-688A,B,C INDUSTRIAL STAGE.** (6) (Restricted to students in the Aerospace Engineering Option/Program) An integral component of the program that is to be completed under the supervision of an experienced engineer in the facilities of a participating company. The topic is to be decided by a mutual agreement between the candidate, the participating company and the Liaison Committee on Aerospace Engineering. An evaluation of the candidate's performance during the work period becomes a part of the student's record.

**305-691A,B,C M.ENG. THESIS LITERATURE REVIEW.** (3) A comprehensive literature review in the general area of the thesis topic, to be completed in the first semester.

**305-692A,B,C M.ENG. THESIS RESEARCH PROPOSAL.** (4) Initiation of research with particular emphasis on the definition of the thesis topic.

**305-693A,B,C M.ENG. THESIS PROGRESS REPORT I** (3) A first status report on the progress in the thesis research.

**305-694A,B,C M.ENG. THESIS PROGRESS REPORT II.** (6) A second status report on the progress in the thesis research.

**305-695A,B,C M.ENG. THESIS.** (12) Submission of the M.Eng. thesis for examination.

**305-701A,B,C Ph.D. PRELIMINARY ORAL EXAM.** Presentation of the Ph.D. thesis proposal by the student and oral examination of the student's background in related areas.

## 48 Medical Physics

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Director — E.B. Podgorsak

### 48.1 Staff

#### Professors

A.C. Evans; B.Sc.(Liv.), M.Sc.(Sur.), Ph.D.(Leeds)  
S.M. Lehnert; B.Sc.(Nott.), M.Sc., Ph.D.(Lond.)  
E.B. Podgorsak; Dipl. Ing.(Ljubljana), M.Sc., Ph.D.(Wis.),  
F.C.C.P.M.  
C.J. Thompson; B.Sc., M.Sc., D.Sc.(Otago), F.C.C.P.M.

#### Associate Professor

G.W. Dean; B.Sc.(Salf.), M.Sc.(Man.), Ph.D.(E. Anglia),  
F.C.C.P.M.

#### Assistant Professors

M.D.C. Evans; B.A.(Queen's), M.Sc.(McG.), F.C.C.P.M.  
C.J. Henri; B.Sc.(New Orleans), M.Sc., Ph.D.(McG.)  
D.H. Hristov; B.Sc.(Sofia), Ph.D.(McG.)  
M. Olivares; B.Sc.(Madrid), M.Sc.(Sask.), F.C.C.P.M.  
G.B. Pike; B.Eng.(St.John's), M.Eng., Ph.D.(McG.)

#### Adjunct Professors

T.M. Peters; B.E.Eng., Ph.D.(Cant.), F.C.C.P.M.  
R.B. Richardson; B.Sc.(Lond.), M.Sc.(Aberdeen), Ph.D.(Bristol)

#### Lecturers

R.A. Corns; B.Sc., M.Sc., Ph.D.(Man.), M.Sc.(McG.)  
P. Léger; B.Eng.(École Poly.) O.I.Q.  
W.A. Parker; B.Sc.(C'dia), M.Sc.(McG.), M.C.C.P.M.  
H.J. Patrocínio; B.Sc.(C'dia), M.Sc.(McG.), M.C.C.P.M.

## 48.2 Programs Offered

The Medical Physics Unit offers an M.Sc. in Medical Radiation Physics. Facilities are available for students to undertake a Ph.D. in Medical Physics through the Department of Physics.

The Unit is a teaching and research unit concerned with the application of physics and related sciences in medicine, especially (but not exclusively) in radiation medicine, i.e. radiation oncology, medical imaging and nuclear medicine.

The research interests of members of the Unit include various aspects of medical imaging, including 3D imaging, the development of new imaging modalities and applications of imaging in radiation therapy; radiation dosimetry, especially solid state, electret and NMR systems; nuclear cardiology; and applications of radiation biology to therapy.

The M.Sc. and Ph.D. programs in Medical Physics are accredited by the Commission on Accreditation of Medical Physics Education Programs, Inc., sponsored by The American Association of Physicists in Medicine (AAPM), The American College of Medical Physics (ACMP), and The American College of Radiology (ACR).

## 48.3 Admission Requirements

Candidates applying to the M.Sc. program must normally hold a B.Sc. degree (Honours or Major) in Physics or Engineering, with a minimum overall GPA of 3.0/4.0 (approximately 70%).

## 48.4 Application Procedures

Students are admitted to the M.Sc. program only at the start of the Fall semester in September of a given academic year. Applications for consideration for the Fall semester of 2000-2001 should be submitted between September 1, 1999 and March 15, 2000.

Only complete applications will be considered. Interested candidates should (a) ask their university(ies) to send two originals of each transcript, and (b) request that original confidential letters of recommendation be sent by professors familiar with their work. The application fee of \$60 Cdn should be remitted in Canadian funds in negotiable form, such as a bank draft, money order, etc. payable to McGill University.

Non-Canadian applicants whose mother tongue is not English and who have not completed a degree using the English language must submit documented proof of competency in English by a TOEFL (Test of English as a Foreign Language) with a minimum score of 550, or an equivalent test. The original test report must be sent by the testing center, i.e. a photocopy sent by the applicant is not acceptable.

All application materials should be sent directly to the Graduate Secretary, Medical Physics Unit.

## 48.5 Program Requirements

### M.Sc. in Medical Radiation Physics

This two-year program provides a comprehensive introduction to the academic, research and practical aspects of physics applied to radiation medicine. In addition to the thesis requirement (32 credits) there are 12 mandatory courses (28 credits). The practical and laboratory sections of the program are conducted in various McGill teaching hospitals.

The program comprises:

- 1) didactic courses in radiation physics, radiation dosimetry, the physics of nuclear medicine and diagnostic radiology, medical imaging, medical electronics and computing, radiation biology and radiation hazards and protection;
- 2) seminars in radiation oncology, diagnostic radiology and miscellaneous aspects of medical physics, e.g. lasers;
- 3) laboratory courses in radiation dosimetry and medical imaging;
- 4) an individual research thesis.

## 48.6 Graduate Level Courses

The course credit weight is given in parentheses (#) after the course title.

**563-601A RADIATION PHYSICS.** (3) The production and properties of ionizing radiation and their interactions with matter; basic theoretical and experimental aspects of radiation dosimetry.

**563-602B APPLIED DOSIMETRY.** (3) (Prerequisite: 563-601A) Theoretical and practical dosimetry of radiation sources, both external and internal with respect to the human body, as applied to radiotherapy, diagnostic radiology, nuclear medicine, radiobiology and radiation protection.

**563-603B LABORATORY PRACTICUM.** (2) (Prerequisite: 563-601A. Corequisite: 563-602B) This laboratory course gives some experience in practical/clinical aspects as applied to radiation therapy and to the techniques for the measurement of different physical parameters which characterize radiation beams. The student is exposed to the operation of various therapy units, dose measuring devices, 3D treatment planning, virtual simulator units.

**563-607A INTRODUCTION TO MEDICAL IMAGING.** (3) (Corequisite: 563-615A) A review of the principles of medical imaging as applied to conventional diagnostic radiography, digital subtraction radiography, computed tomography and magnetic resonance imaging. The course emphasizes a linear system approach to the formation, processing and display of medical images.

**563-608B LABORATORY IN DIAGNOSTIC RADIOLOGY AND NUCLEAR MEDICINE.** (2) (Prerequisite: 563-615A. Corequisite: 563-614B.) This laboratory course takes place in hospital departments of diagnostic radiology and nuclear medicine and is designed to give the student a working knowledge of calibration techniques and quality assurance in these fields of medicine, together with practical applications of the concepts studied in 563-614B and 563-615A.

**563-609A RADIATION BIOLOGY.** (2) Deals with the effects and mode of action of ionizing radiation on biological material from molecular interactions, through sub-cellular and cellular levels of organization, to the response of tissues, organs and the whole body. Includes application of radiation biology in oncology and the biological aspects of environmental radiation exposure.

**563-611A MEDICAL ELECTRONICS.** (2) An introductory course on electronics, with emphasis on digital electronics, data acquisition and microprocessors applied to instrumentation. A basic knowledge of electronics is assumed, but the detailed course contents may vary from year to year, depending on the background of the students.

**563-612B COMPUTERS IN MEDICAL IMAGING.** (2) (Prerequisites: 563-607A, 563-611A or equivalent, 563-615A. Corequisite: 563-614B.) The role of computers in the acquisition and storage of data in medical imaging systems, with special reference to

computed tomography, gamma cameras, positron emission tomography. Special attention is paid to the interfacing requirements of each device and to image display systems. Demonstrations of some of these systems are included.

**563-613A HEALTH PHYSICS.** (2) (Corequisites: 563-601A, 563-609A) The hazards of ionizing radiations and the safe handling of radiation sources. Topics covered include basic principles; safety codes, laws and regulations; organization of radiation safety; and practical safety measures and procedures.

**563-614B PHYSICS OF DIAGNOSTIC RADIOLOGY.** (3) (Prerequisite: 563-601A) The physical principles and instrumentation of radiology, computed tomography, ultrasound and nuclear magnetic resonance imaging systems used in medical diagnosis, with particular attention to X-ray generators, image detectors and sensors.

**563-615A PHYSICS OF NUCLEAR MEDICINE.** (3) (Corequisite: 563-601A) The physics of radioactivity and the applications of radioisotopes and radiopharmaceuticals in medical diagnosis. Topics covered include spectrometry, the gamma camera, single photon emission tomography, and image analysis and data processing in nuclear medicine.

**563-616D SELECTED TOPICS IN MEDICAL PHYSICS.** (1) This course deals with anatomy and physiology, etiology and treatment of cancer and introductory medical statistics, three topics not covered by other courses in the program.

**563-625D M.Sc. THESIS RESEARCH.** (32)

## 49 Medicine, Experimental

Division of Experimental Medicine  
Department of Medicine  
Lady Meredith House, Room 305  
1110 Pine Avenue West  
Montreal, QC  
Canada H3A 1A3  
Telephone: (514) 398-3466  
Fax: (514) 398-3425  
Email: divexmed@med.mcgill.ca

*Chair, Department of Medicine* — D. Goltzman

*Director, Division of Experimental Medicine* — G. Price

### 49.1 Staff

#### Professors

A.J. Aguayo; M.D.(C'dia)  
H. Bennett; B.A.(York, U.K.), Ph.D.(Brun.)  
R. Blostein; M.Sc., Ph.D.(McG.)  
G.M. Bray; B.Sc.(Bran.), M.D., B.Sc.(Med.)(Man.), F.R.C.P.(C)  
T.M.S. Chang; B.Sc., M.D., C.M., Ph.D.(McG.), F.R.C.P.(C)  
F. Doualla-Bell; B.Sc., M.S., Ph.D.(Paris XI)  
S.O. Freedman; O.C., B.Sc., M.D., C.M.(McG.), F.R.C.P.(C), F.A.C.P., F.R.S.C.  
A. Fuks; B.Sc., M.D., C.M.(McG.)  
P. Gold; O.C., M.Sc., M.D., C.M., Ph.D.(McG.), F.R.C.P.(C)  
H.L. Goldsmith; B.A., B.Sc., M.A.(Oxon.), Ph.D.(McG.)  
D. Goltzman; B.Sc., M.D., C.M.(McG.), F.R.C.P.(C)  
A. Grassino; M.D.(Rosario, Argen.)  
S.A. Grover; B.A.(Roch.), M.D., C.M.(McG.), M.P.A.(Harv.), F.R.C.P.(C)  
R.D. Guttman; B.A., B.Sc., M.D.(Minn.)  
G. Hendy; B.Sc.(Sheff.), Ph.D.(Lond.)  
A. Herscovics; B.Sc., Ph.D.(McG.)  
J. Hiscott; B.Sc., M.Sc.(W.Ont.), Ph.D.(N.Y.)  
M. Levy; B.Sc., M.D., C.M.(McG.), F.R.C.P.(C)  
B. Leyland-Jones; B.Sc., M.B., B.S.(Lond.), F.R.C.P.(C), F.A.C.P.  
P.T. Macklem; B.A.(Queen's), M.D., C.M.(McG.), F.R.C.P.(C)  
S. Magder; M.D.(Tor.), F.R.C.P.(C)  
O.A. Mamer; B.Sc., Ph.D.(Windsor)  
E. Marliss; M.D.(Alta.), F.R.C.P.(C)

J. Martin; B.Sc., M.B., B.Ch., M.D.(Cork), F.R.C.P.(C)  
 J. Milic-Emili; M.D.(Milan), F.R.S.C.  
 B.E.P. Murphy; B.A., M.D.(Tor.), M.Sc., Ph.D.(McG.), F.A.C.P.(C)  
 C.K. Osterland; M.D.(Man.)  
 L. Panasci; B.Sc., M.D.(Georgetown)  
 Y.C. Patel; M.D.(Otago), Ph.D.(Monash), F.R.A.C.P., F.R.C.P.(C)  
 M.N. Pollak; M.D.(McG.), F.R.C.P.(C)  
 P. Ponka; M.D., Ph.D.(Prague)  
 B. Posner; M.D.(Man.), F.R.C.P.(C)  
 W.S. Powell; B.A.(Sask.), Ph.D.(Dal.)  
 G.B. Price; B.A.(Kansas St.), Ph.D.(Tenn.)  
 M. Rasminsky; B.A.(Tor.), M.D.(Harv.), Ph.D.(Lond.)  
 J. Shuster; B.Sc.(McG.), M.D.(Alta.), Ph.D.(Calif.)  
 E. Silva; M.D.(Chile), F.A.C.P.  
 E. Skamene; M.D., (Charles U., Czech.), Ph.D.(Czech. Acad. of Sci.), F.R.C.P.(C), F.A.C.P.  
 A.D. Sniderman; M.D.(Tor.)  
 S. Solomon; B.Sc., M.Sc., Ph.D.(McG.), F.R.S.C.  
 C.P. Stanners; B.Sc.(McM.), M.A., Ph.D.(Tor.)  
 M. Stevenson; B.A.(Hood), M.Sc., Ph.D.(Catholic U. of Amer.)  
 S.L. Tan; M.B.B.S., M.Med.(Sing.)  
 D.M.P. Thomson; M.D., (W. Ont.), Ph.D.(Lond.), F.R.C.P.(C)  
 M. Wainberg; B.Sc.(McG.), Ph.D.(Col.)  
 E. Wang; B.Sc.(Taiwan), M.A.(N.Mich.), Ph.D.(Case)  
 M. Zannis-Hadjopoulos; B.Sc., M.Sc., Ph.D.(McG.)  
 H. Zingg; M.D.(Basel), Ph.D.(McG.)

*Associate Professors*

A. Bateman; B.Sc., Ph.D.(Lond.)  
 J. Bates; B.Sc.(Cant., NZ), Ph.D.(Otago)  
 G. Batist; B.S.(Col.), M.D., C.M.(McG.), F.R.C.P.(C)  
 N. Beauchemin; B.A., B.Sc., M.Sc., Ph.D.(Montr.)  
 L.F. Congote; B.Sc.(Zu.r.), Ph.D.(Marburg)  
 D. Cournoyer; M.D.(Sher.), F.R.C.P.(C)  
 A. Cybulsky; M.D.(Tor.), F.R.C.P.(C)  
 D. Eidelman; M.D., C.M.(McG.), F.R.C.P.(C)  
 E.A. Faust; B.Sc., Ph.D.(McG.)  
 R. Gagnon; B.Sc.(Montr.), M.D.(Laval), D.Phil.(Oxon.)  
 R. Germinario; B.A., M.Sc.(Seton Hall U., N.J.), Ph.D.(Dakota)  
 F. Gervais; B.Sc., M.Sc., Ph.D.(Montr.)  
 V. Giguere; B.Sc., Ph.D.(Laval)  
 S.B. Gottfried; M.D.(Penn.)  
 Q.A. Hamid; M.D.(Mosul, Iraq), Ph.D.(Lond.)  
 L.J. Hoffer; B.Sc., M.D., C.M.(McG.), Ph.D.(M.I.T.)  
 L. Kleiman; B.Sc.(Ill.), Ph.D.(Johns H.)  
 R. Kremer; M.D., Ph.D.(Paris)  
 M. Laughrea; B.Sc.(Laval), M.Sc., M.Phil., Ph.D.(Yale)  
 R. Loertscher; M.D.(Basel)  
 W.H. Miller; A.B.(Prin.), Ph.D.(Rock.), M.D.(C'nell)  
 S. Mulay; M.Sc., Ph.D.(McG.)  
 J. Nalbantoglu; B.Sc., Ph.D.(McG.)  
 A. Nepveu; B.Sc., M.Sc.(Montr.), Ph.D.(Sher.)  
 M. Newkirk; B.Sc., M.Sc.(Queen's), Ph.D.(Tor.)  
 T. Owens; B.Sc., M.Sc.(McG.), Ph.D.(Ott.)  
 R. Palfree; B.Sc., M.Sc.(Lond.), Ph.D.(McG.)  
 M. Parniak; B.Sc., Ph.D.(Wat.)  
 A.C. Peterson; B.Sc.(Vic., B.C.), Ph.D.(Br.Col.)  
 S. Rabbani; M.B.B.S.(King Edward Med. Coll., Lahore)  
 D. Radzioch; M.Sc., Ph.D.(Jagiellonian, Cracow)  
 J. Rauch; B.Sc., Ph.D.(McG.)  
 C.P. Rose; B.Sc.(Queen's), M.D., C.M., Ph.D.(McG.)  
 E. Schurr; Diplom., Ph.D.(Al. Ludwigs U., Freiburg)  
 G. Spurl; B.Sc.(Med.), M.D.(Man.)  
 C. Srikant; M.Sc., Ph.D.(Madr.)  
 M. Trifiro; B.Sc., M.D.(McG.)  
 C. Tsoukas; B.Sc.(McG.), M.Sc.(Hawaii), M.D.(Athens), F.R.C.P.(C)  
 B. Turcotte; B.Sc., Ph.D.(Laval)  
 A. Veillette; B.Sc., M.D.(Laval), F.R.C.P.(C)  
 B.J. Ward; M.D.(McG.), M.Sc.(Oxon.), F.R.C.P.(C)

*Assistant Professors*

M. Alaoui-Jamali; D.V.M.(Rabat, Morocco), Ph.D.(René-Descartes, Paris)

S. Ali; B.Sc.(C'dia), Ph.D.(McG.)  
 D. Baran; M.D.C.M.(McG.), F.R.C.P.(C)  
 R. Benoit; M.D.(Montr.)  
 N. Bernard; B.Sc.(McG.), Ph.D.(Duke)  
 L. Chalifour; B.Sc., Ph.D.(Man.), M.A.(Harv.)  
 K. Cianflone; B.Sc., Ph.D.(C'dia)  
 A.E. Clarke; M.D.(Nfld.), M.S.(Stan.), F.R.C.P.(C)  
 C. Couture; B.Sc., M.Sc.(Laval), Ph.D.(McG.)  
 W. Cupples; B.Sc.(Vic.B.C.), M.Sc.(Calg.), Ph.D.(Tor.)  
 S. Daly; B.Sc.(C'dia), Ph.D.(W. Ont.)  
 S. David; B.P.T., Ph.D.(Man.)  
 J. Falutz; B.Sc., M.D., C.M.(McG.), F.R.C.P.(C)  
 G.I. Fantus; B.Sc., M.D., C.M.(McG.), F.R.C.P.(C)  
 M.S. Featherstone; B.Sc., M.Sc.(Ott.), Ph.D.(McG.)  
 J. Galipeau; M.D.(Montr.)  
 B. Gilfix; B.Sc.(Man.), Ph.D.(W. Ont.), M.D.C.M.(McG.), F.R.C.P.(C)  
 M. Greenwood; B.Sc., M.Sc.(C'dia), Ph.D.(McG.)  
 J. Henderson; B.Sc., Ph.D.(McG.)  
 H. Huynh; B.Sc., M.Sc., Ph.D.(McG.)  
 A.C. Karaplis; B.Sc., M.D., Ph.D.(McG.)  
 A.E. Koromilas; B.Sc., Ph.D.(Aristotelian U., Greece)  
 G.A. Kuchel; M.D.(McG.)  
 P. Laneuville; B.Sc.(McM.), M.D.(Ott.), F.R.C.P.(C)  
 L. Larose; B.Sc., Ph.D.(Montr.)  
 D. Lasko; B.S.(Yale), Ph.D.(M.I.T.)  
 J.-J. Lebrun; B.Sc., M.Sc., Ph.D.(Rennes, France)  
 R. Lin; B.Sc., M.Sc.(PRC), Ph.D.(C'dia)  
 M. Lipman; M.D.(McG.), F.R.C.P.(C)  
 D.K. Lloyd; B.Sc., Ph.D.(York, UK)  
 M.S. Ludwig; M.D.(Man.), F.R.C.P.(C)  
 D. Malo; D.V.M., M.Sc.(Montr.), Ph.D.(McG.)  
 B. Mazer; B.Sc.(Columbia, NY); M.D.(McG.), F.R.C.P.(C)  
 M. Park; B.Sc., Ph.D.(Glas.)  
 B.J. Petrof; M.D.(Laval)  
 R.P. Rehfuss; B.Sc.(State U.), Ph.D.(Syr.)  
 P. Renzi; M.D.(Montr.), F.R.C.P.(C)  
 S. Richard; B.Sc., Ph.D.(McG.)  
 D. Richardson; B.Sc., M.Sc., Ph.D.(W. Austr.)  
 G. Rouleau; B.Sc., M.D.(Ott.), Ph.D.(Har.), F.R.C.P.(C)  
 A. Sculptoreanu; B.Sc., M.Sc.(Carl.), Ph.D.(Sher.)  
 A. Sherker; M.D.(Queen's), F.R.C.P.(C)  
 J.P.H. Th'gn; B.Sc., M.Sc.(W.Ont.)  
 P. Tonin; B.Sc., M.Sc., Ph.D.(Tor.)  
 J. Viallet; B.Sc., M.D.(Montr.), F.R.C.P.(C)  
 M. Ward; M.D.(Queen's), Ph.D.(McG.)  
 S. Wing; B.Sc., M.Sc.(McG.)  
 X.-J. Yang; B.Sc.(Zhejiang), Ph.D.(Shanghai)  
 S.-P. Yee; B.Sc., M.Sc., Ph.D.(McM.)

*Associate Members, McGill*

C. Autexier, P. Brodt; M.N. Burnier; D.H. Burns; M. Chevette;  
 S.Chevalier; T. Chow; H. Clarke; E. Colle; D. Boivin;  
 M.M. Frojmovic; C. Gagnon; C. Goodyer; P. Goodyer; B. Gour;  
 B.J. Jean-Claude; W. Lapp; S. Lehnert; M. Miller; E. Mills;  
 C. Polychronakos; R.D. Rajan; G. Rouleau; S.-H. Shen;  
 G. Tannenbaum; H. Tenenhouse; I. Wainer; K. Watkin; S.N. Young

*Associate Members, Université de Montréal*

R. Butterworth; T. Bradley; P. Chartrand; J. Davignon;  
 C.F. Descheppe; J. Drouin; R. Garcia; J. Genest Jr.;  
 J. Gutkowska; P. Hamet; T. Hoang; P. Hugo; P. Jolicoeur; M. Klein;  
 C. Lazure; D. Lohnes; M. Nemer; M. Raymond; T. Reudelhuber;  
 M. Sairam; G. Sauvageau; E. Schiffrin; N. Seidah; R.-P. Sekaly;  
 D. Skup; M. Trudel; J. Vacher

*Associate Members, Institut Armand Frappier,*

*Université du Québec*

S. Lemieux; E. Potworowski; L. Zamir

**49.2 Programs Offered**

Ph.D. in Experimental Medicine.  
 M.Sc. – Specialization in Bioethics.  
 Graduate Diploma in Clinical Research.

### 49.3 Admission Requirements

For all three programs, candidates educated outside of Canada and the United States must submit GRE (General Examination) scores.

#### Ph.D.

Admission to graduate studies and research in Experimental Medicine is restricted to students who wish to register for the Ph.D. degree. Candidates must hold a Major or Honours B.Sc. degree, or an M.D. degree.

Admission is based on an evaluation by the Admissions Committee, which looks for evidence of high academic achievement, and on acceptance by a research director. It is the policy of the Division that all students must be financially supported either by their supervisor or through studentships or fellowships.

In addition to the documentation currently required by the Faculty of Graduate Studies, a letter from the candidate's research director outlining the Ph.D. project is necessary.

#### M.Sc. (Specialization in Bioethics)

Admission to the Master's program in Bioethics, from the base discipline Medicine, shall be limited to students having degrees in Medicine, Nursing, Physical and Occupational Therapy, as well as any other professional health training degree.

For further information regarding this program, please refer to the Bioethics entry.

#### Graduate Diploma in Clinical Research

The diploma program is open to health care and research professionals, medical residents, pharmacists, nurses, and those with an undergraduate degree in the medical and allied sciences.

### 49.4 Application Procedures

Applications will be considered upon receipt of:

1. application form;
2. transcripts;
3. letters of reference;
4. \$60 application fee;
5. test results (TOEFL and GRE).

All information is to be submitted to the Departmental Office.

### 49.5 Program Requirements

#### PH.D.

##### Comprehensive Examination

All students must take and pass the Comprehensive Oral Examination, listed as course 516-701D in the second year of the Ph.D. Students shall give a 30-minute presentation of their Ph.D. project and then answer questions from the Oral Committee. This examination will test: (i) If the student's work is progressing satisfactorily and is of sufficiently high calibre to warrant continuation in the program, and (ii) If the student has a broad knowledge, not only of his/her own field of research, but also of related areas in her/his discipline.

##### Course Work

A minimum of 18 course credits is required for students entering the program with a Bachelor's or M.D. degree. Depending on their background, students with a Masters degree may be required to take only 12 course credits. The following courses are highly recommended: 516-604D Recent Advances in Cellular and Molecular Biology; 516-610B Biochemical Methods in Medical Research.

After consultation with their research supervisor and the Director of the Division, students may choose their courses from those offered by Experimental Medicine, Physiology, Biochemistry as well as other graduate and advanced undergraduate courses in the medical and allied sciences. Where necessary, students may enroll for credit in courses offered in the physical and mathematical sciences.

Students in the third year of the Ph.D. must give a 20-minute oral presentation of their work at the Annual Research Seminar.

#### M.Sc. (Specialization in Bioethics)

The curriculum is composed of required courses (for 6 credits) offered in the Biomedical Ethics Unit, bioethics courses (3 credit minimum) offered by the base department and any graduate courses required or accepted by the base department for the granting of a Master's degree, for a total of 18 to 21 credits. A minimum of 45 credits is required including the thesis.

For further information please contact the Chair, Master's Specialization in Bioethics, Biomedical Ethics Unit, 3690 Peel Street, Montreal, QC, H3A 1W9. Telephone: (514) 398-6980; Fax: (514) 398-8349; e-mail: Glass\_K@falaw.lan.mcgill.ca.

#### Graduate Diploma in Clinical Research

The Diploma consists of 30 credits, 24 of which include specific courses. The additional supplemental 6 credits are optional and may be chosen from course work available through the Division of Experimental Medicine, Department of Pharmacology and Therapeutics and Department of Epidemiology and Biostatistics.

The core element of the diploma is the Practicum in Clinical Research (18 credits). It is a six-step program with active 'clerkship' or 'intern-resident-type' participation in each component that is essential to the successful development and evaluation of a clinical trial.

Six 1-credit workshops will be provided by experts in the academic, industrial and government sectors, and cover wide-ranging issues pertinent to the conduct of clinical research.

### 49.6 Courses for Higher Degrees

- Denotes not offered in 1999-2000.

The course credit weight is given in parentheses (#) after the course title.

**516-502A ADVANCED ENDOCRINOLOGY – PART I.** (3) A multidisciplinary approach will be used to teach biosynthesis and processing of hormones, their regulation, function and mechanism of action. The material will cover hypothalamic, pituitary, thyroid, atrial and adrenal hormones as well as prostaglandins and related substances. **Professors Bennett, Bateman and Staff**

**516-503B ADVANCED ENDOCRINOLOGY – PART II.** (3) The topics covered are the parathyroids, gut and pancreatic hormones and growth factors. In addition, the role of hormones and growth factors in reproduction and fetal maturation will be discussed. **Professors Bennett, Bateman and Staff**

**516-504A BIOLOGY OF CANCER.** (3) An introduction to the biology of malignancy. A multidisciplinary approach dealing with the etiology of cancer, the biological properties of malignant cells, the host response to tumor cell growth and the principles of cancer therapy. **Professor Thomson and Staff**

**516-506B ADVANCED CARDIOVASCULAR PHYSIOLOGY.** (3) (Offered in conjunction with the Department of Physiology.) Current topics, methods and techniques for studying the cardiovascular system. Basic and applied cardiac electrophysiology, mechanisms of pacemaker activity, arrhythmias, the effects of drugs on cardiac functions, fetal circulation, coronary circulation, mechanics of blood flow, cardiovascular diseases, renal and neural control of the circulation, and cardiac assist devices. **Professors Goldsmith and Shrier**

**516-507A ADVANCED APPLIED RESPIRATORY PHYSIOLOGY.** (3) (Prerequisite: 552-313B) Offered in conjunction with the Department of Physiology. In depth coverage of respiratory biology including: functional anatomy of the respiratory system, pulmonary statics and dynamics, chest wall and respiratory muscles, ventilation and perfusion, control of breathing, and defense mechanisms. To provide a solid grounding in pulmonary biology and its research applications. **Professors Fixman and Petrof**

**516-508B ADVANCED TOPICS IN RESPIRATION.** (3) (Prerequisite: 516-507A) Offered in conjunction with the Department of Physi-



ogy. In depth coverage of developmental physiology, pulmonary vascular physiology, biology of airway smooth muscle, respiratory epithelium and molecular biology of respiratory muscles. Dyspnea, mechanical ventilation and respiratory failure also covered. Emphasis on application of respiratory biology to basic and applied research and touches on pulmonary pathophysiology.

**Professor Fixman**

**516-509B GASTROINTESTINAL PHYSIOLOGY AND PATHO-  
PHYSIOLOGY.** (3) (Prerequisite: Graduate students, U3 undergraduates) Course deals with various aspects of gastrointestinal and hepatic function in health and in altered physiological states. The principal focus is on the recent literature pertaining to cell and molecular mechanisms underlying the motility secretory process, absorption and secretion. The molecular biology of the hepatic viruses and various aspects of colonic neoplasia will also be considered.

**Professors Wild and Barkun**

**516-510A BIOANALYTICAL SEPARATION METHODS.** (3) The student will be taught the capabilities and limitations of modern separation methods (gas and high-performance liquid chromatography, capillary electrophoresis, hyphenated techniques). Application of these techniques to solve analytical problems relevant to biomedical research will be emphasized, with special attention being paid to the processing of biological samples.

**Professors Wainer and Lloyd**

**516-511B JOINT VENTURING WITH INDUSTRY.** (3) Presentation skills; preparing a business plan; the planning and control process; and legal, financial and human resource issues as they apply to the researcher. Given in conjunction with the Centre for Continuing Education.

**Professors Price and Yalovsky**

**516-512C RECENT PROGRESS IN AIDS RESEARCH.** (6) Basic, clinical, epidemiologic and psychosocial aspects of HIV infection. Topics include: the pathophysiology of HIV-associated immunodeficiency; review of current antiviral treatment and mechanisms of resistance to anti-HIV drugs; sessions on the natural history, clinical manifestations and general aspects of treatment interventions, as pertaining to different populations. (Awaiting University Approval)

**Professor Sekaly and Staff**

**516-602B ADVANCED TECHNIQUES IN MOLECULAR GENETICS.** (3) (Admission by permission of instructor.) Offered in conjunction with the Department of Human Genetics. Precise description of available methods in molecular genetics, and rationales for choosing particular techniques to answer questions posed in research proposals for targeting genes in the mammalian genome. Emphasis placed on analysis of regulation of gene expression and mapping, strategies for gene cloning. Course divided between lectures and student seminars.

**Professors Malo and Radzioch**

**516-603B SEMINARS IN ENDOCRINOLOGY.** (3) For graduate students to develop skills in critical reading of current literature, interpretation of research data, and seminar organization and presentation. Staff suggest topics. Each student presents two seminars on topics of their choice, supervised by professors responsible for those topics, and one mini-symposium style presentation on any topic.

**Professor Palfree and Staff**

**516-604D RECENT ADVANCES IN CELLULAR AND MOLECULAR BIOLOGY.** (6) Offered in conjunction with the Université de Montréal: given Thursdays 16:00-18:00 at Institut de Recherches Cliniques de Montréal, 110 Pine West. The course is bilingual with abstracts in the other language supplied; more than half the lectures are in French. Aimed at bringing students up to date on recent aspects of cell and molecular biology including cellular organelle structure and function, molecular genetics, signal transduction, cell growth and development, and immunology.

**Professor Drouin and Staff**

**516-607B MOLECULAR CONTROL OF CELL GROWTH.** (3) A course for graduate students in Experimental Medicine, Biology, Biochemistry, Microbiology and Physiology, dealing with molecular control in normal and malignant cell growth, including cell cycle and physiological controls (nutritional and hormonal), mammalian DNA replication, viral effects on host cell growth for DNA and RNA-tumor

viruses and oncogenes, and tissue and organ growth-renewal mechanisms.

**Professors Price and Zannis-Hadjopoulos**

● **516-608A MOLECULAR EMBRYOLOGY.** (3) (Offered in conjunction with the Department of Oncology.)

**516-610B BIOCHEMICAL METHODS IN MEDICAL RESEARCH.** (3) A course intended to introduce students to a variety of basic techniques used in medical research. Lectures and demonstrations given on the purification of biologically active substances by chromatography, analysis of compounds by spectrophotometry and mass spectrometry, immunological techniques, centrifugation, cell culture, binding of hormones to receptors, molecular biology, tumor biology and electron microscopy.

**Professor Powell and Staff**

**516-611D SEMINARS IN ONCOLOGY.** (6) A course in cancer and allied fields aimed at familiarizing students with the current literature relevant to the biology of cancer, developing their critical abilities and providing an opportunity for presenting seminars to their peers.

**Professors Fuks and Featherstone**

**516-614B ENVIRONMENTAL CARCINOGENESIS.** (3) Methods for identification of carcinogens, including epidemiological studies, animal modelling and molecular biomarkers, and characteristics of known environmental carcinogens (viruses, chemical and physical agents and diet). Environmental factors will be placed in the context of overall cancer risk, which involves interaction of genetics, host and environment.

**Professors Lehnert, Franco, Matlashewski and Alaoui-Jamali**

**516-615B MEMBRANE CARBOHYDRATES.** (3) The structure, function and biosynthesis of glycoproteins, glycolipids and glycosaminoglycans, and the biological role of complex carbohydrates at the cell surface.

**Professor Hercovics**

**516-616A MOLECULAR & CELL BIOLOGY TOPICS.** (3) Structured and instructor-directed student presentations and discussions of recent advances in molecular and cellular biology. The course will reinforce the students' knowledge of currently major areas of investigation, with a focus on human disease and medical applications. Important recent publications will extend material from textbook and review articles.

**Professors Miller and Staff**

**516-617A,B,C,T WORKSHOP IN CLINICAL TRIALS I.** (1) Intensive day-long workshop discussing Industrial/Academic/Governmental interactions in the design, testing and approval of drugs.

**Professors Gold, Wainer and Price**

**516-618A,B,C,T WORKSHOP IN CLINICAL TRIALS II.** (1) Intensive day-long workshop discussing the role of the physician in drug testing.

**Professors Gold, Wainer and Price**

**516-619A,B,C,T WORKSHOP IN CLINICAL TRIALS III.** (1) Intensive day-long workshop discussing the pharmacoeconomics of drug design and testing.

**Professors Gold, Wainer and Price**

**516-620A,B,C,T CLINICAL TRIALS AND RESEARCH I.** (1) Intensive day-long workshop discussing a topical subject or recent advance relevant to clinical research and the conduct of clinical trials.

**Professors Gold, Wainer and Price**

**516-625A,B,C,T CLINICAL TRIALS AND RESEARCH II.** (1) Intensive day-long workshop discussing a topical subject or recent advance relevant to clinical research and the conduct of clinical trials.

**Professors Gold, Wainer and Price**

**516-626A,B,C,T CLINICAL TRIALS AND RESEARCH III.** (1) Intensive day-long workshop discussing a topical subject or recent advance relevant to clinical research and the conduct of clinical trials.

**Professors Gold, Wainer and Price**

**516-627A,B,C,T PRACTICUM IN CLINICAL RESEARCH.** (18) Six-step program: 1. Identification of the problem; 2. Experimental design; 3. Protocol development; 4. Execution of the protocol; 5. Data analysis; 6. Generation of final report with active "clerkship" participation in each component with team leaders and experts designated for each stage.

**Professors Gold, Wainer and Price**

**516-631L ADVANCED TOPICS IN ECONOMIC EVALUATION.** (3) This course will cover methodologies in economic evaluation of health

care technologies which are currently in development or changing rapidly, including: willingness-to-pay, theoretical arguments for inclusion/exclusion of cost components, statistical issues in cost effective analysis. Discussion will rely on recently published material.

**Professor Penrod and Staff**

**516-640A,B,C EXPERIMENTAL TOPICS I.** (3) Study, through guided reading, visits, practicals, assignments, of an elected and approved topic of importance in medical science.

**Professor Price and Staff**

**516-641A,B,C, EXPERIMENTAL TOPICS II.** (3) Study, through guided reading, visits, practicals, assignments, of an elected and approved topic of importance in medical science.

**Professor Price and Staff**

**516-642A,B,C EXPERIMENTAL TOPICS III.** (3) Study, through guided reading, visits, practicals, assignments, of an elected and approved topic of importance in medical science.

**Professor Price and Staff**

**516-701D COMPREHENSIVE EXAMINATION.**

**Department of Physiology**

**552-508A ADVANCED RENAL PHYSIOLOGY.** (3)

**Professor Levy and Staff**

**552-513A CELLULAR IMMUNOLOGY.** (3)

**Professor Lapp**

**552-515A PHYSIOLOGY OF BLOOD I: HEMOSTASIS AND THROMBOSIS.** (3)

**Professors Frojmovic and Solymoss**

**552-516B PHYSIOLOGY OF BLOOD II: ERYTHROCYTES AND BONE MARROW.** (3)

**Professors Ponka and Hiscott**

**552-517B ARTIFICIAL INTERNAL ORGANS.** (3)

**Professors Sipehia and Chang**

**552-518A ARTIFICIAL CELLS: IMMOBILIZED ENZYMES AND BIOMATERIALS.** (3)

**Professors Mishiya and Chang**

**519-604B SELECTED TOPICS IN HUMAN IMMUNOLOGY.** (3)

**Professor Brodt and Staff**

**Department of Microbiology & Immunology**

**528-510B SEMINARS ON THE INFLAMMATORY PROCESS.** (3)

**Professors Gervais and Newkirk**

**Scheduled Graduate Seminars**

The Royal Victoria Hospital (1 hour per week):

Respiratory Research  
Immunopathology  
Endocrinology and Metabolism  
Haematology Research  
Renal and Electrolyte Seminar  
Transplantation Conference  
Gastroenterology Conference  
Diabetes Conference  
Chest-Cardiac Disease Conference  
Clinical Endocrinology Conference  
Steroid Biochemistry Research  
Haematology Clinical Conference  
Endocrinology and Metabolism Research Conference  
Clinical Immunology Conference  
Arthritis Conference  
Internal Medicine  
Dermatology Research  
University Clinic Seminar  
Cardiology Research

The Montreal General Hospital (1 hour per week, or in some cases alternate week):

Gastroenterology Conference  
Respiratory Diseases  
Dermatology  
Internal Medicine  
Allergy and Immunology  
Infectious Diseases  
Combined Staff Conference  
Haematology  
Arthritis

Metabolic Diseases  
Cardiac Disease  
Neurology – Neurosurgery  
University Medical Clinic Seminar

## 50 Microbiology and Immunology

Department of Microbiology and Immunology

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Chair — M.S. Dubow

### 50.1 Staff

*Professors*

N.H. Acheson; A.B.(Harv.), Ph.D.(Rockefeller)  
Z. Ali-Khan; B.Sc.(Bilar), M.Sc.(Karachi), Ph.D.(Tulane)  
E.C.S. Chan; M.A.(Texas), Ph.D.(Maryland)  
J.W. Coulton; B.Sc.(Tor.), M.Sc.(Calg.), Ph.D.(W. Ont.)  
M.S. Dubow; B.Sc.(S.U.N.Y.), M.A., Ph.D.(Ind.)  
J. Hiscott; B.Sc., M.Sc., Ph.D.(W. Ont.)  
J. Mendelson; M.Sc.(Rock), M.D., C.M.(McG.), F.R.C.P.(C.)  
R.A. Murgita; B.Sc.(Maine), M.S.(Vt.), Ph.D.(McG.)  
M.J.H. Ratcliffe; B.A.(Glas.), Ph.D.(Coll. Lond.)  
H.G. Robson; B.Sc., M.D., C.M.(McG.), F.R.C.P.(C.)  
M.A. Wainberg; B.Sc.(McG.), Ph.D.(Col.)

*Associate Professors*

M.G. Baines; B.Sc., M.Sc., Ph.D.(Queen's)  
D.J. Briedis; B.A., M.D.(Johns H.)  
A. Dascal; D.C.S.(McG.), M.D.,(Montr.)  
E. Mills; B.Sc., M.D.(Sask.)  
T. Owens; B.Sc., M.Sc.(McG.), Ph.D.(Ont.)

*Assistant Professors*

G.J. Marczynski; B.S., Ph.D.(Ill.)  
D. Portnoy; B.Sc.(Sir G.Wms.), M.D.(Liege)  
J. Portnoy; B.Sc., M.D.C.M., M.Sc.(McG.)  
P. René; B.A., M.D.(Sher.)

*Associate Members*

J. Antel; Neurology and Neurosurgery  
N.V. Christou; Surgery  
C. Couture; Medicine (Div. Exp. Med.)  
G. Faubert; Institute of Parasitology  
L. Kleiman; Microbiology and Immunology  
A.E. Koromilas; Oncology  
V. Loo; Medicine  
J.D. MacLean; Medicine  
M.A. Miller; Medicine  
M. Newkirk; Medicine  
C.K. Osterland; Medicine  
R.G.E. Palfree; Medicine  
A.R. Poole; Surgery  
J. Rauch; Medicine  
P. Ribeiro; Institute of Parasitology  
S. Richard; Oncology  
M. Stevenson; Medicine  
B. Turcotte; Medicine  
B.J. Ward; Medicine

*Adjunct Professors*

A. Descoteaux; B.Sc., M.Sc.(Montr.), Ph.D.(McG.)  
P. Hugo; B.Sc., M.Sc., Ph.D.(McG.)  
P. Lau; Ph.D.(Ottawa)  
R.-P. Sekaly; B.A.(Stanislas), B.Sc., M.Sc.(Montr.),  
Ph.D.(Lausanne)

## 50.2 Programs Offered

The Department offers graduate programs leading to the degrees of M.Sc., M.Sc. Applied and Ph.D. Each program is tailored to fit the needs and backgrounds of individual students.

The Department concentrates on four key areas of research: cellular and molecular immunology, microbial physiology and genetics, molecular biology of viruses, and medical microbiology.

## 50.3 Admission Requirements

### Master's and Master's Applied

Candidates are required to hold a B.Sc. degree in microbiology and immunology, biology, biochemistry or another related discipline; those with the M.D., D.D.S. or D.V.M. degrees are also eligible to apply. The minimum grade point average for acceptance into the program is 3.2 (out of 4.0) B+. All international applicants whose language of instruction is not English must have a TOEFL score of 550.

### Ph.D

Students who have satisfactorily completed a M.Sc. degree in microbiology and immunology, a biological science, or biochemistry, or highly qualified students enrolled in the departmental M.Sc. program, may be accepted into the Ph.D. program provided they meet its standards.

## 50.4 Application Procedures

Applications will be considered upon receipt of:

1. application form;
2. two official transcripts;
3. two letters of reference;
4. \$60 application fee;
5. TOEFL test (GRE not required but recommended).

All information is to be submitted directly to the Student Affairs Officer in the Department of Microbiology and Immunology.

All applicants are encouraged to approach academic staff members during or before the application process since no applicants are accepted without a supervisor.

### Deadlines(s)

All applications and documents must be submitted by the following dates:

#### Canadian Applicants

November 1	for the Winter term (January)
March 1	for the Summer term (May)
June 1	for the Fall term (September)

#### International Applicants

September 1	for the Winter Term (January)
January 1	for the Summer term (May)
April 1	for the Fall term (September)

## 50.5 Program Requirements

### M.Sc. Degree (45 credits)

The following requirements must be satisfied:

- 1) Students must register for and satisfactorily complete the requirements of courses 528-611, 528-612, 528-613, 528-614, 528-615 and two of the following courses: 528-616, 528-617, 528-618 and 528-619 (see list below).
- 2) Other courses may be required to strengthen the student's background.
- 3) A satisfactory M.Sc. thesis (24 credits) must be presented.

### M.Sc.A. Degree (non-thesis degree)

The principal aim is to provide specialized training in Applied Medical Microbiology and Immunology.

Candidates must satisfy requirements (1) and (2) above. In addition, applied laboratory research projects must be pursued as a major part of the overall program. The results of each project

form the basis of a formal report which is reviewed by the Department staff.

### Ph.D

Candidates will be judged principally on their research ability and on the presentation of a satisfactory thesis.

Students must also register for and satisfactorily complete the requirements of courses 528-701D, 528-711, 528-712, 528-713, 528-714, 528-715 and 528-716 and three or the following courses: 528-704A, 528-705B, 528-706A, 528-707B (see list below). Other courses may be required to strengthen the student's background.

Each Ph.D. student has an advisory committee (three professors including research advisor) that meets yearly to consider the student's progress.

## 50.6 Courses

The course credit weight is given in parentheses (#) after the course title.

**528-603H PRACTICAL DIAGNOSTIC MICROBIOLOGY.** (12) (offered to M.Sc.A. students only)

**528-604D INDEPENDENT RESEARCH PROJECT.** (6) (offered to M.Sc.A. students only)

**528-605D ADVANCED INDEPENDENT RESEARCH PROJECT IN APPLIED MICROBIOLOGY AND IMMUNOLOGY.** (12) (offered to M.Sc.A. students only)

**528-611A,B GRADUATE SEMINAR.** (3)

**528-612A,B GRADUATE SEMINAR.** (3) (M.Sc. students - presentation of two seminar topics throughout the course of their degree program).

**528-613A,B CURRENT TOPICS IN MICROBIOLOGY AND IMMUNOLOGY.** (3)

**528-614A,B CURRENT TOPICS IN MICROBIOLOGY AND IMMUNOLOGY.** (3)

**528-615A,B CURRENT TOPICS IN MICROBIOLOGY AND IMMUNOLOGY.** (3) M.Sc. Students (discussion groups with guest speakers).

**528-616A,B READING AND CONFERENCE.** (3)

**528-617A,B READING AND CONFERENCE.** (3)

**528-618A,B READING AND CONFERENCE.** (3)

**528-619A,B READING AND CONFERENCE.** (3) (M.Sc. students - two of these courses required throughout the course of their degree program.) Student presentations, taken from current literature, are concerned with aspects of a central topic. Presentations are designed to be informal and to generate student discussions. Topic will change from term to term.

**528-697A,B,C MASTER'S RESEARCH I.** (8)

**528-698A,B,C MASTER'S RESEARCH II.** (8)

**528-699A,B,C MASTER'S RESEARCH III.** (8) (M.Sc. students) Independent work under the direction of a supervisor on a research problem in the student's designated area of research.

**528-701D COMPREHENSIVE EXAMINATION.**

**528-704A READING AND CONFERENCE.** (3)

**528-705B READING AND CONFERENCE.** (3)

**528-706A READING AND CONFERENCE.** (3)

**528-707B READING AND CONFERENCE.** (3) (Ph.D. students - three of these courses required throughout the course of their degree program.) Description as for M.Sc. students.

**528-711A,B GRADUATE SEMINAR.** (3)

**528-712B GRADUATE SEMINAR.** (3)

**528-713A,B GRADUATE SEMINAR.** (3) (Ph.D. students) Presentation of a maximum of three seminars topics throughout the course of their degree program.

**528-714A,B CURRENT TOPICS IN MICROBIOLOGY AND IMMUNOLOGY.** (3)

**528-715A,B CURRENT TOPICS IN MICROBIOLOGY AND IMMUNOLOGY.** (3)

**528-716A,B CURRENT TOPICS IN MICROBIOLOGY AND IMMUNOLOGY.** (3) (Ph.D. students) Discussion groups with guest speakers.

**528-721D PH.D. RESEARCH PROGRESS REPORT.** (1)

**528-722D PH.D. RESEARCH PROGRESS REPORT.** (1)

**528-723D PH.D. RESEARCH PROGRESS REPORT.** (1)

**528-724D PH.D. RESEARCH PROGRESS REPORT.** (1) Each Ph.D. student has an advisory committee (3 professors including research advisor) that meets yearly to consider student's progress. Students submit a 6-page progress report to the committee and give a 20-minute oral presentation, discussing data obtained and future research plans. Committee gives advice on progress and fine-tuning the research project.

## 51 Mining and Metallurgical Engineering

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Mining –

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Metallurgy –

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Fax: (514) 398-4492

*Chair* — R.A.L. Drew

*Director, Mining Program* — H.S. Mitri

### 51.1 Staff

*Emeritus Professor*

W.M. Williams; B.Sc., M.Sc.(Brist.), Ph.D.(Tor.), Eng.

*Professors*

G.P. Demopoulos; Dipl.Eng.(NTU Athens), M.Sc., Ph.D.(McG.), Eng.

R.A.L. Drew; B.Tech.(Brad.), Ph.D.(N'cle.)

J.A. Finch; B.Sc.(Birm.), M.Eng., Ph.D.(McG.), Eng., F.C.I.M.

J.E. Gruzleski; J.E., B.Sc., M.Sc.(Queen's), Ph.D.(Tor.), Eng., F.C.I.M., F.A.S.M.

R.I.L. Guthrie; B.Sc., Ph.D.(Lond.), D.I.C., A.R.S.M., Eng., F.C.I.M.

F.P. Hassani; B.Sc., Ph.D.(Nott.), C.Eng.(U.K. Reg.)

J.J. Jonas; B.Eng.(McG.), Ph.D.(Cantab.), F.A.S.M., F.R.S.C., Eng.

G.W. Smith; B.Eng., M.Eng., Ph.D.(McG.), Eng.

*Associate Professors*

M.L. Bilodeau; B.Eng.(Montr.), M.Sc.A., Ph.D.(McG.), Eng.

P.A. Distin; B.Sc., Ph.D.(Lond.), D.I.C.

R. Harris; B.Sc.(Q'ld), M.Eng., Ph.D.(McG.)

M. Hasan; B.Eng.(Dhaka), M.Sc.(Dhahran), Ph.D.(McG.)

A. Laplante; B.A.Sc., M.A.Sc., (Montr.), Ph.D.(Tor.), Eng.

H.S. Mitri; B.Sc.(Cairo), M.Eng., Ph.D.(McM.), Eng.

F. Mucciardi; B.Eng., M.Eng., Ph.D.(McG.), Eng.

J. Szpunar; B.Sc., M.Sc., Ph.D., D.Sc.(Krakow)

S. Yue; B.Sc., Ph.D.(Leeds)

*Assistant Professor*

J.A. Kozinski; B.A., M.Eng., D.Sc.(Krakow)

*Lecturer*

J. Mossop

*Adjunct Professors*

W. Comeau, R. Dimitrakopoulos, B. Harris, A. Hemami, H. Keira,

Y. Lizotte, B. Mohanty, M.J. Scoble, J. Stachulak, W.T. Thompson,

G. Van Weert, A.E. Wraith

*Mining Co-op Coordinator*

M. Vachon

### 51.2 Programs Offered

Graduate programs leading to M.Eng., M.Sc. and Ph.D. research degrees are available in rock mechanics, mining environments, mining automation and robotics, operations research, ground fragmentation, mineral economics, materials handling, chemical and process metallurgy, hydrometallurgy, effluent treatment, mineral processing and related surface chemistry, metal casting, materials engineering, composites, ceramics and mechanical metallurgy.

Course programs leading to the M.Eng. (Project) degree in Mining or Metallurgy/Materials and the Graduate Diploma in Mining Engineering are also available.

Special programs are available for those holding degrees in subjects other than Metallurgy, Materials or Mining (e.g. Chemistry, Physics, Engineering Geology).

### 51.3 Admission Requirements

The Graduate Diploma in Mining Engineering is open to graduates with suitable academic standing in any branch of engineering or science. It is designed to provide a sound technical mining engineering background to candidates intending to work in the minerals industry.

The M.Eng. (thesis) degree is open to graduates holding the B.Eng. degree or its equivalent in Metallurgical or Materials Engineering, Mining Engineering, or other related engineering fields.

The M.Sc. (thesis) degree is open to graduates holding the B.Sc. degree or its equivalent in Metallurgy, Geology or related fields. A high academic standing at the undergraduate level is required for admission to these programs.

The Master of Engineering (Project) program (Metallurgy/Materials Option) is primarily designed to train people with appropriate engineering or scientific backgrounds to allow them to work effectively in the metals or materials industries. Industrial experience is favourably viewed for entrance into the program, but is not considered a necessity.

The Master of Engineering (Project) program (Mining Option) is primarily designed for graduates from mining engineering programs who have received adequate academic training in modern mining technology, mineral economics, computer programming and probabilities and statistics. Students without this academic training must follow a qualifying semester of courses established by the Mining Program Director. Industrial experience is favourably viewed for entrance into the program, but is not considered a necessity.

Ph.D. Degree applicants may either be "directly transferred" from the M.Eng. or M.Sc. program (see below) or hold an acceptable Master's degree in Metallurgy or Materials Science, Metallurgical or Materials Engineering, Mining Engineering, or other related fields. The Ph.D. degree is awarded in the appropriate field.

### 51.4 Application Procedures

Applications will be considered upon receipt of:

1. Application form
2. Transcripts
3. Letters of reference
4. \$60 application fee
5. TOEFL test results

All information is to be submitted directly to the Graduate Secretary in the Department of Mining and Metallurgical Engineering.

**Deadlines:**

March 1 – Fall admission

July 1 – Winter admission

November 1 – Summer admission

## 51.5 Program Requirements

### Graduate Diploma in Mining Engineering

This program consists of 30 credits of course work, and normally requires one academic year of full-time study to complete. Candidates are required to take an integrated group of courses (including 306-673 Mining Engineering Seminar), selected in consultation with the Program Adviser and based on their academic background.

### M.Eng. and M.Sc. (Thesis) Degrees

The programs consist of 45 credits of course work, seminars and research. The candidate must pass a minimum number of courses, normally equivalent to 12 credits, chosen in consultation with a supervisor and based on his/her academic background and research interests.

In addition, the candidate must participate in an appropriate Research Seminar course and submit an acceptable thesis based on a series of successfully completed research courses.

M.Eng. and M.Sc. candidates may submit to a qualifying examination and on recommendation, may be admitted to the Ph.D. program.

**Direct Transfer from Master's to Ph.D.** – Students enrolled in a Master's program (thesis) may transfer into the Ph.D. program without obtaining a Master's degree if they have satisfied the following:

- 1) they have been in the Master's program for less than 16 months;
- 2) they have satisfactorily passed all the required Master's courses, and given one seminar;
- 3) they have obtained a letter of recommendation from their supervisor;
- 4) they have passed a preliminary examination (as per the Ph.D. program).

### M.Eng. (Project) Degree Metallurgy/Materials Option

The M.Eng. (Project) program (Metallurgy/Materials Option) consists of 45 credits of course work and projects. The package of courses undertaken will provide any necessary basic training and will be selected in consultation with the Program Advisor to satisfy the desired specialization of the candidate. The project courses may be undertaken in an industrial environment as a 4- to 8-month work term.

The program consists of a minimum of 12 credits of Departmental graduate level courses, 6 to 15 credits of M.Eng Metallurgy Project courses, the Metallurgical Engineering Seminar (306-670) and enough additional courses chosen from within or outside the Department to complete the 45 credit requirement. The external courses and project courses undertaken in an industrial environment are subject to Departmental approval. The program is established in consultation with the Program Advisor.

### M.Eng. (Project) Degree Mining Option

The M.Eng. (Project) program (Mining Option) consists of 45 credits of course work and projects. It is primarily designed for graduates from mining engineering programs who have received adequate academic training in modern mining technology, Mineral Economics, Computer Programming and Probabilities and Statistics. Students without this academic training must follow a qualifying semester of courses (including 306-420 Feasibility Study) established by the Mining Program Director.

The program consists of a minimum 12 credits of Departmental graduate level courses, 6 to 15 credits of M.Eng Mining Project courses, the Mining Engineering Seminar (306-673) and enough additional courses chosen from within or outside the Department to complete the 45 credit requirement. The program is established in consultation with the Program Director. The external courses are subject to Departmental approval.

## Ph.D. Degree

A candidate for this degree must pass courses assigned by the Department. These are selected on the basis of the student's previous academic training and research interests. The candidate is required to participate in an appropriate Research Seminar course and is expected to take a preliminary examination within the first year of his/her Ph.D. registration.

The candidate must submit an acceptable thesis based upon successfully completed research and must satisfy the examiners in an oral examination of the thesis and related topics.

## 51.6 Graduate Courses Offered by the Department

The courses in this Department have been numbered to conform with the following classification system. The first three digits (i.e. 306) represent the departmental code. The next digit represents the level of instruction. The last two digits are classified as follows:

- 01 to 19 technical courses
- 20 to 39 mining courses
- 40 to 49 mineral processing courses
- 50 to 59 extractive and process metallurgy courses
- 60 to 69 metallurgy and materials courses
- 70 to 79 seminars

Certain courses may be cancelled without notice; students should therefore consult the Department before registration.

- Denotes not offered in 1999-2000.

The course credit weight is given in parentheses (#) after the course title.

**306-515A ADVANCED METALLURGICAL AND MATERIALS THERMODYNAMICS.** (3) (Prerequisite: 306-212 or equivalent.) Computational thermodynamics including phase diagram estimation, Gibbs energy minimization and solution modelling are considered in view of the Facility of Chemical Thermodynamics (F\*A\*C\*T) computer database. Students undertake projects developed in consultation with the instructor and prepare verbal and written reports.

**Metallurgy Staff**

**306-520B STABILITY OF ROCK SLOPES.** (3) (Prerequisite: permission of instructor.) The properties of rock masses and of structural discontinuities. Influence of geological structure on stability. Linear, non-linear, and wedge failures. Site investigations. Methods of slope stabilization.

**Professor Hassani**

**306-521B STABILITY OF UNDERGROUND OPENINGS.** (3) (Prerequisite: permission of instructor.) The properties of rock masses and stability classification systems. The influence and properties of geological structural features. Stability related to the design of underground openings and mining systems. Site investigations. Methods of stabilization.

**Professor Mitri**

- **306-524B MINERAL RESOURCE ECONOMICS.** (3) (Prerequisite: 306-310 or equivalent, or permission of instructor.)

**306-526A,B MINERAL ECONOMICS.** (3) (Prerequisite: 306-310) Mineral project evaluation techniques and applications. Topics covered include grade-tonnage relationships, capital and operating cost estimation techniques, assessment of mineral market conditions, taxation, discounted cash flow analysis, risk analysis, and optimization of project specifications with respect to capacity and cutoff grade. (Course given once per academic year.)

**Professor Bilodeau**

**306-528B MINING AUTOMATION.** (3) (Prerequisite: 306-426) System analysis and design in the frequency domain. Review of optimization methods. Mining system modelling applied to rock cutting, materials transport and bunkering, and pitch, yaw and roll steering of mining machines. Control and robotics: digitization, discrete systems, sensors, actuators and real time algorithms, Data communications in mines. Simulation exercises.

**Professor Hemami**

**306-544A MINERAL PROCESSING SYSTEMS I.** (3) The course covers three main topics: principles of separation, including data presentation, properties of recovery/yield plots, technical and eco-

conomic efficiency and identification of limits to separation; column flotation, hydrodynamics of collection and froth zones, mixing, scale-up and design, measurements and control; surface and electrochemistry, including adsorption, surface charge, coagulation, electron transfer reactions, electrochemistry in plant practice. Guest lectures on various specialized topics are also included.

**Professor Finch**

**306-545B MINERAL PROCESSING SYSTEMS II.** (3) Gold recovery (as a Professional Development Seminar); methods of recovery or dissolution (gravity, flotation, cyanidation), refractory gold (roasting, pressure oxidation, bacterial leaching), dissolved gold recovery (Merrill-Crowe) and activated carbon methods. Sampling: definition of errors, sample extraction, size, and processing. Mass Balancing: basic considerations, definition of networks, software. Blending: auto-correlation functions, transfer functions, blending systems. Effect of feed variability. **Professor Laplante**

**306-551B ELECTROCHEMICAL PROCESSING.** (3) (Prerequisite: 306-352) Characterization of aqueous, fused salt and solid electrolytes; laws of electrolysis; ion transport mechanisms; interfacial phenomena (electrolyte-electrolyte, electrode-electrolyte); reversible cells and potentials; electrode kinetics, overpotential and potential-current laws; industrial applications; electrolytic winning and refining, electroplating, surface cleaning and coating, electro-dialysis and electrochemical sensors. **Professor Demopoulos**

**306-555A THERMAL REMEDIATION OF WASTES.** (3) (Prerequisite: 306-212) Process technology and environmental concerns in thermal remediation of wastes substances. Focus on the nature and pathways of pollutant streams during thermal treatment of wastes. Concepts for reduction and control of harmful remediation products. Topics include classification of waste properties; design of thermal remediation systems; waste combustion; toxic metal encapsulation, etc. **Professor Kozinski**

**306-560B JOINING PROCESSES.** (3) (Prerequisite: 306-361 or equivalent.) Physics of joining; interfacial requirements; energy sources, chemical, mechanical and electrical; Homogeneous hot-joining, arc-, Mig-, Tig-, gas-, thermite- and Plasma-welding; Autogeneous hot-joining, forge-, pressure-, friction-, explosive-, electron beam- and laser-welding; Heterogeneous hot-joining, brazing, soldering, diffusion bonding; Heterogeneous cold joining, adhesives, mechanical fastening; Filler materials; Joint metallurgy; Heat affected zone, non-metallic systems; joint design and economics; defects and testing methods. **Metallurgy Staff**

**306-561A MATERIALS DESIGN AND SELECTION.** (3) (Prerequisite: 306-362 or equivalent) Advanced topics in materials design problems. Discussion and laboratory work, supplemented by detailed technical reports. Special attention is given to selection, design and failure problems in various materials systems. **Professors Drew, Gruzleski and Yue**

**306-563A HOT DEFORMATION OF METALS.** (3) (Prerequisite: 306-463 or equivalent.) A lecture and seminar course dealing with the high temperature mechanical properties of metals and alloys, with special emphasis on high strength low alloy steels. Topics covered include recovery and recrystallization; precipitation of microalloy carbonitrides; effect of alloy additions on high temperature mechanical properties, both as solutes and as precipitates; effect of multiple alloying; thermo-mechanical treatment and grain size control; examples of industrial controlled rolling schedules. **Professor Yue**

**306-564B X-RAY DIFFRACTION ANALYSIS OF MATERIALS.** (3) (Prerequisite: 306-317 or equivalent.) The techniques of X-ray and neutron diffraction are discussed as applied to the minerals and materials production industries. Special emphasis is placed upon automated X-ray powder diffractometry as employed for determining the structure and composition of materials. The application of X-ray techniques to studies of crystal structure, crystal orientation, residual stress, short-range order in liquid metals, phase diagram determination, order-disorder transformation and chemical analysis are presented. **Professor Szpunar**

**306-565B INTRODUCTION TO CERAMIC ENGINEERING** (3) Introduction to traditional, advanced ceramics and refractories. Crystalline and amorphous ceramics and their structures. Raw materials, fabrication and sintering of ceramics. Glass formation, melting and shaping. Formation of glass-ceramics and their uses. Ceramic – ceramic composites, ceramic and glass fibre reinforcement of polymers. Mechanical, thermal and electrical properties of ceramics and glasses. Applications, design considerations and limitations of ceramics compared with other materials. **Professor Drew**

**306-566A TEXTURE, STRUCTURE AND PROPERTIES OF POLY-CRYSTALLINE MATERIALS.** (3) (Prerequisite: 306-317 or equivalent) Concepts and quantitative methods for the description of the structure of minerals and materials are discussed. Special emphasis is placed on experimental techniques of texture measurement. Procedures are demonstrated for the control of deformation and recrystallization textures in order to obtain the properties required of industrial products. Finally, the correlation between texture and the anisotropy of elastic, plastic and magnetic properties of engineering materials is described and analysed. **Professor Szpunar**

**306-567B ALUMINUM CASTING ALLOYS.** (3) (Prerequisite: 306-361 or equivalent) The family of aluminum foundry alloys; alloy systems, intermetallic phases and their formation, heat treatment processes, mechanical and physical properties of aluminum casting alloys, foundry properties, eutectic modification, porosity formation, gassing and degassing, refinement of hypereutectic alloys, grain refinement, filtration; non-destructive control of microstructure. **Professor Gruzleski**

**306-569B ELECTRON BEAM ANALYSIS OF MATERIALS.** (3) (Prerequisite: 306-317 or equivalent.) Applications of electron beam techniques in minerals and materials engineering are presented. Special emphasis is placed upon scanning and transmission electron microscopy, wavelength and energy dispersive electron probe microanalysis and quantitative image analysis techniques. Applications of electron diffraction, auger electron spectroscopy, E-beam lithography and associated techniques are also discussed. Students are encouraged to take a "hands-on" approach to instrumentation and to design a project suited to their own discipline involving the use of one or more of these techniques. **Professor Yue**

**Courses at the 600 and 700 level require about 3 contact hours per week per semester or equivalent.**

**306-606A,B SELECTED TOPICS IN MINERAL/METAL PRODUCTION AND MARKETING I.** (3) (Prerequisite: permission of instructor.) Introduction of new topics in Mining and Metallurgical Engineering. **Professor Mossop**

**306-608A,B SELECTED TOPICS IN MINERAL/METAL PRODUCTION AND MARKETING II.** (3) (Prerequisite: permission of instructor.) Introduction of new topics in Mining and Metallurgical Engineering. **Professor Mossop**

**306-620A ROCK MECHANICS I.** (3) A study of the effects of rock properties and ground stresses on problems in mine design. **Professors Hassani and Mitri**

**306-621B ROCK MECHANICS II.** (3) The application of the principles of strength of materials to the analysis of problems in ground control. **Professors Hassani and Mitri**

**306-622A,B HEALTH AND SAFETY IN THE MINERAL INDUSTRY.** (3) (Prerequisite: permission of instructor.) A comprehensive review of health, safety and engineering aspects of the mining environment. Radiation hazards and control; airborne contaminants and ventilation; dust control design; noise and vibration control; illumination theory and design. (Course given once per academic year.) **Mining Staff**

**306-623A,B GROUND FRAGMENTATION.** (3) (Prerequisite: permission of instructor.) A comprehensive review of principles and theory of explosives; rock information systems, cratering concepts and applications to mining. (Course given once per academic year.) **Professor Comeau**

**306-624D MATERIALS HANDLING IN MINES.** (6) (Prerequisite: permission of instructor.) A comprehensive review of materials handling systems used in open pit and underground mines. Review of system selection criteria, and analysis of the impact of particular systems on mine design. **Professor Mitri**

**306-625A APPLIED MINERAL ECONOMICS I.** (3) (Prerequisite: permission of instructor.) A study of analytical techniques employed for project evaluation and decision-making in the mineral industry. **Professor Bilodeau**

**306-627B APPLIED MINERAL ECONOMICS II.** (3) (Prerequisite: permission of instructor.) A study of the techniques employed in the analysis of government policy and the financing of projects in the mineral industry. **Professor Bilodeau**

**306-628D,N,E,G MINING ENGINEERING PROJECT I.** (6) A project of the student's choice, undertaken under the direct supervision of at least one staff member. The final mark is assessed on the basis of a final report which is examined internally, by the supervisor and at least one other staff member. **Mining Staff**

**306-629D,N,E,G MINING ENGINEERING PROJECT II.** (6) Continuation of Mining Engineering Project I. **Mining Staff**

**306-633A INDUSTRIAL EXPLOSIVES.** (4) (Prerequisite: 306-322 and/or Permission of instructor.) Development of industrial explosives and propellants, with particular application to mining, metallurgical and petroleum industries. Chemistry and physics of reactive materials; initiation and detonation process; commercial explosives; rock blasting and explosive energy transfer; specialized blasting techniques; explosive welding and forming; principles of shaped charges; miscellaneous industrial applications. **Professor Mohanty**

**306-634A,B,L MINING ENGINEERING PROJECT III.** (3) Continuation of Mining Engineering Project I. **Mining Staff**

**306-635A,B,L THE FINITE ELEMENT METHOD IN ROCK MECHANICS.** (4) (Prerequisites: 306-521 and/or permission of instructor.) Equilibrium equation solvers; elasticity theory; finite element formulative procedures; convergence and accuracy; 2-D and 3-D isoparametric elements; rock failure criteria; applications to rock/mining engineering; computer programming using available software library (FELIBS) and packages. **Professor Mitri**

**306-636A BOUNDARY ELEMENTS IN GEOMECHANICS.** (4) (Prerequisite: 308-208 or equivalent, and 306-521 or permission of instructor.) Applications of boundary element methods in geomechanics. Elasticity relations. Coordinate transformations. Kelvin's problem, constant tractions, fictitious stress method, symmetry conditions. Displacement discontinuity method. Yield and deformation joint models. Stress and displacement analysis of underground openings in faulted rock. Initial joint deformation technique. Introduction to nonlinear analysis. **Professor Mitri**

**306-638A MINE WASTE MANAGEMENT.** (4) Nature and generation of mine waste. Characteristics of mine waste material. Surface and underground disposal methods. Surface impoundment. Tailing embankment design and stability analysis. Seepage and containment transport. Seepage control methods. Site reclamation. Computer applications in design and monitoring. Case histories. **Professors Keira and Hassani**

**306-639B MANAGEMENT TECHNIQUES FOR ENGINEERING SERVICES OF MINING PROJECTS.** (3) Project phases: preparation of proposals, feasibility studies, tender documents, instrumentation and monitoring during mine development. Project controls: organization charts, scheduling, quality assurance and control, site inspection. Engineering services: budget and manpower, performance analysis, maintenance and filing, policies and administrative procedures. **Professor Keira**

**306-640D ADVANCED MINERAL PROCESSING.** (6) Modern advances in mineral processing techniques. **Professors Finch and Laplante**

**306-650D TRANSPORT PHENOMENA IN PROCESS ENGINEERING METALLURGY.** (6) Metallurgical applications of heat, mass and momentum transfer theories. Particular emphasis is placed on the

applications of computational fluid dynamics and development of appropriate software programs. These are based on the integral control volume, finite difference approach, employing body-fitted co-ordinate schemes to handle arbitrarily shaped flow domains. Turbulence models such as K-E and large eddy simulation are presented. **Professor Hasan**

**306-652B AQUEOUS PROCESSING.** (3) Advanced treatment of the chemical and engineering principles governing aqueous dissolution, purification and deposition operations. Topics include: ionic activities of dilute and concentrated solutions; solution and solid-liquid equilibria; analysis of complexation and redox reactions; high temperature solution thermodynamic kinetics; solvent extraction, equilibria and mass transfer kinetics; nucleation, growth and agglomeration phenomena in aqueous precipitation systems. **Professor Demopoulos**

**306-653A,B TRANSPORT PHENOMENA IN PROCESS METALLURGY.** (3) Process metallurgical applications of heat, mass and momentum transport theories. Methods of numerical solution in the analysis of: continuous casting, ingot solidification, soaking pits, hot mill operations, alloy addition methods in steel-making, etc. Students are assigned individual computer projects and present a report plus a seminar on their findings. **Professor Hasan**

**306-657A ADVANCED EXTRACTIVE METALLURGY.** (3) Field trips focusing on non ferrous metallurgy: energy considerations and minor elements in production and refining of aluminum, copper, gold, titania slag, zinc and other metals. Advanced technology and process design. Visits will reflect instructor's and students' interests. **Professor Harris**

**306-665A ADVANCED CERAMIC AND COMPOSITE MATERIALS.** (3) Advanced topics in structural, electronic ceramics and composites. Current areas of research. Specialized property requirements. Novel processing and fabrication techniques. New and future developments of these materials. **Professor Drew**

**306-670D RESEARCH SEMINAR.** (6) For students registered for a Master's degree in Metallurgy. **Metallurgy Staff**

**306-672D ROCK MECHANICS AND GEOPHYSICS SEMINAR.** (6) Theoretical and practical aspects of ground control practice using the case study method. **Professor Hassani**

**306-673D,N,E,G MINING ENGINEERING SEMINAR.** (6) For students registered in the Graduate Diploma or Master's programs in Mining. **Professor Mitri**

**306-680D,E,G METALLURGICAL/MATERIALS ENGINEERING PROJECT I.** (6)

**306-681D,E,G METALLURGICAL/MATERIALS ENGINEERING PROJECT II.** (6)

**306-682A,B,C METALLURGICAL/MATERIALS ENGINEERING PROJECT III.** (3)

**306-690D,N,E,G,B THESIS RESEARCH I.** (6)

**306-691A,B,L THESIS RESEARCH II.** (3)

**306-692D,N,E,G,B THESIS RESEARCH III.** (6)

**306-693A,B,L THESIS RESEARCH IV.** (3)

**306-694D,N,E,G,B THESIS RESEARCH V.** (6)

**306-695A,B,L THESIS RESEARCH VI.** (3)

**306-771D RESEARCH SEMINAR.** (6) For students registered in a Ph.D. program in Metallurgy. **Metallurgy Staff**

**306-776D MINING RESEARCH SEMINAR.** (6) For students registered in a Ph.D. program in Mining. **Professor Mitri**

**306-780A,B,C,T PH.D. THESIS RESEARCH PROPOSAL** (4) For students registered in a Ph.D. program in Metallurgy. Student submits a document and takes an oral examination to demonstrate familiarity with relevant literature, define a methodology and describe a work plan. **Metallurgy Staff**

**Undergraduate Courses**

The following undergraduate courses are available to graduate students who have not taken an equivalent course. Please consult the Undergraduate Programs Calendar for descriptions.

<b>306-200A MINING TECHNOLOGY.</b>	<b>Professor Mossop</b>
<b>306-320B EXTRACTION OF ENERGY RESOURCES.</b>	<b>Professor Hassani</b>
<b>306-322B ROCK FRAGMENTATION.</b>	<b>Professor Comeau</b>
<b>306-323B ROCK AND SOIL MASS CHARACTERIZATION.</b>	<b>Professor Hassani</b>
<b>306-419C OR T SURFACE MINING.</b>	<b>Mining Staff</b>
<b>306-420B FEASIBILITY STUDY.</b>	<b>Professor Mossop and Professor Bilodeau</b>
<b>306-426C OR T DEVELOPMENT AND SERVICES.</b>	<b>Professor Mossop</b>
<b>306-341B INTRODUCTION TO MINERAL PROCESSING.</b>	<b>Professor Finch</b>

**52 Music**

Faculty of Music  
Strathcona Music Building  
555 Sherbrooke Street West  
Montreal, QC  
Canada H3A 1E3  
Telephone: (514) 398-4469  
Fax: (514) 398-8061

*Dean, Faculty of Music, and  
Chair, Committee on Graduate Studies* — R. Lawton  
*Chair, Department of Theory* — B. Minorgan  
*Chair, Department of Performance* — E. Plawutsky

**52.1 Staff***Emeritus Professors*

B. Hambræus; Fil Kand(M.A.), Fil Lic(Ph.D.), Fil Dr.(Hon.C.)  
(Uppsala); F.R.A.M.(Sweden)  
K. Jones; L.Mus., B.Mus.(Mt.All.), B.Mus., Mus.Dc.(Tor.)  
D. Morton; Graduate, Conservatoire de Musique de Québec

*Professors*

B. Cherney; Mus.Bac., Mus.M., Ph.D.(Tor.)  
R. Gibson; B.S., M.F.A., Ph.D.(Minn.)  
J. Grew; L.T.C.L.(Lond.), B.Mus.(Mt. All.), M.Mus.(Mich.)  
D.D.(U.T.C.); LL.D.(Mt.All.); University Organist  
A. Lanza; Graduate, Instituto Torcuato Di Tella(Buenos Aires)  
B. Mather; B.Mus.(Tor.), M.A.(Stan.), Mus.Doc.(Tor.)  
B. Pennycook; B.Mus. M.Mus.(Tor.), D.M.A.(Stan.)  
J. Rea; B.Mus.(Wayne St.), M.Mus.(Tor.), M.F.A., Ph.D.(Prin.)  
C. Reiner; Graduate, Conservatoire de Genève  
W. Woszczyk; M.A., Ph.D.(F. Chopin Academy of Music, Warsaw)

*Associate Professors*

D. Bartlett; A.R.A.M.(Lond.), LL.D.(Leth.)  
T. Baskin; B.Mus.(Curtis), M.Mus.(Auck.), Principal Oboe,  
Montreal Symphony  
P. Béluse; Graduate, Conservatoire de Musique de Québec  
W. Caplin; B.M.(S.Calif.), M.A., Ph.D.(Chic.)  
E. Costa-Giomi; Profesora Superior de Musica (National Cons.,  
Buenos Aires), Ph.D.(Ohio)  
J. Cumming; B.A.(Col.), M.A., Ph.D.(Calif.)  
K. Dean; B.M.E.(Iowa), M.Mus.(Miami)  
I. Edwards; B.Mus.(U.Coll. of Wales)  
L. Evans; Dip.(Vincent d'Indy)  
G. Foote; B.Sc., M.A.(Minn.)  
P. Helmer; B.A.(Tor.), M.A., Ph.D.(Col.)  
S. Huebner; B.A., B.Mus., L.Mus.(McG.), M.F.A., Ph.D.(Prin.)

T. Hutchins; Dip. L.G.S.M.(Guildhall), B.A.Hons.Mus.(Dal.),  
Principal Flute, Montreal Symphony  
J. Jarczyk; B.A., M.A.(Academy of Music, Cracow), Dip.(Berklee)  
A. Kestenberg  
H. Knox; B.Mus., M.Mus.(McG.)  
R. Lawton; B.Mus.(McG.), M.Mus.(Ind.)  
T. Levitz; B.Mus.(McG.), M.A.(Technische Universität, Berlin),  
Ph.D.(Eastman)  
A. Lysy; P.P.(Royal Northern Coll.), Dip.(Menuhin Academy,  
Gstaad), Performer's Dip.(Maast. Cons., Nether.)  
D. McLean; Mus.Bac., M.A., Ph.D.(Tor.)  
D. McNabney; B.Mus.(Tor.), M.M.(W.Ont.), Mus.Doc.(Montr.)  
M. Mdivani; Post-graduate Dip.(Moscow Cons.)  
B. Minorgan; B.Mus.(Br.Col.), M.A.(Tor.)  
W. Neill; B.Mus., M.Mus.(Texas at Austin)  
L.P. Pelletier; Premier Prix (Conservatoire de Musique de Québec)  
T. Plaunt; B.A.(Tor.), Graduate, Nordwestdeutsche  
Musikakademie (Detmold, Germany)  
E. Plawutsky; Graduate, Conservatoire de Musique de Québec,  
L.Mus., B.Mus.(McG.), M.A.(Tor.)  
P. Schubert; B.A., M.A., Ph.D.(Col.)  
J. Simons  
E. Stuble; B.Mus.(Tor.), M.Mus.(Bran.), Ph.D.(Illinois)  
B. Turgeon; Dip.(Toronto Opera School), Dip.(R.C.M.),  
Dip.(Vienna Staatsoper)  
T. Vernon; Graduate, Hochschule für Musik(Vienna),  
Dip.(Academmmia Chigiana, Italy), Dip.(Mozarteum, Salzburg)  
J. Wapnick; B.A.(N.Y.), M.A.(S.U.N.Y.), M.F.A.(Sarah L.),  
Ed.D.(Syr.)  
T. Williams; B.Mus.(Bran.)  
J. Zirbel; B.Mus.(Wis.), Principal Horn, Montreal Symphony  
L. Zuk; L.Mus.(McG.), Graduate, Conservatoire de Musique de  
Québec

*Assistant Professors*

J. Baboukis; B.A.(Haverford), M.Mus.(S.U.N.Y.), D.Mus.(Ind.)  
Y. Berick; B.Mus., Artist Dip.(Cinn.)  
D. Bouliane; B.Mus., M.Mus.(Laval)  
B. Bower; B.Mus., M.Mus.(Mich.); Montreal Symphony  
C. Christie; B.Mus.(McG.); Montreal Symphony  
J. Klepko; B.F.A.(C'dia.), M.Mus.(McG.)  
R. Roberts; B.Mus.(Ind.); Concertmaster, Montreal Symphony  
D. Ross-Neill; B.Mus.(N. Carolina), M.Mus.(Texas)  
M. Saint-Cyr; B.A.(Laval), Premier Prix (Cons. de Mus. de Qué.),  
Concert Dip.(Hochschule für Musik, Karlsruhe)  
P. Sullivan; Principal Trombone, Montreal Symphony  
T. Talamantes; B.Mus.(Ind.), M.Mus.(McG.)  
A. White; B.A.(C'dia.), M.Mus.(McG.)

**52.2 Programs Offered**

The Master of Arts degree (M.A.) is available as a thesis option in Music Education, Music Technology, Musicology, and Theory and as a non-thesis option in Music Education, Musicology, and Theory.

The Master of Music degree (M. Mus.) is available in Composition, Performance, and Sound Recording. Within the Performance option are offered specializations in: piano, guitar, orchestral instruments, organ, conducting, chamber music, orchestral training, piano accompaniment, vocal, opera, vocal pedagogy, early music, church music - organ, and jazz.

The Doctor of Music degree (D.Mus.) is offered in Composition while the Doctor of Philosophy degree (Ph.D.) is available in Music Education, Musicology, and Theory. Interdisciplinary studies involving Musicology or Theory are encouraged.

There are opportunities for graduate students to obtain funding by being hired as assistants through the Faculty of Music. Positions are available as: teaching assistants, apprentice writers for program notes and Music McGill, sound recording technicians, dubbing technicians, correctors, and invigilators. Inquiries should be directed to the Chair of the Department of Theory or the Chair of the Department of Performance, as appropriate.



## 52.3 Admission Requirements

### Masters' Degrees

Applicants for the Master's degree must hold a B.Mus. or a B.A. degree with a Major or Honours in Music including considerable work done in the area of specialization.

All applicants (except those for performance and sound recording) will be required to take placement examinations. Applicants found to be deficient in their background preparation may be required to take certain additional undergraduate courses.

Applicants to the Composition, Music Education, Music Technology, Musicology, Sound Recording, and Theory programs are requested to submit samples of work done in their special area.

Applicants to the Music Education program should normally have had two years of teaching experience.

All applicants to the Performance program will be required to pass an entrance audition. Only those applicants who clearly demonstrate the potential to become professional performers on their instruments will be admitted.

Applicants to the Vocal Pedagogy option should have a minimum of three to four years experience in studio teaching.

A reading knowledge of German is strongly recommended as a prerequisite for graduate work in Music Education, Musicology, and Theory.

### Prerequisite Undergraduate Courses for M.Mus. – Sound Recording

In order to be considered for admission to the Master of Music in Sound Recording, students must attain a minimum grade of B in all of the courses listed below and must have a B.Mus. degree with a minimum CGPA of 3.00

#### Faculty of Music

213-260A Instruments of the Orchestra  
 213-241A Electroacoustic Music Techniques I  
 213-242B Electroacoustic Music Techniques II  
 216-232A or B Introduction to Electronics  
 216-300D Introduction to Music Recording  
 216-305A or B Personal Computer Applications in Music  
 216-339A or B Introduction to Electroacoustics

#### Faculty of Science

189-112A Fundamentals of Mathematics  
 198-224A Physics and Psychophysics of Music  
 198-225B Musical Acoustics

### Prerequisite Undergraduate Courses for M.Mus. – Performance

#### Piano Accompaniment

An undergraduate major in Piano.  
 214-570 Research Methods in Music  
 One of:

214-372A or B Solo Song outside Germany & Austria  
 214-390A or B The German Lied

Two of:

242-210A Italian Diction (or equivalent)  
 242-211B French Diction (or equivalent)  
 242-212A English Diction (or equivalent)  
 242-213B German Diction (or equivalent)

#### Orchestral Conducting

213-260A Instruments of the Orchestra  
 213-261B Elementary Orchestration  
 213-460D Orchestration  
 214-389A or B Orchestral Literature  
 214-570 Research Methods in Music  
 223-201A String Techniques  
 223-202A Woodwind Techniques  
 223-203A or B Brass Techniques  
 223-204A or B Percussion Techniques  
 242-315D Introduction to Orchestral Conducting (or equivalent)

#### Choral Conducting

129-202D German

213-260A Instruments of the Orchestra  
 213-261B Elementary Orchestration  
 214-397A or B Choral Literature after 1750  
 214-570 Research Methods in Music  
 221-415B Choral Conducting II (or equivalent)  
 253-130A or B Voice Concentration

#### Wind Band Conducting

An undergraduate major in Wind or Percussion instruments  
 213-260A Instruments of the Orchestra  
 213-261B Elementary Orchestration  
 214-398A or B Wind Ensemble Literature after 1750  
 214-570 Research Methods in Music  
 223-202A Woodwind Techniques  
 223-203A or B Brass Techniques  
 223-204A or B Percussion Techniques  
 223-415B Instrumental Conducting II (or equivalent)

#### Early Music (Voice students only)

214-570 Research Methods in Music  
 Two of:  
 242-210A Italian Diction (or equivalent)  
 242-211B French Diction (or equivalent)  
 242-212A English Diction (or equivalent)  
 242-213B German Diction (or equivalent)

#### Jazz Performance

214-393A or B History of Jazz  
 240-440D Advanced Jazz Composition  
 240-461D Advanced Jazz Arranging  
 240-493A or B Jazz Performance Practice

#### D.Mus. Degree

Applicants for the D.Mus. degree must hold an M.Mus. degree in Composition, or its equivalent, and must submit scores and/or tapes of their compositions at the time of application.

#### Ph.D. Degree

Applicants for the Ph.D. degree must hold an M.A., or a Bachelor's degree equivalent to a McGill Honours degree, in Music Education, Music History, or Theory. Applicants with a Bachelor's degree will normally be admitted to the M.A. program for the first year and may apply for admittance to the Ph.D. program after the completion of one full year of graduate course work. Qualified applicants who have already completed an appropriate Master's degree will be admitted to the second year of the program.

## 52.4 Application Procedures

Applications will be considered upon receipt of:

1. application form;
2. transcripts;
3. letters of reference;
4. \$60 application fee;
5. \$40 audition fee;
6. submissions appropriate to area of specialization;
7. TOEFL test results.

All information is to be submitted to Vernoica Slobodian, Admissions Officer, Faculty of Music.

Deadline date for submission of application and accompanying documentation is January 15.

All applicants are requested to submit samples of their work completed during their previous studies. Those applying for the first time will be required to take placement examinations.

## 52.5 Program Requirements

### Masters' Degrees

The minimum residence requirement for Masters' programs is 1½ years (3 full-time terms); for Sound Recording, 2 years (4 full-time terms). In all programs a minimum number of formal courses are prescribed. The student's major work is expected to be thesis, research, composition or performance which will be

done under the supervision of an adviser. This work, as well as any additional courses and/or individual study which the Department considers necessary, constitutes the central part of each program.

Applicants who hold the equivalent of a McGill B.Mus. with Honours in the area of specialization may be able to complete the Master's degree in less than two years.

#### **Master of Music – Composition (thesis)** (48 credits)

213-622D Composition Tutorial.

Two of 213-631A, 213-632B, 213-633A, 213-634B, 213-635A, 213-636B Seminar in 20th-Century Music.

Two approved 3-credit electives or the equivalent.

Language reading examination in one of: French, German, or Italian. Students whose mother tongue is French are exempt from the French Language Reading examination.

Thesis (30 credits). The thesis is a composition, accompanied by an analytical essay of approximately 20 to 30 pages.

#### **M.A. in Music – Music Education (thesis)** (48 credits)

Five 3-credit courses approved by the Department, normally three of these will be Seminars in Music Education.

Thesis (33 credits). The candidate will undertake supervised research leading to a thesis which will be an in-depth investigation in some specialized field of music education.

#### **M.A. in Music – Music Technology (thesis)** (48 credits)

216-605A or B Digital Sound Synthesis & Audio Processing.

Two of 216-610A, 216-611B, 216-612A, 216-613B, 216-614A, 216-615B Computer Music Seminar.

Two 3-credit electives, approved by the Department.

Thesis (33 credits). The candidate will undertake supervised research leading to a thesis which will utilize or investigate computer applications in one of the following areas of music study and practice: performance, jazz, sound recording, theory, composition, music education, musicology.

Note: A reorganization of the program under the designation "Music, Media and Technology" is currently under consideration.

#### **M.A. in Music – Musicology (thesis)** (48 credits)

Four 3-credit courses approved by the Department, normally at least two of these will be Seminars in Musicology.

214-529 Proseminar in Musicology.

Language reading examinations in German and one additional language related to the candidate's field of research. Students whose mother tongue is French are exempt from the French Language Reading examination.

Thesis (33 credits). The candidate will undertake supervised research leading to a thesis which will be an in-depth investigation in some specialized field of musicology.

#### **Master of Music – Sound Recording (thesis)** (60 credits)

##### **Required Courses** (51 credits)

216-629D	(4)	Technical Ear Training
216-667A or B	(3)	Digital Studio Technology
216-668A or B	(3)	Digital/Analog Audio Editing
216-669A or B	(3)	Topics - Classical Music Recording
216-670D	(10)	Recording Theory & Practice I
216-671D	(10)	Recording Theory & Practice II
216-672D	(6)	Analysis of Recordings
216-674A or B	(3)	Electronic and Electroacoustic Meas.
216-677D	(6)	Audio for Video Post-Production
216-678B	(3)	Advanced Digital Editing and Post-Production

##### **Elective Courses** (9 credits)

three 3-credit graduate electives

Note: A reorganization of the program under the designation "Music, Media and Technology" is currently under consideration.

#### **M.A. in Music – Theory (thesis)** (48 credits)

Five 3-credit courses approved by the Department, normally three will be Seminars in Music Theory and either 211-658 History of Music Theory I or 211-659 History of Music Theory II

Language reading examination in German.

Thesis (33 credits). The candidate will undertake supervised research leading to a thesis which will be an in-depth investigation in some specialized field of music theory.

#### **Non-thesis M.A. in Music (options in Music Education, Musicology, and Theory)** (45 credits)

Seven 3-credit courses approved by the appropriate Area, four of which must be in the Area itself.

For students in the Musicology Area, one of the courses must be 214-529 Proseminar in Musicology.

For students in the Theory Area, one of the courses must be 211-658 History of Music Theory I or 211-659 History of Music Theory II.

For students in Music Education, and with the approval of the Music Education Area, two of the seven 3-credit courses may be taken in the Faculty of Education.

219-614 Reading Course I and 219-615 Reading Course II.

219-635 Research Paper I and 219-636 Research Paper II.

Language reading examination (for students in Musicology and Theory, this is normally German; not required for Music Education students).

#### **Master of Music – Performance Solo – Piano, Guitar, Orchestral Instruments, Organ, Conducting** (45 credits)

242-620A, 242-621B, 242-622A Performance Tutorials.

**One** of 215-690A, 215-691B, 215-692A, 215-693B, 215-694A or 215-695B Performance Practice Seminar.

Electives:

One graduate 3-credit seminar with the prefix 211-, 213-, 214-, 215-, 219-, 222-.

One additional graduate 3-credit seminar.

Recitals:

242-660 Solo Recital I and 242-667 Solo Recital II (one of these could optionally include some chamber music).

(Wind Band Conducting – not available 1999-2000)

#### **Master of Music – Performance Chamber Music** (48 credits)

(All instruments except Early Music Instruments, Organ and Double Bass.)

242-620A, 242-621B, 242-622A Performance Tutorials.

**One** of 215-690A, 215-691B, 215-692A, 215-693B, 215-694A or 215-695B Performance Practice Seminar.

Electives:

One graduate 3-credit seminar with the prefix 211-, 213-, 214-, 215-, 219-, 222-.

One additional graduate 3-credit seminar.

Recitals:

242-661 Chamber Music Recital I and 242-668 Chamber Music Recital II (one of these could optionally include some solo music).

Ensembles:

**Three terms** of 243-660 Chamber Music Ensemble.

#### **Master of Music – Performance Orchestral Training – Orchestral Instruments** (45 credits)

242-620A, 242-621B, 242-622A Performance Tutorials.

**One** of 215-690A, 215-691B, 215-692A, 215-693B, 215-694A or 215-695B Performance Practice Seminar.

Practice Seminar.

Electives:

One graduate 3-credit seminar with the prefix 211-, 213-, 214-, 215-, 219-, 222-.

One additional graduate 3-credit seminar.

Recital/Exam:

242-660 Solo Recital I and 242-664 Repertoire Examination.

Ensembles:

**Three terms** of 243-697 Orchestra.

**Master of Music – Performance****Piano Accompaniment** (45 credits)

242-620A, 242-621B, 242-622A Performance Tutorials.

**One** of 215-690A, 215-691B, 215-692A, 215-693B, 215-694A or 215-695B Performance

Practice Seminar **or** 253-690A or B Vocal Styles & Conventions.

Electives:

One graduate 3-credit seminar with the prefix 211-, 213-, 214-, 215-, 219-, 222-.

One additional graduate 3-credit seminar.

Recital/Exam:

242-660 Solo Recital I and 242-663 Quick Study (to be successfully completed before the first recital is performed).

Ensembles:

**Two terms** of 243-679 Song Interpretation and 243-684 Studio Accompanying  
**or three terms** of 243-596 Opera Repetiteur.

**Master of Music – Performance****Vocal Performance** (49 credits)

242-620A, 242-621B, 242-622A Performance Tutorials.

**One** of 215-690A, 215-691B, 215-692A, 215-693B, 215-694A or 215-695B Performance Practice Seminar **or** 253-690A or B Vocal Styles & Conventions.

Electives:

One graduate 3-credit seminar with the prefix 211-, 213-, 214-, 215-, 219-, 222-.

One additional graduate 3-credit seminar (this must have the prefix 253-).

Recitals:

242-660 Solo Recital I and 242-667 Solo Recital II.  
253-600A and 253-601B Vocal Repertoire Coaching.

**Master of Music – Performance****Opera Performance** (45 credits)

242-620A, 242-621B, 242-622A Performance Tutorials.

**One** of 215-690A, 215-691B, 215-692A, 215-693B, 215-694A or 215-695B Performance Practice Seminar **or** 253-690A or B Vocal Styles & Conventions.

Electives:

One graduate 3-credit seminar with the prefix 211-, 213-, 214-, 215-, 219-, 222-.

One additional graduate 3-credit seminar (this must have the prefix 253-).

Recital:

242-660 Solo Recital I and 242-658 Opera Performance Examination.

Ensembles:

**Three terms** of 243-696 Opera Theatre.

**Master of Music – Performance****Vocal Pedagogy** (47 credits)

242-620A, 242-621B, 242-622A Performance Tutorials.

**One** of 215-690A, 215-691B, 215-692A, 215-693B, 215-694A or 215-695B Performance Practice Seminar **or** 253-690A or B Vocal Styles & Conventions.

Electives:

One graduate 3-credit seminar with the prefix 211-, 213-, 214-, 215-, 219-, 222-.

One additional graduate 3-credit seminar (this must have the prefix 253-).

Recital:

242-660 Solo Recital I.  
242-611A, 242-612B, 242-613A Directed Teaching  
242-650D Pedagogy Workshop.  
253-600A or 253-601B Vocal Repertoire Coaching.

**Master of Music – Performance****Early Music** (48 credits)

(Voice, baroque flute, recorder, baroque oboe, baroque violin, baroque viola, baroque cello, viola da gamba, harpsichord)

242-620A, 242-621B, 242-622A Performance Tutorials.

**One** of 215-690A, 215-691B, 215-692A, 215-693B, 215-694A or 215-695B Performance Practice Seminar.

Electives:

One graduate 3-credit seminar with the prefix 211-, 213-, 214-, 215-, 219-, 222-.

One additional graduate 3-credit seminar.

Recitals:

242-660 Solo Recital I and 242-662 Solo and Chamber Music Recital.

Ensembles:

**Three terms** of 243-661 Early Chamber Music Ensemble.

**Master of Music – Performance****Church Music - Organ** (45 credits) (Under revision)

242-620A, 242-621B, 242-622A (1 hr./wk.) or 242-630A and 242-631B (1½ hrs./wk.) Performance Tutorials.

**One** of 215-690A, 215-691B, 215-692A or 215-693B Performance Practice Seminar.

214-570A or B Research Methods in Music.

Recital:

242-660 Solo Recital I.

Courses:

242-616A or B Master Class - Choral Conducting

242-676D Special Project in Performance II

**One** of 242-672D Liturgical Improvisation, 242-674A or B Seminar in Organ Registration, or 242-699D Church Service Playing

One 3-credit elective, to be selected from the list of approved electives.

**Master of Music – Performance****Jazz Performance** (47 credits)

(Saxophone, Trumpet, Trombone, Drums, Piano, Guitar, Bass, Voice)

242-620A, 242-621B, 242-622A (1 hr./wk.) or 242-630A and 242-631B (1½ hrs./wk.) Performance Tutorials.

Recital:

242-660 Solo Recital I

242-659D Performance in Recording Media

Ensemble:

243-695A and B Jazz Ensemble.

Courses:

240-601A or B Jazz Pedagogy

240-640D Jazz Composition & Arranging

**Courses approved as electives for M.Mus. students in Performance:**

211-652A Seminar in Music Theory I

211-653B Seminar in Music Theory II

211-654A Seminar in Music Theory III

211-655B Seminar in Music Theory IV

211-656A Seminar in Music Theory V

211-657B Seminar in Music Theory VI

211-658A History of Music Theory I

211-659B History of Music Theory II

213-552A Computer Applications in Music

213-623A Electronic Music Seminar I

213-624B Electronic Music Seminar II

213-631A Seminar in 20th-Century Music I

213-632B Seminar in 20th-Century Music II

213-633A Seminar in 20th-Century Music III

213-634B Seminar in 20th-Century Music IV

213-635A Seminar in 20th-Century Music V

213-636B Seminar in 20th-Century Music VI

214-591D Paleography

214-653B Music Aesthetics and Criticism

214-680A Seminar in Musicology I

214-681B Seminar in Musicology II

214-682A Seminar in Musicology III

214-683B Seminar in Musicology IV

214-684A Seminar in Musicology V

214-685B Seminar in Musicology VI

214-692A Seminar in Music Literature I  
 214-693B Seminar in Music Literature II  
 214-694A Seminar in Music Literature III  
 214-695B Seminar in Music Literature IV  
 214-696A Seminar in Music Literature V  
 214-697B Seminar in Music Literature VI  
 215-690A Performance Practice Seminar I  
 215-691B Performance Practice Seminar II  
 215-692A Performance Practice Seminar III  
 215-693B Performance Practice Seminar IV  
 215-694A Performance Practice Seminar V  
 215-695B Performance Practice Seminar VI  
 222-610A Seminar in Music Education I  
 222-611B Seminar in Music Education II  
 222-612A Seminar in Music Education III  
 222-613B Seminar in Music Education IV

### Doctor of Music (D.Mus.) Degree Requirements

A minimum of two years' residence is required beyond the M.Mus. in Composition, or its equivalent.

213-722D Doctoral Composition Tutorial (for two years).

Four approved 3-credit electives or the equivalent.

219-701D Doctoral Oral Comprehensive Examination and

219-702D Doctoral Written Comprehensive Examination.

Composition Performance. The candidate must present a concert of his/her compositions. With the permission of the Committee on Graduate Studies, the compositions may be presented as parts of two or three concerts.

Thesis. A musical composition of major dimensions together with a written analysis of the work. The thesis must be defended in an oral examination.

Details concerning the comprehensive examinations, composition performance, thesis and academic regulations are available from the Admissions Officer, Faculty of Music or the Secretary for Graduate Studies, Faculty of Music.

### Ph.D. Degree Requirements

The Ph.D. requires a minimum of three years of full-time resident study (6 full-time terms) beyond a Bachelor's degree. A candidate who holds a Master's degree in the area of specialization may, on the recommendation of the Department, be permitted to count the work done for the Master's degree as the first year of resident study.

Ten 3-credit courses approved by the Department (the Doctoral Tutorial will be considered a course for purposes of this requirement). Applicants who have completed an M.A. degree before entering the Ph.D. program will be required to complete at least five approved 3-credit courses beyond the M.A. requirements.

Language reading examinations in two foreign languages (one foreign language for students in music education; none required for students in music technologies). Normally, one of these will be German and the other related to the candidate's field of research. A third language may be required if considered necessary for the candidate's research. Students whose mother tongue is French are exempt from the French Language Reading examination.

Comprehensive examinations, both written and oral. The language reading examinations must be passed before a candidate will be permitted to sit the Comprehensive Examinations. Participation in 219-705D Colloquium.

Doctoral Dissertation. All courses and language requirements and the comprehensive examinations must be successfully completed before the dissertation is submitted.

## 52.6 Graduate Courses

### Seminars

Topics for graduate seminars vary from year to year and are normally chosen according to the individual instructor's areas of research expertise. A list of detailed seminar descriptions can be obtained from the Secretary for Graduate Studies prior to fall

registration. The following sampling of seminars given in recent years (though not necessarily to be offered in the upcoming year) indicate the scope of course offerings.

**Seminar in Music Literature:** The Music of Bela Bartok; The Symphonies of Beethoven; The Nineteenth-century French Symphony; The Choral Music of Johannes Brahms; French opera from Carmen to Pelléas

**Seminar in Music Theory:** Theory and Analysis of Classical Form; Mathematical Set and Group Theory Models; Theories of Musical Rhythm and Meter

**Seminar in Musicology:** Beethoven Style Periods; The "Roman de Fauvel"; The German Lied; Problems in Verdi Studies

**Seminar in Performance Practice:** Late Renaissance Performance Practice; Baroque Performance Practice; Performance Practice of the Beethoven Piano Sonatas

**Seminar in Music Education:** Music Criticism and Music Education; Musical Ability; Aesthetics, Music, and Music Education

**Seminar in Twentieth Century Music:** Music After 1945; The Symphony in the Twentieth Century; The Music of Olivier Messiaen

(Enrolment in seminars will normally be limited to 10.)

● Denotes not offered in 1999-2000.

The course credit weight is given in parentheses (#) after the course title.

Not all courses listed below will be offered in 1999-2000; for an up-to-date listing, please consult the final Music Graduate Course Timetable for 1999-2000.

● 211-641A ADVANCED COUNTERPOINT I. (3) (2 hours)

● 211-642B ADVANCED COUNTERPOINT II. (3) (2 hours)

211-648A THEORY TUTORIAL. (3)

211-649B THEORY TUTORIAL. (3)

211-652A SEMINAR IN MUSIC THEORY I. (3) (3 hours)

211-653B SEMINAR IN MUSIC THEORY II. (3) (3 hours)

211-654A SEMINAR IN MUSIC THEORY III. (3) (3 hours)

211-655B SEMINAR IN MUSIC THEORY IV. (3) (3 hours)

211-656A SEMINAR IN MUSIC THEORY V. (3) (3 hours)

211-657B SEMINAR IN MUSIC THEORY VI. (3) (3 hours)

211-658A HISTORY OF MUSIC THEORY I. (3) (3 hours) Selected topics in the history of music theory from Greek antiquity to 1700 through readings of primary and secondary literature.

211-659B HISTORY OF MUSIC THEORY II. (3) (3 hours) Selected topics in the history of music theory from 1700 to the present through readings of primary and secondary literature.

213-552A COMPUTER APPLICATIONS IN MUSIC. (3) (3 hours)

213-622D COMPOSITION TUTORIAL. (6)

● 213-623A ELECTRONIC MUSIC SEMINAR I. (3) (3 hours seminar, 6 hours studio time)

● 213-624B ELECTRONIC MUSIC SEMINAR II. (3) (3 hours seminar, 6 hours studio time)

● 213-625D MUSIC NOTATION SEMINAR. (6) (3 hours)

213-631A SEMINAR IN 20TH-CENTURY MUSIC I. (3) (3 hours)

213-632B SEMINAR IN 20TH-CENTURY MUSIC II. (3) (3 hours)

213-633A SEMINAR IN 20TH-CENTURY MUSIC III. (3) (3 hours)

213-634B SEMINAR IN 20TH-CENTURY MUSIC IV. (3) (3 hours)

213-635A SEMINAR IN 20TH-CENTURY MUSIC V. (3) (3 hours)

213-636B SEMINAR IN 20TH-CENTURY MUSIC VI. (3) (3 hours)

213-722D DOCTORAL COMPOSITION TUTORIAL.

● 214-653B MUSIC AESTHETICS AND CRITICISM. (3) (3 hours)

214-678A MUSICOLOGY TUTORIAL. (3)

214-679B MUSICOLOGY TUTORIAL. (3)

214-680A SEMINAR IN MUSICOLOGY I. (3) (3 hours)

- 214-681B SEMINAR IN MUSICOLOGY II.** (3) (3 hours)
- 214-682A SEMINAR IN MUSICOLOGY III.** (3) (3 hours)
- 214-683B SEMINAR IN MUSICOLOGY IV.** (3) (3 hours)
- 214-684A SEMINAR IN MUSICOLOGY V.** (3) (3 hours)
- 214-685B SEMINAR IN MUSICOLOGY VI.** (3) (3 hours)
- 214-692A SEMINAR IN MUSIC LITERATURE I.** (3) (3 hours)
- 214-693B SEMINAR IN MUSIC LITERATURE II.** (3) (3 hours)
- 214-694A SEMINAR IN MUSIC LITERATURE III.** (3) (3 hours)
- 214-695B SEMINAR IN MUSIC LITERATURE IV.** (3) (3 hours)
- 214-696A SEMINAR IN MUSIC LITERATURE V.** (3) (3 hours)
- 214-697B SEMINAR IN MUSIC LITERATURE VI.** (3) (3 hours)
- 215-690A PERFORMANCE PRACTICE SEMINAR I.** (3) (3 hours)
- 215-691B PERFORMANCE PRACTICE SEMINAR II.** (3) (3 hours)
- 215-692A PERFORMANCE PRACTICE SEMINAR III.** (3) (3 hours)
- 215-693B PERFORMANCE PRACTICE SEMINAR IV.** (3) (3 hours)
- 215-694A PERFORMANCE PRACTICE SEMINAR V.** (3) (3 hours)
- 215-695B PERFORMANCE PRACTICE SEMINAR VI.** (3) (3 hours)
- 216-605A OR B DIGIT (SOUND) SYNTH & AUDIO PROCESS.** (3) (3 hours) Basic principles of digital sound synthesis including techniques such as additive synthesis, frequency modulation, tuned resonators, waveshaping and digital audio processing techniques including simple delay systems, filters, reverberators, spatial controllers, etc. will be explored.
- 216-609A OR B MUSIC, MEDIA & TECHNOLOGY PROJECT.** (3) (3 research/project hours) Independent music technology project. Students will prepare a statement of objectives, a comprehensive project design and a schedule of work, and will undertake the project on appropriate music technology platforms.
- 216-610A COMPUTER MUSIC SEMINAR I.** (3) (3 hours) Advanced topics in computer applications in music will be examined. Students will be expected to 1) present critical analyses of current research and 2) develop and implement software demonstrations.
- 216-611B COMPUTER MUSIC SEMINAR II.** (3) (3 hours)
- 216-612A COMPUTER MUSIC SEMINAR III.** (3) (3 hours)
- 216-613B COMPUTER MUSIC SEMINAR IV.** (3) (3 hours)
- 216-614A COMPUTER MUSIC SEMINAR V.** (3) (3 hours)
- 216-615B COMPUTER MUSIC SEMINAR VI.** (3) (3 hours)
- 216-629D TECHNICAL EAR TRAINING.** (4) (1 hour tutorial, 2 hours laboratory) This course will, through a sequence of specific auditory exercises, develop and improve students' aural sensitivity to small changes in sound quality. Students train to identify spectral variables in sound, develop stable reference of sound quality and learn about spectral characteristics of musical instruments.
- **216-631D ADVANCED TECHNICAL EAR TRAINING.** (4) (1 hour tutorial, 2 hours laboratory) (Prerequisite: 216-629D)
- 216-667A OR B DIGITAL STUDIO TECHNOLOGY.** (3) (3 hours lecture) Technical and operational characteristics of different digital recording systems currently employed by the recording industry.
- 216-668A OR B DIGITAL/ANALOG AUDIO EDITING.** (3) (1 hour tutorial, 3 hours studio time) Using analog and digital record/playback equipment, students learn, through practice, the art of replacing, patching, rebalancing, reconstructing, or generally speaking, improving recorded music through editing. Teaching will include cut and splice editing, disk-based editing, and editing by transfer and mixing.
- 216-669A,B,D TOPICS – CLASSICAL MUSIC RECORDING.** (3) (3 hours lecture) Issues involving classical music recording. Topics may include: analysis of performance styles, acoustics of concert halls, production of music videos, seminars with recording producers, tonmeisters, classical music in multimedia, and others.
- 216-670D RECORDING THEORY & PRACTICE I.** (10) (3 hours seminar, 6 hours studio time) (Prerequisite: 216-300D) Theoretical and practice study of recording equipment, procedures and techniques. Recording sessions and live stereo recording, using the recording studio, concert hall and portable equipment for on-location recording. Also included will be an introduction to the areas of radio drama, broadcast recording and radio commercials.
- 216-671D RECORDING THEORY & PRACTICE II.** (10) (3 hours seminar, 6 hours studio time) (Prerequisite: 216-670D) Emphasis on multi-track recording theory and practice. The course will also concentrate on expanded multi-track procedures: signal processing, overdubbing, mixing, editing, and producing.
- 216-672D ANALYSIS OF RECORDINGS.** (6) (3 hours) The analysis of recording engineering, production, performance, aesthetics and technical quality of selected recordings.
- 216-674A OR B ELECTRONIC & ELECTROACOUSTIC MEAS.** (3) (1½ hours lecture, 1½ hours laboratory) This course demonstrates the instruments, measurement procedures, and techniques used in a recording studio to determine the acoustical properties of a room and the transfer functions of devices used in a studio. Theoretical lectures on electronic test instrumentation and measurement methods are combined with practical application.
- 216-676A,B,D AUDIO INDUSTRY EXPERIENCE.** (3)
- 216-677D AUDIO FOR VIDEO POST-PRODUCTION.** (6) (3 hours seminar, 4 hours studio time) Theoretical study includes historical analysis of sound for image, audio post-production process for film and video, aesthetic and technical considerations in sound design, time code and synchronization, and final mix formats. Practical skills include field recording, sound library management, sound design, dialog, effects and music editing, and final mix process.
- 216-678B ADV. DIGITAL EDIT. & POST-PRODUCT.** (3) (3 hours) (Prerequisite: 216-668) This course covers advanced concepts and techniques of audio post-production using digital workstations. Students practise the assembly of raw material into a complete final product through editing, signal processing, mixing, sound restoration and pre-mastering.
- 216-690A MEDIA THEORY & PRACTICE SEMINAR I.** (3) (3 hours) Topics vary from year to year and are normally chosen according to the individual instructor's area of expertise. Topics to be covered may include the following: Media Technology, Digital Restoration of Archival Recordings, Communications Systems and Standards, Audio Aesthetics of Video Musicals, Classical Music and the Television Medium, etc.
- 216-691B MEDIA THEORY & PRACTICE SEMINAR II.** (3) (3 hours)
- 216-692A MEDIA THEORY & PRACTICE SEMINAR III.** (3) (3 hours)
- 216-693B MEDIA THEORY & PRACTICE SEMINAR IV.** (3) (3 hours)
- 216-694A MEDIA THEORY & PRACTICE SEMINAR V.** (3) (3 hours)
- 216-695B MEDIA THEORY & PRACTICE SEMINAR VI.** (3) (3 hours)
- 219-614A OR B READING COURSE I.** (3) Independent study of an approved topic or topics under the guidance of a supervisor. Topics will be chosen to suit individual needs and interests. The extent of reading, synthesis, and reporting will be agreed upon by the supervisor and the student at the beginning of the course.
- 219-615A OR B READING COURSE II.** (3)
- 219-635A,B,D RESEARCH PAPER I.** (9)
- 219-636A,B,D, RESEARCH PAPER II.** (9)
- 219-675A,B,D SPECIAL PROJECT.** (3)
- 219-676A,B,D SPECIAL PROJECT.** (6)
- 219-694A,B SPECIAL TOPIC SEMINAR.** (3) (3 hours)
- 219-695A,B SPECIAL TOPIC SEMINAR.** (3) (3 hours)
- 219-701D DOCTORAL ORAL COMP. EXAM.**
- 219-702D DOCTORAL WRITTEN COMP. EXAM.**
- 219-705D COLLOQUIUM.**
- 219-749A DOCTORAL TUTORIAL.**
- 219-750B DOCTORAL TUTORIAL.**
- 221-602A SEMINAR IN CHORAL TECHNIQUES.** (3) (3 hours)
- 221-603B SEMINAR IN CHORAL TECHNIQUES.** (3) (3 hours)
- 222-610A SEMINAR IN MUSIC EDUCATION I.** (3) (3 hours)

**222-611B SEMINAR IN MUSIC EDUCATION II.** (3) (3 hours)

**222-612A SEMINAR IN MUSIC EDUCATION III.** (3) (3 hours)

**222-613B SEMINAR IN MUSIC EDUCATION IV.** (3) (3 hours)

**222-618A MUSIC EDUCATION TUTORIAL I.** (3)

**222-619B MUSIC EDUCATION TUTORIAL II.** (3)

● **223-606A SEMINAR IN ORCHESTRA/BAND TECH.** (3) (3 hours)

● **223-607B SEMINAR IN ORCHESTRA/BAND TECH.** (3) (3 hours)

**240-601A OR B JAZZ PEDAGOGY.** (3) (3 hours) A course designed to prepare students to teach jazz-related subjects at the university and professional level, with emphasis on ensemble direction and the instruction of improvisation, as well as course and curriculum development. Various pedagogical methods, philosophies, rehearsal techniques, and materials will be investigated.

**240-640D JAZZ COMPOSITION & ARRANGING.** (4) (2 hours) A course intended to guide the student towards an individual musical style. A variety of jazz compositional and arranging techniques will be explored.

**242-603A,B BRASS INSTRUMENT PERF. & REPERTOIRE.** (3) (3 hours) Designed for the brass performer/prospective teacher. Emphasis on a wide variety of brass literature and performance practice: solos, pedagogical materials, and chamber music for various levels of performance.

**242-611A DIRECTED TEACHING I.** (2) (1 hour)

**242-612B DIRECTED TEACHING II.** (2) (1 hour)

**242-613A DIRECTED TEACHING III.** (2) (1 hour)

**242-614B DIRECTED TEACHING IV.** (2) (1 hour)

**242-615A,B MASTER CLASS – ORCHESTRAL CONDUCTING.** (3) (3 hours) Advanced stick techniques, score preparation, stylistic concerns and rehearsal techniques will be discussed with reference to selected major works from the 18th, 19th, and 20th century orchestral repertoire. Emphasis will be placed on practical considerations.

**242-616A,B MASTER CLASS – CHORAL CONDUCTING.** (3) (3 hours) To focus on the problems of advanced choral repertoire, e.g., conducting techniques, score analysis, choral sound and textual criticism. Repertoire will include representative works from Medieval music to the present day.

**242-620A PERFORMANCE TUTORIAL I.** (4) **Staff**

**242-621B PERFORMANCE TUTORIAL II.** (4) **Staff**

**242-622A PERFORMANCE TUTORIAL III.** (4) **Staff**

**242-623B PERFORMANCE TUTORIAL IV.** (4) **Staff**

**242-624A PERFORMANCE TUTORIAL V.** (4) **Staff**

**242-630A PERFORMANCE TUTORIAL VI.** (6) **Staff**

**242-631B PERFORMANCE TUTORIAL VII.** (6) **Staff**

**242-632A PERFORMANCE TUTORIAL VIII.** (6) **Staff**

**242-633B PERFORMANCE TUTORIAL IX.** (6) **Staff**

**242-650D PEDAGOGY WORKSHOP.** (6) (1½ hours) Teaching of one or more students chosen in consultation with the respective area, and a presentation on an approved topic of the candidate's choice.

**242-658A,B,C,D OPERA PERFORMANCE EXAMINATION.** (6) The student performs a major role in a public performance of a full-length opera. To be marked on a pass-fail basis.

**242-659D PERFORMANCE IN RECORDING MEDIA.** (12) The candidate must submit a 60-75 minute audio and/or video document of his or her performances, compiled from various media sources. This might include radio, television, and/or studio recordings. All of the music must be composed and arranged by the candidate.

**242-660D SOLO RECITAL I.** (12)

**242-661D CHAMBER MUSIC RECITAL I.** (12)

**242-662D SOLO AND CHAMBER MUSIC RECITAL.** (12)

**242-663A,B,C,D QUICK STUDY.** (6) (To be successfully completed before the first recital is performed.)

**242-664A,B,C,D REPERTOIRE EXAMINATION.** (6)

● **242-665D ACCOMPANYING RECITAL I.** (12)

**242-666D CONDUCTING CONCERT EXAMINATION.** (24)

**242-667D SOLO RECITAL II.** (12)

**242-668D CHAMBER MUSIC RECITAL II.** (12)

● **242-669D ACCOMPANYING RECITAL II.** (12)

**242-672D LITURGICAL IMPROVISATION.** (3) (1½ hours) The study and practice of cantus firmus-based improvisation according to selected stylistic models so as to provide diversity of techniques, styles and tonalities. Free improvisation is studied in conjunction with C.F. improvisation. Modulation is taught in both C.F.-based and free improvisation; emphasis being placed on clarity and liturgical appropriateness.

**242-673A,B 20TH-CENTURY ORGAN IMPROVISATION.** (3) (3 hours seminar) The relationship between creative improvisation and composition will be examined. Students will develop their knowledge of timbre and dynamics as structural elements. Three different organs will be used to familiarize the students with different aspects of improvisation in different situations.

**242-674A,B SEMINAR IN ORGAN REGISTRATION.** (3) (3 hours) Organ registration from the late Gothic through the symphonic tradition of the 19th century will be discussed. Special attention will be given to the national building styles of German, French, Italian and Iberian organs and their evolution from the Renaissance to the 20th century.

**242-675A,B,D, SPECIAL PROJECT IN PERFORMANCE I.** (3)

● **242-676D SPECIAL PROJECT IN PERFORMANCE II.** (6)

**242-677A SEMINAR IN PERFORMANCE TOPICS I.** (3) (3 hours)

**242-678B SEMINAR IN PERFORMANCE TOPICS II.** (3) (3 hours)

**242-683A,B THE PIANIST AS PARTNER.** (3) (3 hours) Studies in the role of the pianist in partnership with an instrumentalist or singer, with emphasis given to preparation of works for performance. These studies will include a survey of repertoire, comparison of styles, and a basic knowledge of other instruments. Performance of work(s) studied is a requirement for the course.

**242-685A,B MASTER CLASS – 20TH-CENTURY PIANO MUSIC.** (3) (3 hours) Students will explore the piano repertoire of the 20th century. Repertoire will include such diverse music as that of Milhaud, Ives, Boulez, Berio, etc., as well as the recent Canadian music of Tremblay, Mather, etc. Performance of work(s) studied is a requirement for the course.

**242-686A,B MASTER CLASS – STRING CHAMBER MUSIC.** (3) (3 hours) Advanced studies of the chamber music repertoire, intended for graduate string players. Students will gain firsthand experience playing, reading (in rotation) and studying works both with their colleagues and occasionally with the instructor; discussion of master recordings and active listening with scores.

**242-687A,B DEVELOPMENT – WOODWIND INSTRUMENTS.** (3) (3 hours) This course traces the technical, mechanical, and tonal development of woodwinds from antiquity to modern times, and will include performance and discussion of alternate fingerings, addition of ringed keys, different bore designs, Bartolozzi techniques, etc., as well as changes in orchestral function and style.

**242-696A,B TECHNICAL LITERATURE FOR PIANO.** (3) (3 hours) Studies of published works on piano performance technique and interpretation. Students will read and discuss selected texts as well as make individual reports on particular studies on technical schools or methods.

**242-698A,B 20TH-CENTURY WIND REPERTOIRE.** (3) (3 hours) A study of performance problems related to small mixed wind ensembles and wind band repertoire of the late 20th century. Special emphasis will be given to score reading, performance and notational problems, interpretation, and efficient rehearsal procedures.

**242-699D CHURCH SERVICE PLAYING.** (4) (2 hours) The course is designed to assist organists in developing the skills necessary to accompany church services. All aspects of liturgical music will be

dealt with including hymns, Psalms (both Gregorian and Anglican chant), Mass settings, anthem accompaniment, and adaptation of orchestral scores to the organ.

**243-660A,B CHAMBER MUSIC ENSEMBLE.** (1) **Staff**

**243-661A,B EARLY MUSIC CHAMBER MUSIC ENSEMBLE.** (1) (Prerequisite: Audition; 1 hour). Chamber music of the Medieval, Renaissance and Baroque periods.

● **243-671A,B MEDIEVAL & RENAISSANCE MUSIC WORKSHOP.** (2) (4 hours) (Prerequisite: Audition)

**243-672A,B CAPPELLA ANTICA.** (2) (4 hours) (Prerequisite: Audition) An ensemble of 8 to 12 voices specializing in early music.

**Professor Baboukis**

**243-673A,B COLLEGIUM MUSICUM.** (2) (4 hours) (Prerequisites: Audition AND 243-480A & B AND 215-381; Additional prerequisite for keyboard players: 242-372D with a grade of A-) Open to singers and instrumentalists, this ensemble specializes in chamber music primarily of the Baroque era. **Professor Knox and Staff**

● **243-678A,B CHAMBER WINDS.** (2) (4 hours) (Prerequisite: Audition. Corequisite for wind players: 243-697A,B)

**243-679A,B SONG INTERPRETATION.** (1) (Prerequisite: Audition; 2 hours). Study of the standard song repertoire with emphasis on the singer and pianist as partners. The student will be assigned to work with two singers. A public recital will be given at the end of each term.

**243-680A,B EARLY MUSIC ENSEMBLE.** (1) (2 hours) (Prerequisite: Audition. Prerequisite or corequisite for keyboard players: 242-272D) An ensemble of 4-6 vocalists and instrumentalists which performs music of the Medieval, Renaissance and Baroque periods. **Professor Knox and Staff**

**243-684A,B STUDIO ACCOMPANYING.** (2) (Prerequisite: Audition; 2 hours) Students will be assigned to work as accompanists with performance teachers and their students.

● **243-690A,B MCGILL WINDS.** (2) (4 - 6 hours) (Prerequisite: Audition)

**243-693A,B CHORAL ENSEMBLE.** (2) (4 hours) (Prerequisite: Audition) Students enrolling in Choral Ensembles will be assigned to one of the following groups. **Professors Baboukis and Edwards**

*Chamber Singers:* a group of approximately 24 mixed voices which explores the a capella repertoire of all periods as well as works with chamber accompaniment. Section 01

*Concert Choir:* an ensemble of approximately 60 voices (S.A.T.B.) which performs the repertoire from all periods appropriate to a group of this size. Section 02

*University Chorus:* a mixed chorus of approximately 100 which performs a variety of choral material including both traditional and popular selections. Section 03

*Women's Chorale:* an ensemble of approximately 40 women stressing the fundamentals of singing and ensemble participation. Works are chosen from the substantial repertoire available for women's voices. Section 04

**243-694A,B CONTEMPORARY MUSIC ENSEMBLE.** (2) (4 hours) (Prerequisite: Audition) An ensemble of approximately 15 performers which will explore 20th-century ensemble repertoire.

**Professor Bouliane**

**243-695A,B JAZZ ENSEMBLE.** (2) (3-4 hours) (Prerequisite: Audition) **Professor Foote and Staff**

**243-696A,B OPERA THEATRE.** (2) (3-6 hours) (Prerequisite: open to all Graduate Performance and Artist Diploma students who have completed 243-496 or its equivalent.) Individual coaching in acting, movement and role preparation; possibility for roles in Opera McGill productions (by audition).

**Professors Ross-Neill, Vernon and Staff**

**243-697A,B ORCHESTRA.** (2) (6-7 hours) (Prerequisite: Audition. Corequisite for wind players: 243-678A,B) A full orchestra of

approximately 90 which performs the symphonic repertoire. N.B. Woodwind and brass players will take one hour per week of Repertoire Class as a part of Orchestra. **Professor Vernon and Staff**

**253-600A VOCAL REPERTOIRE COACHING I.** (2) (1 hour) A course in which the performer will have individual coaching sessions on repertoire, with emphasis on musical and linguistic nuance.

**253-601B VOCAL REPERTOIRE COACHING II.** (2) (1 hour)

**253-690A OR B VOCAL STYLES & CONVENTIONS.** (3) (3 hours) Emphasis on vocal performance practices through practical application: text, language, inflection, pronunciation and interpretation considered with individuality of each student's voice and technical development. After examining historical treatises, students will discuss and present musical selections utilizing modern performance standards yet remaining true to stylistic demands of each period.

**253-691A VOCAL SEMINAR I.** (3) (3 hours) (Open to singers, pianists, and conductors with permission of instructor.)

**253-692B VOCAL SEMINAR II.** (3) (3 hours) (Open to singers, pianists, and conductors with permission of instructor.)

● **253-693A VOCAL TREATISES & METHODS.** (3) (3 hours)

● **253-694B VOCAL PHYSIOLOGY FOR SINGERS.** (3) (3 hours)

### Advanced Undergraduate Courses

Students deficient in their background preparation may be required to take some of the following undergraduate courses in addition to their required graduate courses.

For an up-to-date listing of upper-level music history courses that will be offered, please consult the final 1999-2000 Faculty of Music timetable.

With the exception of 211-501, 211-502 and 211-503, all 500-level courses are available as elective courses to graduate students.

211-301A Modal Counterpoint I  
211-302B Modal Counterpoint II  
211-303A Tonal Counterpoint I  
211-304B Tonal Counterpoint II  
211-327D 19th-Century Analysis  
211-427D 20th-Century Analysis  
211-501 Theory Review I  
211-502 Theory Review II  
211-503 Theory Review III  
211-522D Advanced Counterpoint  
211-523D Advanced Harmony  
211-528 Schenkerian Techniques  
211-529 Proseminar in Music Theory  
211-538 Mathematical Models for Musical Analysis  
214-366 Era of the Fortepiano  
214-372 Solo Song Outside Germany & Austria  
214-377 Baroque Opera  
214-379 Solo Song 1100-1700  
214-380 Medieval Music  
214-381 Renaissance Music  
214-382 Baroque Music  
214-383 Classical Music  
214-384 Romantic Music  
214-385 Early Twentieth-Century Music  
214-386 Chamber Music Literature  
214-387 Opera from Mozart to Puccini  
214-388 Twentieth-Century Opera  
214-389 Orchestral Literature  
214-390 The German Lied  
214-391 Canadian Music  
214-392 Music Since 1945  
214-395 Keyboard Literature before 1750  
214-396 Era of the Modern Piano  
214-397 Choral Literature after 1750  
214-398 Wind Ensemble Literature after 1750  
214-489 History of Music Theory  
214-570 Research Methods in Music

214-591D Paleography  
 215-381 Topics in Perf. Practice before 1800  
 215-385 Topics in Perf. Practice after 1800  
 216-306 Computer Programming for Musicians I  
 216-307 Computer Programming for Musicians II  
 221-315A Choral Conducting I  
 221-415B Choral Conducting II  
 222-402D Principles and Processes of Music Ed.  
 222-403A,B Selected Topics in Music Ed.  
 222-404A,B Selected Topics in Music Ed.  
 223-315A Instrumental Conducting I  
 223-415A Instrumental Conducting II  
 242-372D Continuo  
 243-494A,B Contemporary Music Ensemble

## 53 Natural Resource Sciences

Department of Natural Resource Sciences  
 Macdonald Campus  
 21,111 Lakeshore Road  
 Sainte-Anne-de-Bellevue, QC  
 Canada H9X 3V9  
 Telephone: (514) 398-7890  
 Fax: (514) 398-7990  
 Email: [info@nrs.mcgill.ca](mailto:info@nrs.mcgill.ca)  
 Website: <http://www.nrs.mcgill.ca>

Chair — W. Hendershot

Graduate Program Director — R.D. Titman

### 53.1 Staff

#### Emeritus Professors

A.C. Blackwood; B.Sc., M.Sc.(Alta.), Ph.D.(Wis.), F.R.S.C.;  
 Microbiology  
 R. Knowles; B.Sc.(Birm.), Ph.D., D.Sc.(Lond.); Microbiology  
 A.F. MacKenzie; B.S.A., M.Sc.(Sask.), Ph.D.(C'nell); Soil Science  
 R.A. MacLeod; B.A., M.A.(Br.Col.), Ph.D.(Wis.), F.R.S.C.;  
 Microbiology

#### Emeritus Curator of the Lyman Museum

V.R. Vickery; B.Sc.(Agr.), M.Sc., Ph.D.(McG.)

#### Curator of the Lyman Museum

C.C. Hsiung; B.Sc.(Taiwan), B.Ed.(Queen's), Ph.D.(McG.)

#### Professors

N.N. Barthakur; B.Sc.(Gauh.), M.Sc.(Alld.), Ph.D.(Sask.);  
 Agricultural Physics  
 D.M. Bird; B.Sc.(Guelph), M.Sc., Ph.D.(McG.); Wildlife Biology  
 W.H. Hendershot; B.Sc.(Tor.), M.Sc.(McG.), Ph.D.(Br.Col.); Soil  
 Science  
 E.S. Idziak; B.Sc.(Agr.), M.Sc.(McG.), D.Sc.(Delft); Microbiology  
 P.H. Schuepp; Dipl.Sc.Nat.(Z[u.r.], Ph.D.(Tor.); Agricultural  
 Physics  
 R.K. Stewart; B.Sc.(Agr.), Ph.D.(Glas.); Entomology

#### Associate Professors

B. Côté; B.Sc., Ph.D.(Laval); Forest Resources  
 M.A. Curtis; B.Sc., M.Sc., Ph.D.(McG.); Wildlife Biology  
 G.B. Dunphy; B.Sc.(U.N.B.), M.Sc., Ph.D.(Mem.); Entomology  
 J.W. Fyles; B.Sc., M.Sc.(Vic., B.C.), Ph.D.(Alta.); Forest  
 Resources  
 D.J. Lewis; B.Sc., M.Sc., Ph.D.(Mem.); Entomology  
 G.R. Mehuy; B.Sc., Ing.Agron.(Gembloux), Ph.D.(Calif.); Soil  
 Science  
 D.F. Niven; B.Sc., Ph.D.(Aber.); Microbiology  
 M.E. Rau; B.Sc.(Purdue), M.Sc., Ph.D.(McG.); Entomology  
 R.D. Titman; B.Sc.(McG.), M.Sc.(Bishop's), Ph.D.(U.N.B.); Wildlife  
 Biology

#### Assistant Professors

D. Berteaux; Bqcc.(Lycée M. Genevoix), Dip.(Nantes),  
 M.Sc.(Rennes), Ph.D.(Sherbrooke); Wildlife Biology

B.T. Driscoll; B.Sc., Ph.D.(McM.); Microbiology  
 C. Hamel; B.Sc., Ph.D.(McG.); Soil Science  
 T.A. Wheeler; B.Sc.(Mem.), M.Sc., Ph.D.(Guelph); Entomology

#### Adjunct Professors

F. Archibald; K. Blanchard; G. Boivin; N. Calero; T. Charles;  
 H. Chiasson; R. Desjardins; W. Fairchild; C. Greer;  
 M. Guillemette; P. Mineau; H. Murkin; M. St-Arnaud; N. Seymour;  
 R. Simard; T.G. Smith; I. Thompson; C. Vincent; F.G. Whoriskey

#### Associate Members

W.D. Marshall (*Food Science and Agricultural Chemistry*);  
 G.J. Matlashewski (*Parasitology*)

#### Cross-Appointed Professors

P. Brown (*Geography and McGill School of Environment*); L. Chan  
 (*Dietetics and Human Nutrition*); D. Smith (*Plant Science*)

### 53.2 Programs Offered

The Department of Natural Resource Sciences offers programs leading to M.Sc. and Ph.D. degrees in Entomology, Microbiology, and Renewable Resources (includes Agrometeorology, Forest Science, Soil Science and Wildlife Biology).

The Department possesses, or has access to, excellent facilities for laboratory research and research in the field. Affiliated with the Department are the Lyman Entomological Museum and Research Laboratory, the Morgan Arboretum, the Avian Science and Conservation Centre, and the Ecomuseum of the St. Lawrence Valley Natural History Society.

### 53.3 Admission Requirements

#### General

Competency in English – Non-Canadian applicants whose mother tongue is not English and who have not completed an undergraduate degree using the English language, are required to submit documented proof of competency in oral and written English by appropriate exams, e.g. TOEFL (Test of English as a Foreign Language) with a minimum score of 550 or equivalent in other tests before registration.

The Graduate Record Exam is not required, however, it is highly recommended.

#### M.Sc.

Candidates are required to have a Bachelor's degree with an equivalent cumulative grade point average of 3.0/4.0 and a sufficient background in the appropriate basic sciences.

#### Ph.D.

Candidates, normally, are required to hold an M.Sc. Degree and will be judged primarily on their ability to conduct an original and independent research study.

### 53.4 Application Procedures

Applications for Admission and all supporting documents must be sent directly to:

Student Affairs Office (Graduate Studies)  
 Macdonald Campus of McGill University  
 21,111 Lakeshore  
 Ste-Anne-de-Bellevue, Québec  
 H9X 3V9 CANADA  
 Telephone: (514) 398-7708  
 Fax: (514) 398-7968  
 Email: [GRAD@macdonald.mcgill.ca](mailto:GRAD@macdonald.mcgill.ca)

Applications will be considered upon receipt of a signed and completed application form, \$60 application fee, all official transcripts, two signed original letters of reference on official letterhead of originating institution, and (if required) proof of competency in oral and written English by appropriate exams.

**Deadlines** – For **international students**, complete applications with supporting documents must reach the Student Affairs Office