UNIVERSITY OF WATERLOO
SENATE GRADUATE & RESEARCH COUNCIL
NOTICE OF MEETING

DATE: Monday 3 October 2022 — Chair – J. Casello
TIME: 10:30 a.m. – 12:00 noon
PLACE: NH 3318/3308

AGENDA

Item	Action
Declarations of Conflict of Interest	
a. Excerpt from Bylaw 1, section 8*	Information
CONSENT AGENDA	
Motion: To approve or receive for information by consent, items 1-2 below	
1. Minutes of 12 September 2022*	Decision (SGRC)
2. Research Ethics* (Joza)	
a. Clinical Research Ethics Board – revision to Terms of Reference	Decision (SGRC)
b. Clinical Research Ethics Board – membership update	Decision (SGRC)
REGULAR AGENDA	
3. Business Arising from the Minutes	Information
4. Co-chairs' Remarks	Information
5. Office of the Registrar – Academic Calendar dates 2023/24* (Coghlin)	SEN-Regular
6. New Program: Doctor of Philosophy in Entrepreneurship and Organization* (Siva Sivoththaman, Shavin Malhotra)	SEN-Regular
7. Consultation Plan – Senate Governance Review: Future of SGRC (Casello/Dean)	Information
8. Curricular Submissions	
a. Mathematics* (Bertrand Guenin)	SEN-Regular (unless indicated)
9. Other Business	Information
10. Future Business Topics (what and how)	Information
a. Create Grants (success rate, ways to improve)	
b. Graduate Studies and Postdoctoral Affairs Vision Document	
11. Next Meeting: 14 November 2022 from 10:30 a.m. - 12 noon; NH3318	Information

*material attached
** to be distributed separately
"SGRC" to be approved on behalf of Senate
"SEN" to be recommended to Senate for approval

Kathy Winter, PhD, CPsych
Assistant University Secretary

26 September 2022

Excerpt from Senate Bylaw 1

8. Declarations of conflict of interest

8.01	At the beginning of each meeting of Senate or any of Senate's committees or councils, the chair will call for members to declare any conflicts of interest with regard to any agenda item. For agenda items to be discussed in closed session, the chair will call for declarations of conflict of interest at the beginning of the closed portion of the meeting. Members may nonetheless declare conflicts at any time during a meeting.
8.02	A member shall be considered to have an actual, perceived or potential conflict of interest, when the opportunity exists for the member to use confidential information gained as a member of Senate, or any of Senate's committees or councils, for the personal profit or advantage of any person, or use the authority, knowledge or influence of the Senate, or a committee or council thereof, to further her/his personal, familial or corporate interests or the interests of an employee of the university with whom the member has a marital, familial or sexual relationship.
8.03	Members who declare conflicts of interest shall not enter into debate nor vote upon the specified item upon which they have declared a conflict of interest. The chair will determine whether it is appropriate for said member to remove themselves from the meeting for the duration of debate on the specified item(s).
8.04	Where Senate or a committee or council of Senate is of the opinion that a conflict of interest exists that has not been declared, the body may declare by a resolution carried by two-thirds of its members present at the meeting that a conflict of interest exists and a member thus found to be in conflict shall not enter into debate on the specified item upon which they have declared a conflict of interest. The chair will determine whether it is appropriate for said member to remove themselves from the meeting for the duration of debate on the specified item(s).

University of Waterloo
SENATE GRADUATE & RESEARCH COUNCIL
Minutes of the 12 September 2022 Meeting
[in agenda order]
Needles Hall 3318/3308

Present: Steven Bednarski (for Drysdale), Amelia Clarke, David Clausi, Peter Deadman, Charmaine Dean, Bernie Duncker, Anna Esselment, Ana Ferrer, Bertrand Guenin, Alison Hitchens, Aiden Huffman, Brian Laird, Anita Layton, Bill McIlroy, Ian Milligan, Liz Nilsen, Jennifer Reid, Martin Ross, Marianne Simm, Siva Sivoththaman, Julian Surdi, Mike Szarka, Kathy Winter (secretary).

Resources: Trevor Clews, Amanda McKenzie.

Guests: Elizabeth Demers, Richard Wikkerink, Olaf Weber.

Regrets: Julie Joza*, John Thompson*, Jeff Casello*

Organization of Meeting: Charmaine Dean, co-chair of the council, took the chair, and Kathy Winter acted as secretary. The secretary advised that due notice of the meeting had been given, a quorum was present, and the meeting was properly constituted.

DECLARATIONS OF CONFLICT OF INTEREST
No conflicts of interest were declared.

CONSENT AGENDA
Council heard a motion to approve or receive for information the items of the consent agenda. Milligan and Clarke. Carried.

1. MINUTES OF 13 JUNE 2022
Council approved the minutes of the meeting as distributed.

2. RESEARCH ETHICS
Council approved membership updates to the Clinical Research Ethics Board and Human Research Ethics Board as presented.

3. GRADUATE AWARDS
Council approved items (a) and (b), as presented; and received items (c) through (f) for information.

REGULAR AGENDA
4. BUSINESS ARISING FROM THE MINUTES
There was no business arising.

5. CO-CHAIRS' REMARKS
Dean welcomed council members to the start of the fall 2022 academic term and provided updates regarding provincial funding of Mitacs paid Internships for both undergraduate students and post-doctoral fellows: (a) money for this year has already been utilized, (b) proposals approved prior to 28 August 2022 will be supported, whereas those received since are on hold until provincial funding decisions are finalized, (c) programs include Accelerate, Elevate, Business-ready, and International programs. Dean committed to ensure that Mitacs will remain a priority in the University's ongoing talks with the province.

6. GRADUATE STUDIES AND POSTDOCTORAL AFFAIRS–revised ACADEMIC CALENDAR DATES
Council heard a motion to recommend to Senate revised academic calendar dates for 2022-2023 and calendar guidelines for establishing academic dates, as presented. The in-person exam days for online courses have now been established and replace the "TBD" designation in the table of academic calendar dates approved at the 15 November 2021 meeting of Senate. Simm and Nilsen. Carried.

7. RESEARCH CENTRES AND INSTITUTES

b. New: Centre for Sustainability and Business

Council heard a motion to recommend to Senate the establishment of the Centre for Sustainability and Business (CSB), as presented. Olaf Weber (Professor, School of Environment, Enterprise and Development) and Elizabeth Demers (Professor, School of Accounting and Finance) provided a short PowerPoint presentation, including how sustainable business models have become ubiquitous and a tremendous amount of research across disciplines is underway to support this new approach. Accordingly, the CSB, a faculty-funded research centre of the Faculties of Environment and Arts, is being proposed in order to support interdisciplinary research that creates a societal impact and increases the visibility of the University of Waterloo as a powerhouse for sustainability and business, accounting, and economics. The centre will become a hub to support sustainability and business research across campus by raising funds, hosting interdisciplinary academic and joint academic-practitioner conferences, and fostering partnerships with corporations to enable practical collaborations, as well as the development of new experiential pedagogical materials—including executive training—in sustainability and business. Notably, with its focus on sustainability, interdisciplinary research, and high impact, the CSB is perfectly aligned with the University's strategic plan. In response to questions, the CSB stakeholders emphasized anticipated collaborations with other Faculties, as well as institutions (e.g., Balsillie School of International Affairs, Centre for International Governance Innovation, Waterloo Institute for Sustainable Energy, Waterloo Climate Institute). Council identified the following areas of change for the CSB proposal: (a) details on how the members of the Governing Body will be selected should be added, (b) income line items should be added to the budget depicted in Table 2, and (c) a potential connection to the Economics Futures initiative being led by Joel Blit could be indicated. As well, at the 5-year review stage, Senate Graduate and Research Council anticipates seeing the creation of more formal pathways for Graduate Students. Duncker and Clarke. Carried with one abstention.

8. CONSULTATION PLAN – SENATE GOVERNANC E REVIEW: FUTURE OF SGRC

Council received the Future of SGRC Consultation Plan as presented by Dean. In addition, members were provided a contextual overview as to how this particular element (i.e., recommendation #32) fits within the larger framework of the Senate Governance Review as it pertains to SGRC (i.e., recommendations #28, #32, #33). Members are to anticipate invitations to separate stakeholder consultation sessions to be held in October 2022. Council was invited to send any comments thereon to committee secretary Winter.

9. CURRICULAR SUBMISSIONS

Faculty of Environment. On behalf of Senate, council heard a motion to approve item 1, as presented. Deadman and Esselment. Carried.

10. OTHER BUSINESS

There was no other business.

11. FUTURE BUSINESS

Council was informed of two business items for future strategic discussion: Create Grants and GSPA Vision Document.

12. NEXT MEETING

The next meeting will be held Monday 3 October 2022 from 10:30 a.m. to 12 noon in NH3318.

15 September 2022

Kathy Winter, PhD, CPsych,
Assistant University Secretary

Memorandum

To: **Members**
Senate Graduate and Research Council (SGRC)

From: **Julie Joza**
Director, Research Ethics

Date: **September 19, 2022**

Subject: **Revision to the Clinical Research Ethics Board Terms of Reference and Membership Update**

This memo outlines a revision to the minimal board composition and a membership update for the Clinical Research Ethics Board (CREB). These changes are for consideration and approval by the Senate Graduate and Research Council.

Clinical Research Ethics Board

Revision to the CREB Terms of Reference
The community member role is an essential component of an REB, helping to broaden the perspective of the REB and to reflect the perspective of study participants. The Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2) states: "to maintain effective community representation, the number of community members should be commensurate with the size of an REB and should increase as the size of an REB increases". Currently, CREB has a single community member to provide community representation. The size of CREB has expanded in recent years to include additional members such as a member with expertise in statistical methodologies and a student member. The CREB terms of reference is being revised from "one community member who has no affiliation with the institution" to "two community members who have no affiliation with the institution". Adding a second community member ensures the participant perspective remains in proportion with the overall membership of the REB. The revised Terms of Reference is attached.

New Member
Ms. Amy Ross, BA, MPS, will begin a three-year term on CREB as the second community member beginning October 4, 2022, and continuing through to October 3, 2025. Amy is a long-time resident of Waterloo and a City of Waterloo employee, whose roles have included research and policy analysis, cultural planning, and project management. Amy is an Accessibility Advocate for the Indigenous Initiatives, Anti-Racism, Accessibility and Equity team with the City of Waterloo. Amy has been a consultant for the Accessibility for Ontarians with Disabilities Act (AODA) and coordinated local activities of Special Olympics Kitchener-Waterloo. Amy has served as a community representative for the Grand River Accessibility Advisory Committee (GRAAC) and the Grand River Transit Specialized Services Advisory Committee. Moreover, Amy is familiar with research ethics, having worked as a research associate and during her doctoral studies. Amy's research focused on inequities in policymaking outcomes in Canada for people with disabilities. Amy brings an equity lens perspective to CREB helping ensure appropriate protections for study participants.

Reminder: SGRC members who wish to learn more about the qualifications or academic background and interests of the individual being nominated to the REB are encouraged to contact Julie Joza, Director, Research Ethics at jajoza@uwaterloo.ca. Julie will be pleased to discuss with SGRC members in advance of the meeting the information they may need to help support their decision to recommend the nomination of the individual in becoming a member of the REB. On behalf of the SGRC, the research ethics office retains a copy of each member's CV and expression of interest in being a REB member.

UNIVERSITY OF WATERLOO
CLINICAL RESEARCH ETHICS BOARD

TERMS OF REFERENCE

A. Statement of Institutional Authority for Research Ethics Boards

The University of Waterloo has two Research Ethics Boards (REBs): the Clinical Research Ethics Board and the Human Research Ethics Board. As constituted sub-committees of the University of Waterloo's Senate Graduate and Research Council, both of the University of Waterloo's REBs are established and empowered under the authority of the University of Waterloo Senate.

B. Mandate and Accountability of the Research Ethics Boards

The REBs' mandate, on behalf of the University, is to protect the rights and welfare of human participants who take part in research conducted under the auspices of the University. The University of Waterloo's REBs review such research to ensure that it meets ethical principles and that it complies with all applicable regulations, guidelines and standards pertaining to human participant protection. These include but are not limited to the University of Waterloo's Statement on Human Research; its Guidelines for Research with Human Participants (Guidelines) and the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans, 2nd edition (TCPS 2). For clinical trials, the REBs follow Health Canada's Food and Drugs Act, the International Conference on Harmonization (ICH) Good Clinical Practice: Consolidated Guideline, and where applicable, U.S. federal regulations. The University of Waterloo's REBs also operate under applicable laws and regulations of the Province of Ontario and of Canada.

The University of Waterloo requires that all research involving humans or human biological materials conducted in its jurisdiction or under its auspices, undergo ethics review and clearance by one of its two REBs prior to initiation of any research related activities, including recruitment and screening activities.

The Clinical Research Ethics Board (CREB) has jurisdiction over clinical trials research (i.e., involving a drug or natural health product or is medical device testing) conducted under the auspices of the University of Waterloo, research involving a "controlled act" as defined under the Regulated Health Professionals Act of Ontario, 1991, and other research activities as defined under approved standard operating procedures. The Human Research Ethics Board (HREB) has jurisdiction over all other research involving humans with which the University is affiliated.

C. Membership of the CREB

Membership shall be consistent with the requirements for REB composition specified in Article 6.4. of the TCPS 2 and ICH Good Clinical Practice: Consolidated Guideline. All REB members shall be competent to judge the ethical acceptability of research ethics applications they review. In accordance with Article 6.3 and Chapter 8 of the TCPS 2, in the interest of fostering a collaborative spirit and appropriate levels of information sharing between both REBs, and to facilitate timely and effective reviews for researchers, members of CREB may be required to serve as reviewers, in either a delegated or ad-hoc sub-committee capacity, for applications

made to HREB if, in the judgment of the Chair of HREB, the application requires expertise which the CREB member has been judged to possess.
To fulfill the mandate of the Board, the membership will be comprised of both voting and non-voting members.

The CREB shall consist of a minimum of ~~10~~ 11 voting members:

- three faculty members including
  - one faculty member with expertise in vision science from Optometry
  - one faculty member with expertise in Pharmacology or Immunology/Toxicology from Pharmacy
  - one faculty member with expertise in the science of human movement from Kinesiology
- two clinical physicians knowledgeable about clinical trials research
- one lawyer preferably knowledgeable about clinical trials research and privacy
- one member knowledgeable in ethics/bioethics
- ~~one~~ two community members who ha~~s~~ves ~~no~~ affiliation with the institution
- one member that is a student or post-doctoral fellow preferably with experience in the conduct of research with humans
- one member with expertise in statistical methodologies

The committee must reflect gender diversity, including at minimum both men and women.

Non-voting members of the Board act as resource support, offer expertise and assistance on matters under consideration by the Board, and share information as needed[1]. The following additional members are ex-officio (non-voting):

- Director, Research Ethics
- Senior Manager / Manager, Research Ethics
- Research Ethics Advisor(s), Research Ethics

An alternate community member and an alternate student member may be sought to ensure these positions are represented on the Board at each meeting, whenever possible.

D. Terms of Office for the CREB

1. Following consultation with the respective Faculty Deans and Department Chairs/School Directors and the CREB Chair, the Director will nominate members of the CREB.

2. The Senate Graduate and Research Council shall appoint members of CREB.

3. The Vice-President Research and International will nominate the Chair and Vice Chair from the CREB membership. The Chair will have a minimum of one year prior experience as a member of the CREB. An additional member may be appointed from the same area of expertise as the Chair. The Vice Chair may discharge the responsibilities of the Chair when the Chair is unable to do so, discharge responsibilities assigned by the Chair and assist in the overall operation of the REB, as requested.

[1] TCPS 2, Article 6.4 stipulates “where research ethics administration staff have the requisite experience, expertise and knowledge comparable to what is expected of REB members, institutions may appoint them (based on written policies and procedures of the institution) to serve as non-voting members on the REB.

4. Members of the CREB, except the ex-officio members, will serve for a three-year term when possible, normally renewable once. Terms will be overlapping to preserve experience and continuity of function.

E. Meetings of the CREB

1. The CREB normally will meet face to face eleven times per year. In the absence of any business, meetings may be cancelled by the Manager (or delegate) in consultation with the Chair.

2. Additional meetings of the CREB, or of a sub-committee of its members, may be called by the Manager in consultation with the Chair, as necessary.

3. Each meeting will require the involvement of a quorum defined as half the total voting membership plus one. Quorum must also meet membership criteria specified by relevant research ethics guidelines and regulations. Every effort will be made to ensure that each meeting includes the community member.

4. Members shall normally attend CREB meetings with at least 70% attendance per year. When unexpected circumstances arise that prevent a regular member from attending a CREB meeting in person, arrangements will be made where feasible with the member to participate through use of technology (e.g., telephone or video link). In cases where a regular member cannot attend CREB meetings for a protracted period (e.g., during a 6 month's sabbatical), a substitute member from the same discipline may be appointed to serve during the regular member's absence.

5. Members shall notify the Manager of an anticipated absence at least one day prior to a meeting. Members who cannot attend a meeting are expected to provide written comments or each of the protocols under review at the respective meeting. This information is provided to other members of the CREB and becomes part of the discussion and meeting minutes.

6. At the outset of each meeting, members shall declare any real, perceived or potential conflict(s) of interest related to the applications under review. Examples of conflicts of interest include but are not limited to applications on which they are listed as Principal Investigator (PI) or co-investigator; current or past research collaborations with investigators listed on the application; applications on which students they supervise are listed. Other members of the CREB will decided whether the member with the conflict of interest should recuse themselves from related discussions.

7. The CREB will reach its decisions concerning the ethical acceptability of research that is undergoing ethics review through a process of open discussion and consensus. When members are unable to reach consensus, a vote of the quorum present may be taken and recorded.

8. The CREB's deliberations and decisions will be documented in comprehensive, confidential minutes that are securely maintained. The Research Ethics Advisor, shall serve as secretary to the CREB.

9. Detailed written feedback from the CREB including its decision on the ethical acceptability of the research shall be communicated to the researcher(s) by the Manager following consultation with the Chair, CREB, in an efficient and timely manner according to standard operating procedures. Feedback is based on minutes of discussion of the research project.

10. The CREB may, where appropriate, request that the PI or his/her designate attend a meeting to provide further information about and/or to discuss his/her research. The CREB will also accommodate reasonable requests from a PI to attend a meeting to participate in discussions about their research.

11. The CREB may seek the confidential opinion or advice of an ad hoc advisor/reviewer from among University of Waterloo faculty or from a confidential external consultant on a particular application to ensure it has the necessary background information and knowledge to review the ethical acceptability of the application.

F. Responsibilities and Mandates of the CREB

1. To ensure that all research under CREB jurisdiction, involving human participants conducted by students, staff and faculty affiliated with the University of Waterloo, and all clinical trials research conducted at Waterloo by unaffiliated students, staff and faculty researchers, undergo ethics review and clearance prior to being conducted. This research may be conducted on- or off-campus and may be funded or unfunded.

2. To review the ethical acceptability of all research projects, under CREB jurisdiction, involving human participants on behalf of the institution including, but not limited to, those that:
    - may pose greater than minimal risk to participants (i.e., physiological, psychological, economic, social, or other);
    - involve recruitment of persons who may be vulnerable as research participants in the context of a specific study, and/or cannot legally give free and informed consent
    - include ethically sensitive issues, topics and/or procedures; and
    - stipulate full REB review as required by certain granting agencies

The CREB may grant clearance, propose modifications, disapprove, or terminate proposed or ongoing research conducted within the jurisdiction of the University or under its auspices to ensure that a proportionate review of risks and benefits has occurred in accordance with the ethical framework proposed under the TCPS 2.

G. Delegation of CREB Authority Related to Ethics Review and Clearance

The CREB delegates to the Director, Senior Manager / Manager, and Research Ethics Advisor(s), by virtue of their membership on the CREB, and according to standard operating procedures, authority to conduct:

1. Initial ethics review and clearance of research under its jurisdiction that poses minimal risk to research participants, and includes provision of comprehensive and timely written feedback.

2. Ethics review and clearance of modifications to ongoing research under its jurisdiction that poses minimal risk to research participants, and includes provision of comprehensive and timely written feedback.

3. Annual ethics review and clearance of all research under its jurisdiction that continues beyond one year.

4. Ethics review and clearance of all revised materials and related documents associated with the ethics review feedback process involving minimal and greater than minimal risk research that have been categorized as requiring a review by a sub-committee of the CREB or the full CREB.

H. Delegation of CREB Responsibility for Record Keeping and Research Ethics Education

The CREB ensures with assistance of Research Ethics Staff that:

1. CREB members are provided with opportunities for research ethics education during their tenure on the CREB beginning with a new member orientation session.

2. Comprehensive, accurate records (i.e., paper and electronic) of the initial and continuing (i.e., modifications, annual) ethics review and clearance processes are securely maintained for all research under its jurisdiction. This includes all revised materials associated with initial and continuing ethics review.

3. CREB meeting dates and submission deadlines are easily accessible by researchers through information posted on the Research Ethics website.

4. CREB members receive a monthly report is received on minimal risk research that has undergone ethics review and clearance through the delegated ethics review process by the Research Ethics staff.

5. Timely information and regular reports are received on any unanticipated issues (events) that have occurred in association with research under its jurisdiction.

6. University of Waterloo guidelines, procedures and sample materials related to the conduct of research with humans are reviewed and updated on a regular basis (e.g., annually) to ensure that they remain current in an evolving research ethics environment.

7. Educational activities (e.g., in-class presentations, seminars and workshops) are provided to University of Waterloo students, faculty and staff involved in research with human participants.

8. Legal or other advice is sought, as required, on matters related to the protection of human participants in research.

9. Timely information on guidelines, procedures, and other matters related to the conduct of research with human participants is provided to the CREB as well as student, staff and faculty researchers who conduct research with humans.

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G. Reconsideration and Appeal of CREB Decisions

1. Reconsideration Process

A Principal Investigator (PI) may make a written request for reconsideration of a CREB decision when ethics clearance is not granted, or when ethics clearance is conditional on revisions that the PI believes may jeopardize the feasibility or integrity of the research. In consultation with the Chair, the Director (or delegate) will refer such a request, including documentation and supporting materials received for reconsideration from the PI, to other members of the CREB for discussion at its next meeting. The CREB will review the written documents, and where appropriate, will request an informal meeting with the PI (or their designate). Following consideration of all additional information (verbal and written), the CREB will reach a final decision with respect to its position on the original decision. Every attempt will be made, in consultation with the PI to reach a resolution by this informal route.

2. Appeal Process

In the event the matter cannot be resolved through a reconsideration or informal process, the institution shall provide the PI with prompt access to an established appeal process through which the PI may appeal the CREB's decision. An appeal can be requested for procedural or substantive reasons. An appeal committee shall be appointed through the same authority that established the REB, ensuring that members of the appeal committee will have expertise and knowledge to be able to competently judge the ethical acceptability of the research ethics application under review. Members of the CREB whose decision is under appeal shall not serve on the appeal committee. The appeal committee will act impartially in its review of documentation provided by the CREB and the PI (or designate), and will consult with others as required, including but not limited to, members of the CREB and the PI (or designate). The appeal committee will issue a written report with its decision on the matter with copies to the PI and CREB. It may approve, reject or request modifications to the research proposal. The appeal committee's decision will be final.

Approved Senate Graduate & Research Council, February 2009;
Revised CREC Oct. 2011; approved Senate Graduate & Research Council, Nov. 14, 2011
Revised CREC August 2012, approved Senate Graduate & Research Council, Sept. 10, 2012
Revised ORE August 2013; approved Senate Graduate & Research Council, September 9, 2013;
Revised ORE August 2016; approved Senate Graduate & Research Council, September 12, 2016
Revised CREC December 2019; approved Senate Graduate & Research Council, February 10, 2020
Revised CREB September 2022;

OFFICE OF THE REGISTRAR REPORT TO
SENATE UNDERGRADUATE COUNCIL and
SENATE GRADUATE & RESEARCH COUNCIL
October 2022

1. **REGULATIONS**

1.1. **Academic Calendar Dates for 2023-2024**

Symbols and abbreviations:
(M) Monday, (T) Tuesday, (W) Wednesday, (R) Thursday, (F) Friday, (S) Saturday, (U) Sunday, N/A – Not Applicable

	Fall 2023	**Winter 2024**	**Spring 2024**
Co-operative Work Term Begins	Sept. 5 (T)	Jan. 8 (M)	May 6 (M)
Classes Begin	Sept. 6 (W)	Jan. 8 (M)	May 6 (M)
Holidays	Oct. 9 (M)	Feb. 19 (M) Mar. 29 (F)	May 20 (M) July 1 (M) Aug. 5 (M)
Reading Week	Oct. 7-15 (S-U)	Feb. 17-25 (S-U)	N/A
Convocation	Oct. 20, 21 (F,S)	N/A	June 11-15 (T-S)
Classes End	Dec. 5 (T)	Apr. 8 (M)	July 30 (T)
Make-up Day(s) for in-term holidays	N/A	Apr. 8 (M) for Mar. 29 (F schedule)	May 21 (T) for May 20 (M schedule) July 29 (M) for July 1 (M schedule) July 30 (T) for May 21 (T schedule)
Pre-Examination Study Day(s)	Dec. 6, 7 (W,R)	Apr. 9, 10 (T,W)	July 31, Aug. 1 (W,R)
Examinations Begin	Dec. 8 (F)	Apr. 11 (R)	Aug. 2 (F)
In-Person Exam Days for Online Courses	Dec. 8, 9 (F,S) Dec. 13, 16 (W,S)	Apr. 12, 13 (F,S) Apr. 17, 20 (W,S)	Aug. 9, 10 (F,S) Aug. 14, 17 (W,S)
Examinations on Sunday	Dec. 10 (U)	N/A	N/A
No Exams on the Following Days	Dec. 17 (U)	Apr. 14 (U) Apr. 21 (U)	Aug. 3 (S) Aug. 4 (U) Aug. 5 (M) Aug. 11 (U)
Examinations End (including Emergency Day)	Dec. 22 (F)	Apr. 26 (F)	Aug. 17 (S)
Co-operative Work Term Ends	Dec. 22 (F)	Apr. 26 (F)	Aug. 23 (F)
Teaching days	60	60	60
Pre-examination Study Day(s)	2	2	2
Examination days	13 (+1 Emergency Day)	13 (+1 Emergency Day)	11 (+1 Emergency Day)

Guidelines for Determining Academic Calendar of Dates

The following are principles and guidelines either formally agreed upon by Senate or adopted as common practice in determining the dates for the academic year.

1. That the practice of setting dates for each academic year continues to be an annual exercise.
2. That there be no fewer than **60 teaching days** (12 weeks) in a term. A clear rationale for fewer than 60 teaching days must be communicated to Senate at the time calendar dates are approved. In calculating teaching days in a term, Saturdays, Sundays, and public or University holidays are excluded.
3. That attention be given to **balancing the number of meets** in courses. Where an imbalance may occur because of public holidays, the class schedule for a day different than the calendar day can be used to balance the number of course meets.
4. That **fall convocation** be the Friday and Saturday that fall in the third full week (beginning Sunday) of October.
5. That **spring convocation** be the Tuesday to Saturday in the second full week (beginning Sunday) in June.
6. That the **reading weeks** occur in all faculties in the fall and winter terms. They must begin on the Saturday before the public holidays of Thanksgiving Day and Family Day and will end on the following Sunday.
7. That **fall term** classes begin on the Wednesday following the public holiday of Labour Day. **Exception:** The fall term begins on Tuesday, September 8 when Labour Day is September 7.
8. That the start date for **winter term** be set as follows:
    - If January 1 is a Sunday, then start of classes is Wednesday, January 4.
    - If January 1 is a Monday, then start of classes is Wednesday, January 3.
    - If January 1 is a Tuesday, then start of classes is Monday, January 7.
    - If January 1 is a Wednesday, then start of classes is Monday, January 6.
    - If January 1 is a Thursday, then start of classes is Monday, January 5.
    - If January 1 is a Friday, then start of classes is Tuesday, January 5.
    - If January 1 is a Saturday, then start of classes is Wednesday, January 5.
9. The start date for **spring term** be set as follows:
    - If May 1 is a Sunday, then start of classes is Monday, May 2.
    - If May 1 is a Monday, then start of classes is Monday, May 1.
    - If May 1 is a Tuesday, then start of classes is Tuesday, May 1.
    - If May 1 is a Wednesday, then start of classes is Wednesday, May 1.
    - If May 1 is a Thursday, then start of classes is Monday, May 5.
    - If May 1 is a Friday, then start of classes is Monday, May 4.
    - If May 1 is a Saturday, then start of classes is Monday, May 3.
10. That there be no fewer than one **pre-examination study day** and when possible, two pre-examination study days (excluding Saturday, Sunday, and public holidays) between the end of classes and the beginning of examinations. A clear rationale for using fewer than two days or

Saturday, Sunday, and holidays as pre-examination study days, must be communicated to Senate at the time calendar dates are approved.

11. That there be no fewer than 13 **examination days** in the fall and winter terms, and 11 examination days in the spring term. In addition, one Emergency Day with no scheduled examinations is added to the end of the examination period.
12. In calculating **examination days**, Saturdays which fall within the period are included, whereas Sundays and public or University holidays are excluded.

    Exceptions:

    - Examinations will not be scheduled on the Saturday following Good Friday when that day falls within the examination schedule or the Saturday of the Civic Day weekend.
    - The first Sunday within the examination period may be used when required to accommodate the prescribed number of examination days in the fall term.

13. That for the **fall term's examination period**, no examinations be scheduled beyond December 22. The Emergency Day cannot be scheduled beyond December 23.
14. That **online course examination days** in each term be the first consecutive Friday and Saturday in the examination period.
15. **Grades due dates** for on campus courses are normally scheduled seven days from the date of the final examination. Grades for online (Centre for Extended Learning) courses that have a scheduled final examination are due on the last day of the grades submission period. Grades for all courses without a scheduled final examination are normally due 14 days after the start of examinations.
16. **Co-op work terms** are expected to be 16 week in duration. Actual start and end dates may vary depending on employer or student requirements in consultation with Co-operative Education.

Prepared by:
C. Newell Kelly, Registrar
August 2022

Rules that Require Exceptions with Rationale:

Rule 8

*That the start date for **winter term** be set as follows:*

- *If January 1st is a Monday, then start of classes is Wednesday, January 3rd.*

To allow for adequate transition time between the fall and the winter terms, classes will begin on Monday, January 8, 2024 rather than Wednesday, January 3, 2024.

Rule 9

*The start date for **spring term** be set as follows:*

- *If May 1st is a Wednesday, then start of classes is Wednesday, May 1st.*

To allow for adequate transition time between the winter and the spring terms, classes will begin on Monday, May 6, 2024 rather than Wednesday, May 1, 2024.

Rule 12

… The first Sunday within the examination period may be used when required to accommodate the prescribed number of examination days in the fall term.

With fall term classes beginning September 6, 2023, and the scheduling of two study days prior to the fall final exam period, the first Sunday within the exam period was required for scheduling exams to accommodate the prescribed number of examination days.

… Examinations will not be scheduled on the Saturday following Good Friday when that day falls within the examination schedule or the Saturday of the Civic Day weekend.

Saturday, August 3, 2024 will not be used for schedule of examinations during the 2024 spring term final exam period, as it is the Saturday of the Civic Day weekend.

Rule 14

*That **online course examination days** in each term be the first consecutive Friday and Saturday in the examination period.*

It has been determined that with the expected volume of online courses with in-person exams, additional days will be required, and therefore dates have been selected for the first a consecutive Friday and Saturday and second consecutive Wednesday and Saturday of each exam period.

UNIVERSITY OF
WATERLOO

GRADUATE PROGRAM PROPOSAL
OF
DOCTOR OF PHILOSOPHY (PHD)
IN
ENTREPRENEURSHIP AND ORGANIZATION

Submitted to the
Ontario Universities Council on Quality Assurance

VOLUME I - PROPOSED BRIEF

(SEPTEMBER / 2022)

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Brief Listing of the Program

This is a research-based program offering a Doctor of Philosophy (PhD) in Entrepreneurship and Organization, offered by the Conrad School of Entrepreneurship and Business in the Faculty of Engineering at the University of Waterloo (UW). The PhD program will include course work, a comprehensive examination, a thesis proposal, and a thesis. The program will charge tuition consistent with all other PhD programs at the institution and will be delivered as a full-time program on-campus.

1.2 Method Used for Preparation of the Brief

The brief was prepared by the Conrad School of Entrepreneurship and Business in the Faculty of Engineering. The proposal was drafted by Dr. Shavin Malhotra (Professor of Strategy) with inputs from Mark Weber (Director, Conrad School). The proposal was also discussed internally with other Conrad School faculty members and the staff and their inputs were also included in drafting this proposal. It was approved by the School on 16/November/2021 and Faculty on 15/FEBRUARY/2022.

1.3 Objectives of the Program

The objective of this PhD program is to train students to conduct independent scientific research in the domains of Entrepreneurship and Organizations. Many business schools have departments and programs in "Management and Organizations". This program's focus on Entrepreneurship and Organizations captures both what makes it the same, and different, from related programs elsewhere. Like PhDs in Management and Organizations, this program builds on the fundamental theoretical foundations of the micro, macro and meso organizational behavior and strategy literatures. What makes the program different is that, instead of primarily using a management lens, or studying behavior in management contexts, this program applies an entrepreneurial lens and studies behavior in entrepreneurial contexts. Some specific areas of research include:

- New venture creation
- Small business and entrepreneurship
- Entrepreneurial strategy
- Entrepreneurship policy
- Entrepreneurial organizations
- Family-owned organizations
- Organizing entrepreneurial firms
- Entrepreneurial cognition and decision-making
- Corporate and social entrepreneurship
- Innovation and strategic renewal within existing organizations
- Organizational management and leadership

The new PhD program is consistent with the priorities identified in University of Waterloo's strategic plan 2020-2025: "Be a global powerhouse for commercializing research,

developing new enterprises and supporting business growth". The proposed PhD program in Entrepreneurship and Organization will be the first such program offered in Canada. While there are universities that offer PhD in Management with specialization in Entrepreneurship, to the best of our knowledge, there is no such similar PhD program which is designed entirely around Entrepreneurship. A key strategy for the University of Waterloo is to continuously build on its distinguishing strengths: Experiential education, Entrepreneurship, and Transformative research – with entrepreneurship at the center of its strategic plan.

A PhD program in Entrepreneurship and Organization will not only complement UW's strategic plan, but also other programs in the Conrad School, such as the Master of Business, Entrepreneurship and Technology (MBET) program. The School's goal is to move towards a place where students view the School as their first choice for both entrepreneurial practice and entrepreneurial research. A PhD program at Conrad School will help achieve both these goals. In addition, the program will increase Conrad's research intensity, assist faculty in advancing their research programs, and position the school as a center for thought leadership in Entrepreneurship and related fields.

In addition, by offering a PhD program that focuses predominantly on Entrepreneurship, UW will seize a strategic opportunity in the marketspace. Currently, in Ontario, there is no university that offers a PhD in Entrepreneurship and Organization. While the PhD program in Business at the Ivey Business School at Western University, does offer a specialization option in Entrepreneurship, it is markedly different from the program we are suggesting. In the Western program, the PhD is offered in Business Administration, and students have an option to enroll in one of the 11 possible disciplines in the third year. One of these 11 discipline options is Entrepreneurship. On the other hand, our PhD program is entirely oriented towards Entrepreneurship, unlike the Western program, where students will only focus on entrepreneurship towards the latter end of their PhD program.

There is a growing demand for tenure-track faculty in the area of entrepreneurship and innovation. A simple search of the Academy of Management placement website shows 164 advertised faculty openings in Entrepreneurship and Innovation, while there are 111 positions in Strategy, 99 in Organizational Behavior, and 113 in Human Resource Management. This shows that there are substantially more openings in Entrepreneurship than in other major management disciplines. Also, the number of openings in the area of Entrepreneurship has increased by 6.5 percent since last year.

While this program is designed most clearly to support students in pursuit of academic careers and positions at research intensive institutions, in addition to academic positions, students motivated to pursue work with government related to innovation and entrepreneurship can pursue opportunities to shape their doctoral studies accordingly. Some, though not all, of Conrad's faculty have interests in this domain.

The program learning outcomes are listed below. By the end of this program, students will:

LO1 have a thorough knowledge of the entrepreneurship literature and more broadly of the organizational literature and be able to summarize, compare and review the main theories and frameworks in both literatures;

LO2 understand, apply and critically evaluate different scientific research methods, whether quantitative or qualitative, to test theory and hypotheses in the entrepreneurship literature;

LO3 devise theories and propose hypotheses or research questions to address an important theoretical and empirical gap in the entrepreneurship literature;

LO4 demonstrate self-direction and originality in planning, executing, tackling and solving problems in academic research;

LO5 explain and communicate complex theoretical ideas, constructs, and causal relationships clearly and effectively both through presentations and writing;

LO6 make an original and substantial contribution to the discipline and also understand and appreciate limitations of one's own work.

These learning outcomes have been mapped to the Doctoral Degree Level Expectations at the University of Waterloo and are presented in the following table:

Doctoral DLEs	LOs
1. Depth and Breadth of Knowledge. A thorough understanding of a substantial body of knowledge that is at the forefront of their academic discipline or area of professional practice including, where appropriate, relevant knowledge outside the field and/or discipline.	1. have a thorough knowledge of the entrepreneurship literature and more broadly of the organizational management literature and be able to summarize, compare and review the main theories and frameworks in the entrepreneurship literature. 2. understand, apply and critically evaluate different scientific research methods, whether quantitative or qualitative, to test theory and hypotheses in the entrepreneurship literature 3. devise theories and propose hypotheses or research questions to address an important theoretical and empirical gap in the entrepreneurship literature
2. Research and Scholarship. a) The ability to conceptualize, design, and implement research for the generation of new knowledge, applications, or understanding at the forefront of the discipline, and to adjust the research design or methodology in the light of unforeseen problems; b) The ability to make informed judgments on complex issues in specialist fields, sometimes requiring new methods; and	1. have a thorough knowledge of the entrepreneurship literature and more broadly of the organizational management literature and be able to summarize, compare and review the main theories and frameworks in the entrepreneurship literature. 2. understand, apply and critically evaluate different scientific research methods, whether quantitative or qualitative, to test theory and hypotheses in the entrepreneurship literature 3. devise theories and propose hypotheses or research questions to address an important

c) The ability to produce original research, or other advanced scholarship, of a quality to satisfy peer review, and to merit publication	theoretical and empirical gap in the entrepreneurship literature 4. demonstrate self-direction and originality in planning, executing, tackling and solving problems in academic research 6. make an original and substantial contribution to the discipline and also understand and appreciate limitations of one's own work
3. Level of Application of Knowledge. The capacity to a) Undertake pure and/or applied research at an advanced level; and b) Contribute to the development of academic or professional skills, techniques, tools, practices, ideas, theories, approaches, and/or materials.	1. have a thorough knowledge of the entrepreneurship literature and more broadly of the organizational management literature and be able to summarize, compare and review the main theories and frameworks in the entrepreneurship literature. 2. understand, apply and critically evaluate different scientific research methods, whether quantitative or qualitative, to test theory and hypotheses in the entrepreneurship literature 3. devise theories and propose hypotheses or research questions to address an important theoretical and empirical gap in the entrepreneurship literature 4. demonstrate self-direction and originality in planning, executing, tackling and solving problems in academic research 6. make an original and substantial contribution to the discipline and also understand and appreciate limitations of one's own work
4. Professional Capacity/Autonomy. a) The qualities and transferable skills necessary for employment requiring the exercise of personal responsibility and largely autonomous initiative in complex situations; b) The intellectual independence to be academically and professionally engaged and current; c) The ethical behavior consistent with academic integrity and the use of appropriate guidelines and procedures for responsible conduct of research; and	1. have a thorough knowledge of the entrepreneurship literature and more broadly of the organizational management literature and be able to summarize, compare and review the main theories and frameworks in the entrepreneurship literature. 3. devise theories and propose hypotheses or research questions to address an important theoretical and empirical gap in the entrepreneurship literature 4. demonstrate self-direction and originality in planning, executing, tackling and solving problems in academic research 6. make an original and substantial contribution to the discipline and also

d) The ability to evaluate the broader implications of applying knowledge to particular contexts.	understand and appreciate limitations of one's own work
5. Level of Communications Skills. The ability to communicate complex and/or ambiguous ideas, issues and conclusions clearly and effectively.	1. have a thorough knowledge of the entrepreneurship literature and more broadly of the organizational management literature and be able to summarize, compare and review the main theories and frameworks in the entrepreneurship literature 5. explain and communicate complex theoretical ideas, constructs, and causal relationships clearly and effectively both through presentations and writing
6. Awareness of Limits of Knowledge. An appreciation of the limitations of one's own work and discipline, of the complexity of knowledge, and of the potential contributions of other interpretations, methods, and disciplines.	1. have a thorough knowledge of the entrepreneurship literature and more broadly of the organizational management literature and be able to summarize, compare and review the main theories and frameworks in the entrepreneurship literature. 2. understand, apply and critically evaluate different scientific research methods, whether quantitative or qualitative, to test theory and hypotheses in the entrepreneurship literature 4. demonstrate self-direction and originality in planning, executing, tackling and solving problems in academic research 6. make an original and substantial contribution to the discipline and also understand and appreciate limitations of one's own work

1.4 Admission Requirements

The admission requirements will include:

1. Applicants will ideally hold a graduate degree in Business, Management, Economics, Psychology, Sociology or a related social science discipline, and must have a minimum overall average of 75%, or equivalent, in the previous degree. Those with more technical degrees (e.g., Engineering, Computer Science, Statistics) may also be considered where there is clear evidence of interest in the application of those fields to human behavior and choice in organizational or entrepreneurial settings. Applicants should highlight any prior research or research assistantship experience in their applications. The graduate degree could be a one or two-year program. There are several programs at University of Waterloo whose graduates might wish to apply to our PhD program. These include: Master of Business,

Entrepreneurship and Technology (MBET) (Conrad), Master of Management Sciences (MMSc), Master of Arts (MA) in Economics, Master of Accounting (MAcc), Master of Quantitative Finance (MQF), Master of Arts (MA) in Psychology. Those with degrees in computer science and engineering, especially where modeling human behavior has been a focus or interest, may also find this program appealing.

2. In exceptional cases, where a student has performed extremely well in a 4-year honours degree in one of the domains listed above, and excelled in a scholarly research project, applicants can gain direct admission to the PhD program with the agreement of the Committee, Associate Director, Research and Doctoral Studies, and the Director of the Conrad School.
3. GMAT or GRE results are required for domestic and international applicants to the PhD program. Applicants should have written these tests within the past five years.
4. All applicants must submit their transcripts, a CV and a 'Statement of Purpose' highlighting their academic background, prior experience in conducting research, area of research interest, their interest in Conrad's PhD program, and proposed research studies.
5. Applicants must also submit three letters of reference, of which at least two should be academic references and one can be professional.
6. Applicants must satisfy the University's English language proficiency requirements. For this program, we will require the "higher scores" option (as listed in the above link).

1.5 Structure

The PhD program is structured in a way so as to meet the above listed learning outcomes. The students will first complete mandatory course work. They will then be tested on their ability to carry out an independent study through a comprehensive exam; this will be followed by a thesis proposal defense. Students will then submit a written thesis followed by an oral defense. Our intention is to have students complete the program by the end of their fourth year.

1. complete the required course work (in the first three terms of the program);
2. pass a comprehensive examination (by the end of Term 4);
3. present and defend a Thesis proposal (by the end of Term 8);
4. document their research work in a thesis document followed by an oral defence (by the end of Term 12).

Timeline

Activities	Terms											
	1	2	3	4	5	6	7	8	9	10	11	12
1: Courses												
2: Comprehensive exam												
3: Thesis proposal												

4: Thesis and defence												

A more detailed discussion of the courses and the other requirements is provided in Sections 1.6, 1.8 and 4. Moreover, under Assessment of Teaching and Learning (Section , 1.8), we provide a detailed explanation on how assessments of these program requirements help achieve our learning outcomes.

Effect of Structure on Quality

The PhD program includes intensive coursework, a comprehensive exam, a thesis proposal, and rigorous research work culminating in the completion of a thesis document that will make an original and distinct contribution to entrepreneurship research. As students go through the program, they will gain experiential education and training in the area of entrepreneurship and organization. All of these elements are essential to the development of an academic scholar in the area of entrepreneurship. Students are expected to complete the program in 12 terms (4 years) with approximately one-third time devoted to coursework and the remaining time devoted to extensive research work. The PhD program in Entrepreneurship and Organization will provide students with a strong understanding of the strengths and limitations of a wide range of quantitative and qualitative methods, theories used in entrepreneurship research, while also developing their skills to carry out their own independent research. The length and depth of course work and research training is in line with most PhD programs at University of Waterloo (for examples, please see PhD in Management Sciences; and PhD in Pure Mathematics).

1.6 Program Content

The program will focus on entrepreneurship and organization; however, within this area, students can focus on several areas of research such as*, new venture creation, small business and entrepreneurship, entrepreneurial strategy, entrepreneurship policy, entrepreneurial organizations, family-owned businesses, entrepreneurial cognition and decision-making, corporate and non-profit entrepreneurship*, and *organizational management and leadership*. While entrepreneurship is an established area in other business schools, rarely do these schools focus on such a wide array of topics in this field. Having an entrepreneurship doctoral program that encompasses many interesting topics will put Conrad School and UW at the forefront of Canadian entrepreneurship graduate programs.

The expertise of the tenured and the tenure-track faculty at Conrad School covers these areas of specializations and will allow them to contribute to graduate courses and supervisory committees. Evidence for this is provided in the curriculum vitae of the individual core faculty members (Volume II).

Coursework

The students will complete the coursework in the first 3 terms of the program. The course work will consist of five courses. These courses will help the student become familiar with advanced topics in entrepreneurship and in their particular area of study. During these

courses, students will develop applied skills and learn methodologies that will become useful over the execution of their research work.

Required courses will include:

- Entrepreneurship Theory (New Course – BET 701)
- Organization Behavior (New Course – BET 702)
- Business Strategy (New Course – BET 703)
- Business Research Methods (New Course – BET 704)
- Two graduate level method or data analysis courses from the following options:
    - Applied Microeconometrics I (Existing course – ECON 622)
    - Advanced Analysis of Variance (Existing course – PSYCH 630)
    - Multiple Regression (Existing course – PSYCH 632)
    - Qualitative Methods (Existing course – SOC 716)
    - Quantitative Data Analysis for Management Sciences (Existing course – MSCI 609)

(Students who have taken prior graduate-level statistics or data analysis courses can request an exemption from one of the two method or data analysis course requirements). The criteria for selecting an appropriate statistic or a data analysis course will be based on the students' research interest (for example a student may wish to do a qualitative study as part of their thesis). The student supervisor (in consultation with the student) and the Associate Director, Research and Doctoral Studies will need to approve the course selection. We have consulted with all these departments (Economics, Psychology, Sociology, and Management Science), and they are all on board.

Details on these courses are provided under Section 4.4.

A supervisor, in consultation with the student and the Associate Director, Research and Doctoral Studies, may advise the student to take additional courses, anytime during the program, if the courses directly advance the student's work on their thesis.

Other Requirements

In addition to completion of the course requirements, students must complete the comprehensive examination, thesis proposal and thesis and defense. We discuss these briefly below and present a more detailed discussion around their assessments in Section 1.8.

Comprehensive Examination. Students will take their comprehensive exam in the fourth term. The comprehensive examination will measure the breadth and depth of the candidate's knowledge of the academic discipline, and the qualitative and quantitative methods in that discipline. A committee of faculty members who taught the core courses will set the comprehensive examination.

Students must complete the comprehensive exam before proceeding to their thesis. Please refer to UW's guidelines on completion of the comprehensive exam.

Thesis Proposal. As part of the degree requirements, each student will present their thesis proposal to a Thesis Examination Committee. The exam will include a critical assessment of students' thesis proposal based on a written report provided in advance. The Committee will examine the candidate's understanding of the proposed research, suggested theoretical framework, methods, and whether the proposed research makes an original contribution to the candidate's academic discipline. The candidates will present their thesis proposal latest by the end of the 8th term.

The PhD thesis proposal experience serves two main purposes:

- To examine and approve students' thesis proposals;
- To verify that students have complete understanding of the proposed research, suggested theoretical framework, methods, and whether the proposed research makes an original contribution to the candidate's academic discipline.

Thesis and Defence. In terms 9 to 12, candidates will work on their thesis and aim to defend their thesis by the end of the 12th term or the fourth year. This thesis must contain original research which makes a distinct contribution of knowledge to entrepreneurship and organization research, and the candidate will submit and later defend their thesis to their supervisory committee.

Program Innovations

The inclusion of the multidisciplinary area of entrepreneurship in the program is an innovative aspect. The entire PhD program will focus on the context of entrepreneurship, which will be the first of its kind in Canada. Some innovative features include:

- During the course work and the comprehensive, students will get in-depth understanding of theories and methods that apply specifically to entrepreneurship research.
- Students will be exposed to a variety of different start-ups and entrepreneurs due to Conrad School's and UW's close association with Communitech and the Accelerator center.
- Conrad School and UW's access to start-ups will also provide excellent access for students to collect data for their theses.
- Easy access to one of the largest and most dynamic university entrepreneurship ecosystems embedded in one of the world's most dynamic tech innovation hubs is of high potential value to doctoral students in this area.

1.7 Mode of Delivery

This program will combine both coursework and research. The courses will normally be delivered in a face-to-face setting by the instructor. In these courses, students will commonly complete weekly reading assignments and prepare to participate in focused discussions in the classrooms. Students will be expected to accomplish independent and original research work. They will work closely with their supervisors and the work will

involve both a theoretical and an empirical component. It will also include a proposal defence, a written thesis report and a final oral defence.

1.8 Assessment of Teaching and Learning

Assessment of Student Achievement of the Learning Outcomes and DLEs
In the table below, each learning outcome is mapped to the DLEs and the program assessment activities.

LOs	**PhD DLEs**	**Assessment activities**
1. have a thorough knowledge of the entrepreneurship literature and more broadly of the organizational management literature and be able to summarize, compare and review the main theories and frameworks in the entrepreneurship literature.	1,2b,3,4b,4d,5, 6	Independent research essays in courses, annotated bibliographies and literature reviews; presenting workshop and seminars in course work; comprehensive exam defense; thesis proposal defence and thesis defence (both oral and written).
2. understand, apply and critically evaluate different scientific research methods, whether quantitative or qualitative, to test theory and hypotheses in the entrepreneurship literature	1,2a,2b,3,6	Research essay and project assignments in courses; method course exam; comprehensive exam; thesis proposal defence; thesis and defence.
3. devise theories and propose hypotheses or research questions to address an important theoretical and empirical gap in the entrepreneurship literature	1,2,3,4	Thesis proposal defence; Thesis and defence (both oral and written); Conference paper submissions.
4. demonstrate self-direction and originality in planning, executing, tackling and solving problems in academic research	2a,2b,3,4,6	Thesis proposal defence; Thesis and defence (both oral and written)
5. explain and communicate complex theoretical ideas, constructs, and causal relationships clearly and effectively both through presentations and writing	5	Course presentations; Research essays in coursework; Thesis proposal defence; Thesis and defence (both oral and written); Students in the program will participate in conferences and present research seminars.
6. make an original and substantial contribution to the	2c,3,4a,6	Thesis proposal defence; Thesis and defence (both oral and written)

discipline and also understand and appreciate limitations of one's own work		

Below we provide more details around the assessment activities.

Research Essay: Instructors will assess students on their research essays in their coursework. Most courses will require an independently produced research essay or in-depth research-creation project. Instructors will assess students' essays for their level of critical engagement, breadth of knowledge, and lucidity and concision of expression.

Course Presentations: Instructors will also require students to present work orally to the class in the form of seminars. Through seminars, instructors can assess how well the students present their ideas, cogently and coherently summarize material for the class, engage the class in meaningful discussion, and present original research material in a compelling and accessible manner.

Course Exam (method courses)*:* Method courses will have an end of the course exam that will assess students' knowledge, understanding (recalling, describing, recognising, relating, comparing) and application of different qualitative and quantitative methods in the field of entrepreneurship and more broadly in management. The exam will use a mix of multiple choice and essay questions to accommodate different student strengths.

Comprehensive Examinations*:* Students will take their comprehensive exam in the fourth term. The comprehensive examination will test students' competence in applying both the theoretical and methodological material covered in the courses. It will assess whether the student is ready to begin independent research work. The comprehensive examination questions will be proposed by the comprehensive examination committee. The committee will consist of faculty members that have taught the core courses. In the comprehensive exam, the examination committee will assign three research questions to the students. The students will select one of these questions or suggest a slightly modified version of one of the questions. In all cases the question(s) must serve to require the substantive breadth covering different courses. The students will write a research study that will address this question. The research study will include relevant background information, literature review, hypotheses, discussion of potential methods to test the hypotheses, a description of how results will be interpreted, and a discussion of possible problems in implementing the method and how those problems could be addressed. The students will submit the written study 10-14 days before the oral examination with the comprehension examination committee. The comprehensive will be assigned either a pass, passed conditionally, or re-examination. The purpose of these categories is to offer students early feedback on the degree to which they are demonstrating competence with the program material. In the case of re-examination, Conrad will follow the UW's guidelines on completion of the comprehensive exam.

Thesis proposal. The thesis is the capstone assessment of the program. Its assessment begins with the submission and the defence of a proposal by the end of term 8. The students will present their thesis proposal in front of their Thesis Supervisory Committee (Thesis Committee here onwards), which will include at least three, and typically no more than six, faculty members as follows:

- The supervisor, along with the co-supervisor, if there is one.
- Two tenured or tenure-track faculty members from Conrad School.
- One tenured or tenure-track faculty member from outside Conrad School but from within University of Waterloo.
- In addition, at a later time but before the Thesis defence, one external member from outside UW will be added to the committee. This external member should have expertise in the area of research of the thesis and meet all other Graduate Studies and Postdoctoral Affairs criteria regarding the selection of external reviewers. Selection of the external examiner will be made by the Supervisor, in consultation with the Associate Director, Doctoral Studies.

The student must write a thesis proposal and submit it to the Thesis Committee at least one month prior to the examination. In their proposals, they should identify the research problem, review the relevant literature, describe the tasks planned to solve the problem, and propose a timetable for the completion of the project and the defence of the PhD thesis. Students, with the approval of their supervisor(s), may wish to distribute background working papers to members of the thesis committee to provide further evidence of background preparation.

The exam will start with students presenting (oral presentation) the main parts of their thesis proposal in about 30 minutes. Following the presentation, the students will answer questions from the thesis committee. The thesis committee will assess students' thesis proposal on the basis of its potential contribution to knowledge (originality, quality, quantity), research adequacy and thoroughness, understanding of the subject (review of previous work, choice of project), presentation (organization, grammar, style, bibliography), and overall quality. The thesis committee will decide if the proposal is passed, passed subject to completion of recommendations or the student will appear for a re-exam within six months of the exam.

Thesis and Defence. PhD candidates will submit a thesis to their thesis committee latest by the end of term 12 (end of the fourth year) of their program. Any student who requests an extension to this time limit will need to follow the graduate studies guidelines on program extension. Students will be required to follow the University's PhD thesis examination regulations.

A thesis must ensure that breadth of knowledge and skills are acquired by doctoral candidates through highly specialized, independent, original research which makes a distinct contribution of knowledge to the entrepreneurship discipline.

The completed thesis goes forward to defense when each of the internal faculty members on the student's thesis committee deem it ready to be evaluated. (Although per Graduate Studies guidelines, a negative assessment by the internal faculty members does not preclude the student to proceed to defence, such a case will be rare). The thesis is then submitted to a reviewer external to the university, who writes a report assessing the thesis project on the grounds of its contribution to knowledge in the area of entrepreneurship, adequacy and thoroughness of the research (review of previous work, theoretical arguments, robustness of the analytical methods, evaluation of results, validity of conclusions), presentation (organization, grammar, style, bibliography), and overall quality. To pass, the student must demonstrate, both in the written report and in the defence, an in-depth intellectual engagement with a scholarly field; a demonstrable ability to stay current on research in the field; the ability to carry out insightful, rigorous, and original research or research-creation; an appreciation of the complexities and limitations of knowledge; the intellectual independence and initiative to plan and accomplish a long-term research project; the ability to communicate one's research; the ability to produce original, sophisticated, convincing work of a quality to satisfy peer-review.

Documenting and Demonstrating the Level of Performance of Students

The level of student performance in terms of learning outcomes will be assessed using a number of sources of data. Each source of data will provide an indicator of the level of achievement for learning outcomes. Below is a list of planned data sources.

- Assessment of student deliverables, such as course assignments, course exams, course project reports, comprehensive exams, thesis proposal, and thesis defence.
- Annual supervisory meetings. As part of the annual supervisory committee review, students will be asked to complete a self-assessment, reflecting on their intellectual and professional growth through the past year, setting goals for the coming year.
- Students' activities in the public sphere: offering conference papers, engaging in teaching activities—each student will be offered a teaching assistantship in their second and third year of the program and where possible, an opportunity to teach a course during their third and fourth year of the program), publishing work in academic and non-academic venues, securing external funding, etc. All of these will be tracked by the supervisor as part of the annual supervisory meetings with the students.
- The success of the proposed program will also be evaluated by students themselves through exit surveys and reflective essays upon degree completion.
- Alumni surveys to measure the degree to which past students believe they achieved program-level learning outcomes and overall satisfaction with the program. It will be collected every three years.
- Thesis assessment forms: the thesis committee will assess the thesis on the depth and breadth of knowledge, novelty, research and scholarship, critical thinking, application of knowledge, communication skills (both written and oral), robustness of methods used, and awareness of limitations of the study, using a rubric with a three point likert scale (does not meet expectations, meet expectations, exceed expectations).
- Further the formal IQAP cyclical program review process will offer a detailed reflection on the success of the program.

1.9 Fields in a Graduate Program [optional]

Not applicable.

2. HUMAN RESOURCES

The Conrad School of Entrepreneurship and Business currently has a total of fourteen full-time faculty members. Faculty who are primarily engaged in entrepreneurship and management research include eight tenured or tenure-track faculty members (all of whom are able to teach and supervise PhD students), and an additional three lecturers who are engaged in applied entrepreneurship research. Active areas of research include but are not limited to: financing of new entrepreneurial ventures, entrepreneurship strategy, entrepreneurship education, international entrepreneurship, leadership and decision-making, entrepreneurship policy and ecosystems, social enterprise and organizational behaviour. The diversity of research areas within the School ensures that PhD students will have opportunities to pursue a wide range of topics in the entrepreneurship area.

Further, faculty members have a wide range of methodological expertise from sophisticated econometric research using large-scale databases, to experiments, to survey research, to data science, to policy analysis and ethnography.

Our existing faculty and administrative support staff have capacity to manage the requirements of launching a new doctoral program. We also anticipate the addition of several more tenure-stream faculty over the next four years to accommodate other program growth at Conrad that has been approved in principal by the Dean of Engineering. Finally, we will add of a new role of Associate Director, Research and Doctoral Studies. This new role will have clear responsibility for doctoral program oversight and leadership, but also for spearheading research intensification and support initiatives that are part of Conrad's strategic plan and objectives.

2.1 Resources for Graduate Programs Only

All nine faculty members will be eligible to supervise the PhD students. The School is in the process of obtaining the ADDS (Approved Doctoral Dissertation Supervisor) status for these faculty – they all meet the Graduate Studies and Postdoctoral Affairs (GSPA) qualifications for the ADDS status.

For the first three years of the PhD program, we anticipate the six tenured faculty members to share the supervisory load of the PhD students. Given our projections (See Table 4), this would amount to supervision of 2 students per faculty member in the first three years. We anticipate that both our tenure-track faculty members (who are currently not tenured) would also begin to supervise from Year 4 and we expect one or two new hires who would also supervise PhD students from Year 4 onwards.

In Section 2.6, we elaborate on the quality of Conrad School faculty to contribute to the PhD program.

2.2 List of Faculty by Field

The Conrad School of Entrepreneurship and Business currently has a diverse faculty group consisting of various expertise and backgrounds. Our eight tenured or tenure-track faculty members (all of whom are able to teach and supervise PhD students) include:

Harvir Bansal, Tenured Associate Professor, specializes in methods and data analytics, marketing, and services marketing;

Nada Basir, Tenure-track Assistant Professor, specializes in strategy, organizational and institutional theory, start-ups, and social enterprise;

Janet Boekhorst, Tenure-track Assistant Professor, specializes in entrepreneur, leader, and employee wellbeing; compassion in the workplace; star performers; and diversity and inclusion.

Victor Cui, Tenured Associate Professor, specializes in entrepreneurship, strategy, and international business

Margaret Dalziel, Tenured Associate Professor, specializes in entrepreneurship, entrepreneurship policy, entrepreneurship ecosystems and entrepreneurship support systems

Shavin Malhotra, Tenured Full Professor, specializes in organizational strategy, entrepreneurship, and international business;

Horatio Morgan, Tenured Associate Professor, specializes in immigrant entrepreneurship, and internationalization of small and medium sized enterprises

Mark Weber, Tenured Full Professor, specializes in organizational behavior, social psychology, decision-making and leadership;

The detailed CVs of these faculty members are provided in Volume II.

In addition to these core research faculty, Conrad School has three full-time lecturers who conduct and publish research, two as part of their normal duties. They are:

Christopher Holt, Lecturer, specializes in entrepreneurship education

Marc Hurwitz, Lecturer, specializes in leadership and collaboration

Doug Sparkes, Lecturer, specializes in technology innovation and entrepreneurship education

Table 1 lists the above faculty members. Please note that currently only Howard Armitage holds the Approved Doctoral Dissertation Supervisory (ADDS) status. The School has initiated the process of applying for the ADDS status for the remaining faculty members. Since Conrad School has not had a research graduate program, this process has been unnecessary till now. All of the faculty members meet the GSPA qualifying requirements for the ADDS status. The Director of the Conrad School has submitted these files for consideration and we are awaiting formal recognition.

Currently, the Conrad School does not have any approved fields of study and does not plan to propose any for the new PhD program. Table 1 was completed by IAP.

TABLE 1

Faculty Members Involved in Proposed Program				
Faculty Name	**Rank (Professor, Assistant, etc.)**	**Gender (M/F/U)**	**Home Unit [1]**	**Supervisory Privileges [2]**
Harvir Bansal	Associate Professor	M	Conrad School	Full
Nada Basir	Assistant Professor	F	Conrad School	Full, awaiting formal approval
Janet Boekhorst	Assistant Professor	F	Conrad School	Full
Victor Cui	Associate Professor	M	Conrad School	criteria believed to be satisfied, approval in process
Margaret Dalziel	Associate Professor	F	Conrad School	Full
Shavin Malhotra	Professor	M	Conrad School	Full
Horatio Morgan	Associate Professor	M	Conrad School	criteria believed to be satisfied, approval in process
Mark Weber	Professor	M	Conrad School	Full
Christopher Holt	Lecturer	M	Conrad School	Co-supervisor
Marc Hurwitz	Lecturer	M	Conrad School	Co-supervisor
Doug Sparkes	Lecturer	M	Conrad School	Co-supervisor

Notes:

1. This is the home department of the faculty member associated with the program under review.
2. The level of supervisory privileges held by each faculty member, e.g. full, masters only, co-supervision only, etc.

2.3 External Operating Research Funding

Table 2 presents the external research funding by source received by the core faculty for the past seven years. The table was compiled by IAP.

TABLE 2

Operating Research Funding ($) by Source and Fiscal Year[1]				
Fiscal Year[2]	**Tri-Agency Awards[3]**	**Public Sector and Non-Profit Funding[4]**	**Internal Awards**	**Total**
2012/13	$0	$130,321	$0	$130,321
2013/14	$15,000	$437,168	$0	$452,168
2014/15	$56,500	$410,763	$0	$467,263
2015/16	$67,188	$584,675	$0	$651,863
2016/17	$67,373	$138,400	$0	$205,773
2017/18	$59,048	$785,074	$0	$844,122
2018/19	$74,188	$166,200	$1,520	$241,908
Totals	$339,297	$2,652,601	$1,520	$2,993,418

Notes:

1. Data is reported on the primary investigator only. Table includes research awards for primary investigators included in Table 1.
2. Data is reported on the fiscal year. Waterloo's fiscal year runs from May 1st in one year until April 30th in the subsequent year, and includes three consecutive terms – Spring, Fall, and Winter. Please update the seven year window as appropriate.
3. Excludes equipment grants (e.g. NSERC RTI).
4. Excludes equipment grants and internal awards (e.g. CFI, UW-RIF, UW-SSHRC).
5. Includes funding received from Industry partners.
6. Includes UW-RIF and UW-SSHRC.
7. Includes NSERC-RTI and CFI.

2.4 Graduate Supervision

Table 3 presents the number of completed thesis supervisions for each of the core faculty members over the course of their career, and the number of thesis supervisions currently underway.

TABLE 3

Completed and Current Numbers of Thesis Supervisions by Faculty Member						
Faculty Name and Rank[1]	**Total Completed Over Career[2]**			**Current[3]**		
	Master's	**PhD**	**PDF**	**Master's**	**PhD**	**PDF**
Harvir Bansal, Associate Professor	0	0	0			
Nada Basir, Assistant Professor	0	0	0			
Janet Boekhorst, Assistant Professor	0	0	0			
Victor Cui, Associate Professor	0	1	0		1	
Margaret Dalziel, Associate Professor	2	0	0			
Shavin Malhotra, Professor	12	1				
Horatio Morgan, Associate Professor	5	0	0			
Mark Weber, Professor	0	1	0			

Notes:

1. Faculty members and ranks as specified in Table 1.
2. Number of thesis supervisions completed thus far over the faculty member's career.
3. Number of current thesis supervisions underway for each faculty member.

Table 3 understates the supervision capacity of Conrad School faculty. As an example, Mark Weber was significantly involved in the research training of several doctoral students at University of Toronto, including publishing two-authored papers with doctoral students, but was not their direct supervisor. Further, many faculty have served actively on the committees of doctoral students in other areas. For example, almost all of these faculty members have served as dissertation committee members for Management Science PhD students. Conrad School faculty have not had the opportunity to supervise research students in the absence of research programs.

2.5 Commitment of Faculty from Other Graduate Programs/Other Institutions

The Conrad School has developed collaborations with other units within the University of Waterloo that will provide additional support to the PhD program. Of particular relevance are collaborations with the Department of Management Sciences, Department of Economics and the School of Accounting and Finance. Currently, for example, many Conrad School faculty are cross-listed in the Department of Management Sciences, and can participate as co-supervisors or committee members in their PhD program. We also sustain positive relationships with the School of Accounting and Finance, which can offer support

of finance related projects, and in which there are several experimentalists with complementary interests to Conrad School faculty. While the main supervisor of our PhD students will be from Conrad School, the other members of the supervisory committees may be from other Departments/Schools at UW, including Management Sciences, Economics and Accounting and Finance, and possibly the industrial/organizational group in Psychology. In addition, one of the core courses will be housed in either of these Departments/School.

2.6 Quality of Faculty

Research quality of faculty is primarily measured through their publications, citations and success in obtaining funding from external agencies. By these measures, the Conrad School faculty has had considerable success considering that there are currently only eight tenure-stream faculty members. Conrad School faculty have secured nearly $3 million (see Table 2) in funding over the past 7 years to support their research despite not having access to graduate research students and when funding through agencies such as SSHRC has been historically challenging.

Conrad School tenure-stream faculty members have authored or co-authored 89 papers in the management literature in the last seven years (please see Vol. II). In addition, the faculty have published four books or monographs and four technical papers during the same period. The published research of Conrad's seven tenure-stream faculty has attracted almost 15,000 citations (Google Scholar). The group has produced 22 papers that have attracted at least 100 citations or more, 11 papers with 250 citations or more and 5 papers with 500 citations or more. Two thirds of the group have at least one paper that has more than 100 citations. Our newly hired junior faculty member arrived on July 1, 2018 with nine peer reviewed publications, including a solo authored piece in a Financial Times 50 journal. In addition, Shavin Malhotra was appointed as the inaugural Conrad Research Excellence Chair. Since Shavin's appointment, we have added two additional Conrad Research Excellence Chairs – Janet Boekhorst and Victor Cui. These appointments are based on a set of criteria to select those whose recent research output is comparable to the best researchers anywhere. We have a small but dense cluster of top-flight research talent and its trajectory is unquestionably positive.

Besides research, Conrad School has rapidly built a reputation for the quality of its teaching. Members of the faculty have received numerous teaching awards within the University of Waterloo and elsewhere. Collectively, the Conrad School faculty has both research and teaching expertise to contribute substantively to this PhD program.

3. PHYSICAL AND FINANCIAL RESOURCES

As this is a PhD program, the tuition for this program is expected to be comparable to the rate of $2,254 per term for domestic students and $7,396 per term for international students that is currently associated with the PhD program at the University of Waterloo as of Fall 2021. It is anticipated that the majority of the students will be domestic students. As we show below in Table 4 on 'Projected student intake and enrolment', we are not planning a large intake of students, so we are confident that we will be able to get enough strong domestic applications. Also, unlike engineering, where there may be a larger cohort

of international students, most PhD programs in Strategy, Entrepreneurship, and Organizational Behavior have a much more balanced cohort of domestic and international students. For example, the link below shows the current PhD students at Ivey Business School. Off those who mention their previous education, in the area of Entrepreneurship, there are three domestic and three international students, in strategy, there are two domestic and three international students, and in OB, there is one domestic and one international student.

https://www.ivey.uwo.ca/phd/students/

Conrad School has sufficient physical space to support the PhD program and will not require any additional physical or computer resources to sustain the program.

3.1 Library Resources

This section is written by a representative of the University Librarian, using a standard format.

Report provenance
Written by Rachel Figueiredo, Engineering & Entrepreneurship Librarian, rachel.figueiredo@uwaterloo.ca
Reviewed by Jennifer Haas, Department Head, Information Services and Resources, Davis Centre Library, j2haas@uwaterloo.ca
Victoria Chu, Associate University Librarian, Learning, Research and User Services, victoria.chu@uwaterloo.ca

Level of support summary

The Library provides a high level of support for the existing programs and courses offered through the Conrad School of Entrepreneurship and Business. Currently, a Liaison Librarian with responsibilities for supporting multiple engineering departments and programs, as well as campus-wide curricular and co-curricular entrepreneurship initiatives, supports the Conrad School. This Librarian is highly-skilled with expertise to support the research needs of the PhD program in Entrepreneurship and Organization, however actual support may be limited by capacity. Should the PhD program in Entrepreneurship and Organization require more extensive and dedicated librarian support beyond what is currently available, the Library is committed to engaging in discussions with the Conrad School to explore implications and opportunities.

Strengths of support provided

The University of Waterloo Library curates a collection for both the practical and theoretical approaches to entrepreneurship studies. This collection includes research databases, full text journals, and monographs. Some of the research databases of particular interest to these subject areas include Frost and Sullivan, IBISWorld, MarketLine Advantage, Scopus, Business Source Elite, Factiva, and ABI/Inform. The Library provides access to journals of particular relevance to the Conrad School, including the Academy of Management Journals, Administrative Science Quarterly, Organization Science, Entrepreneurship Theory and Practice, and Journal of Business Venturing. In addition to

the local collection, the University of Waterloo Library partners with other Ontario and Canadian universities to further expand access to relevant resources. Such collaborations include the Ontario Council of University Libraries (OCUL) and the Canadian Research Knowledge Network (CRKN). Assuming the Library's acquisitions budget remains stable, current collection strengths would support the new program. Should new subject areas emerge or if research intensity develops in subject areas currently outside of collection priorities, the Library is committed to engaging in discussions to articulate collection needs and assess funding implications.

The Engineering and Entrepreneurship Librarian provides research, teaching and learning support for students and faculty. Instructional support includes the development of research guides as well as the preparation of classroom sessions and outcomes-based workshops. The Librarian also offers weekly office hours in the Conrad School to consult with individuals to support coursework, market research, publication of research, meeting open access requirements, and copyright.

More information

The Library would be happy to be meet with the program reviewers to discuss this report and answer their questions.

For additional information about University of Waterloo Library and the support it provides for programs, please visit https://uwaterloo.ca/library/about/policies-and-guidelines/support-academic-programs.

3.2 Laboratory Resources

Not applicable.

3.3 Computer Facilities

PhD students will have access to the Department's printers as well as the support of the Engineering Computing Department. Students are required to provide their own laptops and standard software. All tailored software that directly relates to the research will be provided by the Conrad School.

3.4 Space

The Conrad School occupies most of the second floor of Engineering 7 at the University of Waterloo. This space includes ample offices, seminar rooms, and classroom space to support the proposed program. Doctoral students will share dedicated office space, with two PhD students per office.

In addition, there is lounge space that can be shared with faculty and lounge space that can be shared with professional Master's students.

3.5 Financial Support

Conrad School will follow the minimum value of Graduate Research Studentships mandated for Faculty of Engineering PhD students (please see https://uwaterloo.ca/engineering/future-graduate-students/funding-and-awards).

Currently, this amounts to $25,000/year for four years (12 terms). Students may also have the opportunity to take on assignments as Teaching Assistants (TA) in Conrad's undergraduate and Masters programs, and also in the clinical and professional practice courses of the undergraduate curriculum (please refer to UW's compensation rates). In addition, these students will be eligible to apply for Faculty of Engineering Scholarships and Tri-Council Scholarships.

4 CURRICULUM

4.1 The Intellectual Development and the Educational Experience of the Student

Seminars are a vital part of most PhD programs and give faculty and students an opportunity to discuss their research topics. It fosters critical debate, important in developing one's grasp and understanding of their subject. In the PhD program, courses on organizational behavior, business strategy and entrepreneurship theory, will be offered predominantly as seminars as opposed to lectures. These seminars will facilitate the integration of related sub-disciplines, critical thinking, and the synthesis of ideas often crossing disciplinary boundaries. Fundamental to these seminar courses are group discussions among peers, facilitated by faculty, and student presentations. Students will often be invited to take a lead role in the preparation of a seminar and chairing the discussion.

Seminars will help PhD students learn by:

- applying knowledge from lectures and background reading;
- testing their understanding of their subjects and developing new insights;
- observing other people's approaches and ideas;
- clarifying any concepts that are not clear.

In addition to seminars, a student's supervisor will support the student's progress through the program through regular meetings, including an annual committee meeting, meetings to discuss preparation for the comprehensive exams and regular thesis meetings. When appropriate, faculty in the program will engage students as research assistants, where they can collaborate and co- publish papers on topics of their interests and expertise. This will ensure that students are provided with support and mentorship in learning the processes involved with preparing and disseminating intellectual work.

While PhD students will be encouraged to participate in workshops on teaching and research offered by UW, these will not be a part of their program deliverables.

a. The students will be asked to participate in the UW orientation program. In addition, Conrad School will also run its own 3-day orientation event, which will introduce new students to Conrad School and its PhD program, discuss the PhD process, deliverables, and learning outcomes. We will invite representatives from Velocity, Communitech and Grand Innovations to talk about their centers and share information on their data hubs and data collection opportunities at their centers. The event will also explore what it means to work in academia, including various aspects related to the publication of their research. We will

also invite a representative from the Library, who will share specific library services and electronic resources of interest to PhD students. We will also host a citation and bibliography workshop through the University of Waterloo's writing and communication center during the first term of the program. In addition, in the first year, we will introduce site visits at Velocity, Communitech and Grand Innovations for PhD students to meet the startup community in Kitchener-Waterloo. Finally, we will also Invite entrepreneurs from the Kitchener-Waterloo region to give talks to both our PhD and MBET students, where they discuss their struggles and successes as an entrepreneur. This will provide expose our PhD students to interesting research questions they can pursue as part of the course term papers or for their thesis.

Conrad School will offer up to $2,500 per student per year for conference travel. However, this funding will be restricted to students who are presenting their research at a conference. In addition, students will be encouraged to apply for travel funding through the Graduate Studies Research Travel Assistantship program (https://uwaterloo.ca/forms/graduate-studies/graduate-studies-research-travel-assistantship-application).

4.2 Program Regulations

The admission policies have been discussed in detail earlier (please see 1.4). We have also discussed the course requirements (see 1.6 'course requirements'), comprehensive and thesis evaluation procedures (see 1.8) and annual student assessments (see 1.8 "Documenting performance of students") earlier. There are no co-op placements in this program.

To maintain good standing during the coursework, students have to maintain a minimum average of 75%.

4.3 Part-time Studies

This will be a full-time program. There are no part-time options.

4.4 Curriculum

Below we provide a brief description of the courses. We have also included the course activation forms for each of the new courses at the end of the report; please click titles to see these forms.

Entrepreneurship Theory (New Course – BET 701)

This course will offer insights into the main theories and issues in the studies of entre-/intrapreneurship and innovation. It will also discuss the complex and dynamic reality of the entrepreneur and the innovating organization as well as explore research traditions, methodologies, and approaches in entrepreneurship research.

Organizational Behavior (New Course – BET 702)

This course will offer an understanding of classic and contemporary issues in organizational behavior. Drawing on theory and research in psychology, social psychology, and

organizational behavior, this course will explore individual, interpersonal, and group processes in work organizations.

Business Strategy (New Course – BET 703)
This course will examine the current state of knowledge in strategic management. Topics may include the sources of competitive advantage, the role of industry evolution and technology, the organization of top management, and managerial decision-making and cognition. It will also cover alternative theoretical perspectives and available empirical evidence related to these topics.

Business Research Methods (New Course – BET 704)
The course will examine the different stages in the research process beginning with how to frame research questions, speculate hypotheses, understand the merits of alternative research methods, and cover topics and provide examples in areas such as experimental design, survey design, case studies, and archival research. By the end of the course, students will be prepared to critically evaluate research method and design choices for their own research.

In addition to the above four courses offered through the Conrad School, students will also be required to successfully complete one graduate level method or data analysis course from the following options:

- Applied Microeconometrics I (Existing course – ECON 622)
- Advanced Analysis of Variance (Existing course – PSYCH 630)
- Multiple Regression (Existing course – PSYCH 632)
- Qualitative Methods (Existing course – SOC 716)
- Quantitative Data Analysis for Management Sciences (Existing course – MSCI 609)

Note: With two recent senior faculty hires, the current faculty at Conrad School can readily staff the four new courses listed here through the rearrangement of current teaching commitments.

4.5 Collateral and Supporting Departments

As stated earlier, there are natural synergies between Conrad School and a number of other excellent research-intensive departments at UW, including Management Sciences, within our own Faculty, and the School of Accounting and Finance, and the Department of Economics in the Faculty of Arts.

4.6 Organizational Structure

This PhD program will be based in the Conrad School of Entrepreneurship and Business, Faculty of Engineering. The Faculty of Engineering will be involved in offering this program and no other institutions other than the University of Waterloo will be directly involved in offering this program. The PhD program in Entrepreneurship and Organization will be

managed by an Associate Director, Doctoral Studies, who will report to the Director of the Conrad School.

5. PROJECTED ENROLMENT

Enrolment projections are based on an anticipated intake of two full-time domestic students each Fall and one full-time international student every second Fall, when the program reaches full capacity in Year 6. Further increases in student enrollment may be considered if there is sufficient student demand and the Conrad School has sufficient capacity for supervision of research projects.

The program is expected to begin its first intake by Fall 2023.

Table 4 shows the projected student intake and total fiscal year enrolment in the proposed program over the next nine fiscal years.

TABLE 4

Projected Student Intake and Enrolment					
Fiscal Year	**FULL-TIME**				
	Fall Intake[1] (Student Headcount)		**Fiscal Year Full-Time Enrolment (FFTE)[2]**		**Total Fiscal year Enrolment (FFTE)**
	Domestic fee-paying	**International fee-paying**	**Domestic fee-paying**	**International fee-paying**	
2023/24	2	0	3.9	0	3.9
2024/25	2	1	9.3	1.9	11.2
2025/26	2	0	14.4	2.4	16.8
2026/27	2	1	18.9	3.7	22.6
2027/28	2	0	20.4	3.9	24.3
2028/29	2	1	20.4	4.7	25.1
2029/30	2	0	20.4	3.9	24.3
2030/31	2	1	20.4	4.7	25.1
2031/32	2	0	20.4	3.9	24.3

[1]The PhD student intakes will only be in the Fall term of every year.

[2] Fiscal year enrolment (FFTE) is the total student enrolment over the three terms in the fiscal year (Spring + Fall + Winter). A full-time graduate student will generate 1.0 FFTE per term, and 3.0 FFTE in a fiscal year. Note that student retention is estimated using existing Arts PhD transitions and numbers are rounded to one decimal place. By the start of the fifth year (2027/28), the first year cohort of students will have graduated. Similarly, by the sixth year, our second year cohort will have graduated and so on.

6. FINANCIAL PLAN

A financial viability analysis (FVA) investigating the financial parameters and assumptions of this proposed program was constructed by Institutional Analysis and Planning (IAP) and discussed in detail with the Faculty of Engineering. IAP has not identified significant financial challenges to this proposal moving forward with the proposed enrolment, tuition rates, and costs as outlined in the FVA. The Faculty of Engineering has acknowledged that this program will require additional financial resources in excess of what is generated by the program to operate, and that these will be the responsibility of the Faculty of Engineering. The financial viability analysis was approved by the Provost on December 15, 2021.

Appendix A – Summary of Learning Outcomes Mapped to Courses and Assessment Methods

Specific GDLEs and Associated Learning Outcomes	Course						Assessment method							
		MSCI 609\ECON 622\PSYCH 630\PSYCH 632\ SOC 716	BET 701	BET 702	BET 703	BET 704	Research Essays	Literature reviews	Quizzes/Tests	Comprehensive Exam	Data interpretation, synthesis, visualization	Thesis proposal defense	Thesis defense	Presenting workshop/seminar
1. Depth and Breadth of Knowledge														
LO1. have a thorough knowledge of the entrepreneurship literature and more broadly of the organizational management literature and be able to summarize, compare and review the main theories and frameworks in the entrepreneurship literature.			✓	✓	✓		✓	✓	✓	✓		✓	✓	
LO2. understand, apply and critically evaluate different scientific research methods, whether quantitative or qualitative, to test theory and hypotheses in the entrepreneurship literature		✓	✓	✓	✓	✓			✓	✓	✓		✓	✓
LO3. devise theories and propose hypotheses or research questions to address an important theoretical and empirical gap in the entrepreneurship literature						✓	✓					✓	✓	

2. Research & Scholarship														
LO1. have a thorough knowledge of the entrepreneurship literature and more broadly of the management literature and be able to summarize, compare and review the main theories and frameworks in the entrepreneurship literature.			✓	✓	✓		✓	✓				✓	✓	✓
LO2. understand, apply and critically evaluate different scientific research methods, whether quantitative or qualitative, to test theory and hypotheses in the entrepreneurship literature		✓	✓	✓	✓	✓			✓	✓	✓		✓	✓
LO3. devise theories and propose hypotheses or research questions to address an important theoretical and empirical gap in the entrepreneurship literature						✓	✓					✓	✓	
LO4. demonstrate self-direction and originality in planning, executing, tackling and solving problems in academic research							✓					✓	✓	
LO6. make an original and substantial contribution to the discipline and also understand and appreciate limitations of one's own work												✓	✓	✓
3. Level of Application of Knowledge														
LO1. have a thorough knowledge of the entrepreneurship literature and more broadly of the management literature and be able to summarize, compare and review the main theories and frameworks in the entrepreneurship literature.			✓	✓	✓		✓	✓	✓	✓		✓	✓	
LO2. understand, apply and critically evaluate different scientific research methods, whether quantitative or qualitative, to test theory and hypotheses in the entrepreneurship literature		✓	✓	✓	✓	✓			✓	✓	✓		✓	✓

LO3. devise theories and propose hypotheses or research questions to address an important theoretical and empirical gap in the entrepreneurship literature						✓	✓					✓	✓	
LO4. demonstrate self-direction and originality in planning, executing, tackling and solving problems in academic research							✓					✓	✓	
LO6. make an original and substantial contribution to the discipline and also understand and appreciate limitations of one's own work												✓	✓	✓
4. Professional Capacity/Autonomy														
LO1. have a thorough knowledge of the entrepreneurship literature and more broadly of the management literature and be able to summarize, compare and review the main theories and frameworks in the entrepreneurship literature.			✓	✓	✓		✓	✓	✓	✓		✓	✓	
LO3. devise theories and propose hypotheses or research questions to address an important theoretical and empirical gap in the entrepreneurship literature							✓					✓	✓	
LO4. demonstrate self-direction and originality in planning, executing, tackling and solving problems in academic research							✓					✓	✓	
LO6. make an original and substantial contribution to the discipline and also understand and appreciate limitations of one's own work												✓	✓	✓
5. Level of Communications Skills														
LO1. have a thorough knowledge of the entrepreneurship literature and more broadly of the management literature and be able to summarize,			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	

compare and review the main theories and frameworks in the entrepreneurship literature.														
LO5. explain and communicate complex theoretical ideas, constructs, and causal relationships clearly and effectively both through presentations and writing			✓	✓	✓		✓	✓				✓	✓	✓
6. Awareness of Limits of Knowledge														
LO1. have a thorough knowledge of the entrepreneurship literature and more broadly of the management literature and be able to summarize, compare and review the main theories and frameworks in the entrepreneurship literature.			✓	✓	✓		✓	✓	✓	✓		✓	✓	
LO2. understand, apply and critically evaluate different scientific research methods, whether quantitative or qualitative, to test theory and hypotheses in the entrepreneurship literature		✓	✓	✓	✓	✓			✓	✓	✓		✓	✓
LO4. demonstrate self-direction and originality in planning, executing, tackling and solving problems in academic research							✓					✓	✓	
LO6. make an original and substantial contribution to the discipline and also understand and appreciate limitations of one's own work												✓	✓	✓

COURSE ACTIVATION FORMS

UNIVERSITY OF WATERLOO

GRADUATE STUDIES OFFICE
Waterloo, Ontario, Canada N2L 3G1
uwaterloo.ca/graduate-studies | gsoffice@uwaterloo.ca
Fax 519-746-3051

Senate Graduate and Research Council – Course/Milestone – New/Revision/Inactivation form

Faculty: Engineering

Effective term: Term/Year ~~Fall~~ Winter Year: ~~2022~~ 2023

Course ☒ New ☒ Revision ☐ Inactivation ☐

Milestone ☐ New ☐ Revision ☐ Inactivation ☐

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:
(e.g. consent, description, title, requisites)

Course Subject code: BET Course number: 701

Course Title (max. 100 characters incl. spaces): Entrepreneurship Theory

Course Short Title (max. 30 characters incl. spaces): Entrepreneurship Theory

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: ☒ Department

Course Description:

This course will offer insights into the main theories and issues in the studies of entre-/intrapreneurship and innovation. It will also discuss the complex and dynamic reality of the entrepreneur and the innovating organization as well as explore research traditions, methodologies, and approaches in entrepreneurship research.

New course description (for revision only):

Meet Type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

Requisites:

Special topics course: Yes ☐ No ☒

Cross-listed: Yes ☐ No ☒

Course Subject(s) to be cross-listed with and approval status:

Sections combined/heldwith:

Rationale for request:

This will be one of the core courses for the PhD program in Entrepreneurship and Organization. This course will cover both older and contemporary theories on Entrepreneurship.

Prepared by: Date:Click here to enter a date.

UNIVERSITY OF WATERLOO

GRADUATE STUDIES OFFICE
Waterloo, Ontario, Canada N2L 3G1
uwaterloo.ca/graduate-studies | gsoffice@uwaterloo.ca
Fax 519-746-3051

Senate Graduate and Research Council – Course/Milestone – New/Revision/Inactivation form

Faculty: Engineering

Effective term: Term/Year ~~Fall~~ Winter Year: ~~2022~~ 2023

Course ☒ New ☒ Revision ☐ Inactivation ☐

Milestone ☐ New ☐ Revision ☐ Inactivation ☐

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:
(e.g. consent, description, title, requisites)

Course Subject code: BET Course number: 702

Course Title (max. 100 characters incl. spaces): Organization Behaviour

Course Short Title (max. 30 characters incl. spaces): Organization Behaviour

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: ☒ Department

Course Description:

This course will offer an understanding of classic and contemporary issues in organizational behavior, with an emphasis on their study in entrepreneurial contexts. Drawing on theory and research in psychology, social psychology, and organizational behavior, this course will explore individual, interpersonal, and group processes in work organizations.

New course description (for revision only):

Meet Type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

Requisites:

Special topics course: Yes ☐ No ☒

Cross-listed: Yes ☐ No ☒

Course Subject(s) to be cross-listed with and approval status:

Sections combined/heldwith:

Rationale for request:
This will be one of the core courses for the PhD program in Entrepreneurship and Organization.

Prepared by: Date:Click here to enter a date.

UNIVERSITY OF WATERLOO

GRADUATE STUDIES OFFICE
Waterloo, Ontario, Canada N2L 3G1
uwaterloo.ca/graduate-studies | gsoffice@uwaterloo.ca
Fax 519-746-3051

Senate Graduate and Research Council – Course/Milestone – New/Revision/Inactivation form

Faculty: Engineering

Effective term: Term/Year ~~Fall~~ Winter Year: ~~2022~~ 2023

Course ☒ New ☒ Revision ☐ Inactivation ☐

Milestone ☐ New ☐ Revision ☐ Inactivation ☐

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:
(e.g. consent, description, title, requisites)

Course Subject code: BET Course number: 703

Course Title (max. 100 characters incl. spaces): Business Strategy

Course Short Title (max. 30 characters incl. spaces): Business Strategy

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: ☒ Department

Course Description:

This course will examine the current state of knowledge in strategic management. Topics may include the sources of competitive advantage, the role of industry evolution and technology, the organization of top management, and managerial decision-making and cognition. It will also cover alternative theoretical perspectives and available empirical evidence related to these topics. Emphasis will be placed on the study of strategy in entrepreneurial contexts.

New course description (for revision only):

Meet Type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

Requisites:

Special topics course: Yes ☐ No ☒

Cross-listed: Yes ☐ No ☒

Course Subject(s) to be cross-listed with and approval status:

Sections combined/heldwith:

Rationale for request:
This will be one of the core courses for the PhD program in Entrepreneurship and Organization.

Prepared by: Date:Click here to enter a date.

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Faculty: Engineering

Effective term: Term/Year ~~Fall~~ Winter Year: ~~2022~~ 2023

Course ☒ New ☒ Revision ☐ Inactivation ☐

Milestone ☐ New ☐ Revision ☐ Inactivation ☐

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:
(e.g. consent, description, title, requisites)

Course Subject code: BET Course number: 704

Course Title (max. 100 characters incl. spaces): Business Research Methods

Course Short Title (max. 30 characters incl. spaces): Research Methods

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: ☒ Department

Course Description:

The course will examine the different stages in the research process beginning with how to frame research questions, speculate hypotheses, understand the merits of alternative research methods, and cover topics and provide examples in areas such as experimental design, survey design, case studies, and archival research. By the end of the course, students will be prepared to critically evaluate research method and design choices for their own research.

New course description (for revision only):

Meet Type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

Requisites:

Special topics course: Yes ☐ No ☒

Cross-listed: Yes ☐ No ☒

Course Subject(s) to be cross-listed with and approval status:

Sections combined/heldwith:

Rationale for request:

This will be one of the core courses for the PhD program in Entrepreneurship and Organization.

Prepared by: Date:Click here to enter a date.

Graduate Studies
New Program Template

Prior to form submission, review the new graduate program instructions. For questions about the form submission, contact Trevor Clews, Graduate Studies and Postdoctoral Affairs.

Faculty: Engineering

Program: Doctor of Philosophy (PhD) in Entrepreneurship and Organization

Program contact name(s): Shavin Malhotra, Mark Weber

Form completed by:

Note: new courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form (PC docx version).

Proposed effective date: Term: Fall Year: 2023

Graduate Studies Academic Calendar (GSAC) section (include the link to the section (web page) where the new program will be located):

https://uwaterloo.ca/graduate-studies-academic-calendar/engineering/conrad-school-entrepreneurship-and-business

Proposed Graduate Studies Academic Calendar content:

DOCTOR OF PHILOSOPHY (PHD) IN ENTREPRENEURSHIP AND ORGANIZATION

Program information

- **Admit term(s)**
  - Fall
- **Delivery mode**
  - On-campus
- **Length of program**
  - Students are required to complete the program in accordance with the University program time limits.
- **Program type**
  - Doctoral
  - Research
- **Registration option(s)**
  - Full-time
- **Study option(s)**

- Thesis

Admission requirements

- **Minimum requirements**
  - Applicants will ideally hold a graduate degree in Business, Management, Economics, Psychology, Sociology or a related social science discipline, and must have a minimum overall average of 75%, or equivalent, in the previous degree. Those with more technical degrees (e.g., Engineering, Computer Science, Statistics) may also be considered where there is clear evidence of interest in the application of those fields to human behavior and choice in organizational or entrepreneurial settings. Applicants should highlight any prior research or research assistantship experience in their applications. The graduate degree could be a one or two-year program.
  - In exceptional cases, where a student has performed extremely well in a 4-year Honours degree in one of the domains listed above, and excelled in a scholarly research project, applicants can gain direct admission to the PhD program with the agreement of the Committee, Associate Director, Research and Doctoral Studies, and the Director of the Conrad School.
  - GMAT or GRE results are required for domestic and international applicants to the PhD program. Applicants should have written these tests within the past five years.

- **Application materials**
  - Curriculum vitae
  - Supplementary information form
  - Transcript(s)

- **References**
  - Number of references: 3
  - Type of references: at least two should be academic references and one can be professional

- **English language proficiency (ELP) (if applicable)**

Degree requirements

- **Graduate Academic Integrity Module (Graduate AIM)**

- **Courses**
  - Students must complete the following courses by the end of the third term:
    - BET 701 Entrepreneurship Theory
    - BET 702 Organization Behavior
    - BET 703 Business Strategy
    - BET 704 Business Research Methods
  - Two graduate level method or data analysis courses from the following options:
    - ECON 622 Applied Microeconometrics I
    - MSCI 609 Quantitative Data Analysis for Management Sciences
    - PSYCH 630 Advanced Analysis of Variance
    - PSYCH 632 Multiple Regression
    - SOC 716 Qualitative Methods
    - An alternate method or data analysis course pre-approved by the student's supervisor and Associate Director, Research and Doctoral Studies
  - Students who have taken prior graduate-level statistics or data analysis courses can request an exemption from one of the two method or data analysis course requirements. The criteria for selecting an appropriate statistic or a data analysis course will be based on the students'

Proposed Graduate Studies Academic Calendar content:

research interest (for example a student may wish to do a qualitative study as part of their thesis). The student supervisor (in consultation with the student) and the Associate Director, Research and Doctoral Studies will need to approve the course selection.
    - The student's supervisor, in consultation with the student and the Associate Director, Research and Doctoral Studies, may advise the student to take additional courses, anytime during the program, if the courses directly advance the student's work on their thesis.
    - To maintain good standing during the coursework, students must maintain a minimum average of 75%.

- **PhD Comprehensive Examination**
    - Students are required to meet the University-level PhD Comprehensive Examination minimum requirements outlined in the "Minimum requirements for the PhD degree" section of the Graduate Studies Academic Calendar (GSAC), with certain noted differences that are specific to the Faculty of Engineering Comprehensive Examination minimum requirements:
        - Comprehensive examination purpose: Consistent with University-level minimum requirements.
        - Timing: Students must follow the Faculty of Engineering completion timelines whereby students shall complete their comprehensive examination before the end of their 4th term or 6th term in cases where the student is admitted to the PhD program without a completed Master's degree.
        - Committee: Students must follow the Faculty of Engineering committee composition guidelines which differ from the University-level minimum requirements in both number of committee members and committee makeup.
        - Who Chairs an examination: Students must follow the Faculty of Engineering Chair guidelines whereby the Chair is normally selected from outside of the student's home department.
        - Format / Content: Consistent with University-level minimum requirements but with additional information provided in the Faculty of Engineering Comprehensive Examination minimum requirements.
        - Academic integrity: Consistent with University-level minimum requirements.
    - In addition to the University-level and Faculty-level PhD Comprehensive Examination minimum requirements, students in the PhD in Entrepreneurship and Organization program are also required to meet the following requirements:
        - The comprehensive examination questions will be proposed by the comprehensive examination committee. The committee will consist of faculty members that have taught the core courses. In the comprehensive examination, the examination committee will assign three research questions to the students. Students will select one of these questions or suggest a slightly modified version of one of the questions. In all cases the question(s) must serve to require the substantive breadth covering different courses. Students will write a research study that will address this question. The research study will include relevant background information, literature review, hypotheses, discussion of potential methods to test the hypotheses, a description of how results will be interpreted, and a discussion of possible problems in implementing the method and how those problems could be addressed. Students must submit the written study 10-14 days before the oral examination with the comprehension examination committee.

- **PhD Thesis Proposal**
    - Students must present their thesis proposal to a Thesis Examination Committee. Students are required to follow the thesis proposal requirements outlined in the Faculty of Engineering minimum requirements. In addition, the exam will include a critical assessment of students' thesis proposal based on a written report provided in advance. The student must submit the thesis proposal to the Thesis Committee at least one month prior to the examination. The thesis committee will assess students' thesis proposal on the basis of its potential contribution

Proposed Graduate Studies Academic Calendar content:

to knowledge (originality, quality, quantity), research adequacy and thoroughness, understanding of the subject (review of previous work, choice of project), suggested theoretical framework, methods, and presentation (organization, grammar, style, bibliography). Students must present their thesis proposal by the end of the 8th term.

- **PhD Thesis**
  - Students must submit and defend a thesis by the end of the 12th term or the fourth year. A thesis must ensure that breadth of knowledge and skills are acquired by doctoral candidates through highly specialized, independent, original research which makes a distinct contribution of knowledge to the entrepreneurship and organization discipline. Students are required to follow the thesis examination requirements outlined in the Graduate Studies Academic Calendar. The candidate will submit and later defend their thesis to their Thesis Committee.

Departmental approval date (mm/dd/yy):
Reviewed by GSPA (for GSPA use only) ☐ date (mm/dd/yy):
Faculty approval date (mm/dd/yy):
Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):
Senate approval date (mm/dd/yy) (if applicable):

UNIVERSITY OF WATERLOO

NEW GRADUATE PROGRAM PROPOSAL*

OF

PHD

IN

ENTREPRENEURSHIP AND ORGANIZATION

SUBMITTED TO THE
ONTARIO UNIVERSITIES COUNCIL ON QUALITY ASSURANCE

VOLUME II – FACULTY CURRICULA VITAE
(2022)

CURRICULA VITAE
TABLE OF CONTENTS

CV's found here

EXTERNAL REVIEWERS' REPORT FOR CYCLICAL PROGRAM REVIEWS

Reviewers' Report on the Doctoral Program in Entrepreneurship and Organization at the University of Waterloo.

Moren Lévesque
Schulich School of Business
York University, Toronto
mlevesque@schulich.yorku.ca

Lukas Neville
Asper School of Business
University of Manitoba, Winnipeg
lukas.neville@umanitoba.ca

SUMMARY

Please provide a brief synopsis of your review (3-4 paragraphs) that addresses the following:

- What is the overall assessment of the quality of the program? *Describe.*
- Identify and commend notably strong and creative attributes of each discrete program documented in the self-study.
- Identify each discrete program's respective strengths, areas for improvement, and opportunities for enhancement.
- Provide a summary of your recommendations*. *Please include the full list of recommendations in Section 4.*

***NOTE** A *minimum* of three recommendations for specific steps to be taken that will lead to the continuous improvement of the program, distinguishing between those the program can itself take and those that require external action, must be included.

We appreciated the opportunity to speak with the faculty, staff, and leadership of the Conrad School of Entrepreneurship & Business and the University of Waterloo, to learn more about the proposed Ph.D. program in Entrepreneurship and Organization. We view the offering as relevant, well-suited to the aspirations of the faculty, and likely to succeed, particularly considering the school and university's strengths in the field and its position in the Waterloo entrepreneurial ecosystem. There are issues with the present conceptualization of the program that if left unaddressed might undermine the viability and success of the program. However, our conversations with the school's leadership and the program proponents give us assurance that the school is ready and prepared to make the refinements needed to make this program a strong offering.

Above all, we were favourably impressed by the commitment and engagement shown by the program's faculty. It is clear they have a genuine interest in this offering and are willing to do the work to make it happen. The school has a clear ambition for its doctoral program and sees it as an important step in establishing the Conrad School as a leader in knowledge generation in entrepreneurship. The school's position in the entrepreneurial ecosystem is a strong and hard-to-replicate competitive advantage, and the faculty seem to be collectively committed to leveraging this advantage to transform Waterloo into a leader in doctoral education in entrepreneurship. When we asked them questions – tough and critical ones in many cases – they responded with a genuine problem-solving approach and showed a strong collegial spirit.

The areas for improvement are described in detail in our comments throughout the report. We summarize them here, roughly in the order of progression through the program.

1) **Admissions**. A strategy for recruitment is needed, with competitive funding to attract high-quality candidates, particularly if there is a priority attached to attracting domestic applicants.
2) **Coursework.** The number of courses is low compared with leaders in this space, and without prior training or additional coursework requirements, may not be sufficient to train students to generate the specified outcomes.
3) **Comprehensive exam.** A meaningful way of assessing the capacity for independent research is needed, along with an 'offramp' for those wishing to exit after coursework.
4) **Supervision.** A structure to enhance the school's collective capacity for doctoral supervision is needed, and it must be aligned with the school's faculty merit framework.
5) **Thesis research.** A more structured approach is needed for granting students access to the school's network and entrepreneurial ecosystem.
6) **Job market.** Students graduating will need a record of effective teaching; the program must find a way to integrate this requirement.

Throughout, and related to each of the above, we encourage the proponents to conduct a more comprehensive review of the competitive landscape. Such an analysis would help to answer certain key questions (e.g., how much to offer in funding for a PhD applicant), to validate certain assumptions (e.g., lack of supply for academic entrepreneurship jobs), and to identify other schools' solutions to issues raised by our review (e.g., how to provide greater training without requiring a much longer program). We encourage the faculty to consider the national and international landscape, since it is on those scales (rather than regional or provincial) that the Conrad School will need to compete for PhD applicants and will need to market its PhD graduates.

1. DETAILS OF THE SITE VISIT

1.1 Outline of the Visit

- With whom did you meet?
  - Amanda McKenzie, Director, Quality Assurance (Academic Programs)
  - Harvir Bansal, Associate Professor, Conrad School
  - Horatio Morgan, Associate Professor, Conrad School
  - James Rush, Vice President Academic and Provost

- Janet Boekhorst, Assistant Professor, Conrad School
- Jeff Casello, Associate Vice-President, Graduate Studies and Postdoctoral Affairs
- Jennifer Haas, Head, Information Services and Resources, Davis Library
- Margaret Dalziel, Associate Professor, Conrad School
- Mark Weber, Eyton Director, Conrad School of Entrepreneurship and Business
- Mary Wells, Dean of Engineering
- Nada Basir, Assistant Professor, Conrad School
- Nina Ripley, Academic Program Advisor, Conrad School
- Rachel Figueiredo, Librarian, Information Services and Resources, Davis Library
- Shavin Malhotra, Professor and PhD Program Director, Conrad School
- Siva Sivoththaman, Associate Dean, Graduate Studies
- Tracie Wilkinson, Administrative Office, Conrad School
- Victor Cui, Associate Professor, Conrad School

- What facilities were seen?

Photos were provided of classrooms, seminar rooms, and graduate student office space.

- Discuss any other activities relevant to the appraisal. **NA**

1.2 Effectiveness

In order to continuously improve the effectiveness and efficiency of site visits, please comment on the following:

- How effective was the self-study in preparing you for the visit?
- How could the logistics of the visit be improved?

We recommend structuring such visits around questions/topics rather than people. This could start with, for instance, *"strategy and program rationale"*, then continue to *"competitive landscape", "program design and academics"*, *"staffing and resourcing"*, *"recruitment and admission", "learning and career outcomes", "institutional fit and alignment",* etc. These would allow for a more focused exploration of the program. Topics would be provided to the assessors who can then ask (once they have reviewed the submission) whether other topics/meetings are needed.

We encourage you to think about the timing of the review. We found that this review occurred at a very early stage of the proposal development process. For instance, only a superficial market analysis was conducted, course descriptions were not fleshed out, and no details were provided about the format or structure of the comprehensive exams. Without these details, our advice is simply that the proponents should build these out. If those details had been included, we could have provided more focused and constructive advice on the substance of these elements.

2. EVALUATION CRITERIA

2.1 Objectives

For the following Yes/No questions, if 'No', please explain.

- Is the program consistent with the University of Waterloo's mission and relevant academic strategic plans? **INCREMENTAL IMPROVEMENT REQUIRED**

The strategic imperative behind a new doctoral program could be articulated more forcefully. In the proposal, there is a superficial mention of a wide range of strategic priorities (e.g., commercializing research, fostering the development of new enterprises, and driving experiential learning) that are not clearly or centrally advanced by this proposal. These references to less-relevant aspects of strategic fit detract from the overall positioning.

Recommendation

We encourage the proponents to focus on what seems from our interviews to be a **singular and clear strategic motivation, well aligned with Waterloo's overall mission and strategy**: This program will increase the research intensity of the Conrad School, assist faculty in advancing their research programs, and position the Conrad School as a well-recognized centre for thought leadership in entrepreneurship.

- Are the program requirements and learning outcomes
  - in alignment with the University of Waterloo's Undergraduate or Graduate Degree Level Expectations? **YES**
  - clear and appropriately communicated? **YES**

- Do the program name and credential earned (e.g., BA, MSc, PhD, etc.)
  - reflect the content of the program? **YES**
  - advance the program's objectives? **NOT AS ORIGINALLY PROPOSED**

The *"Entrepreneurship and Organizations"* label seems better suited to a program where you intend to recruit and train organizational scholars. While we like the echoes of "Management and Organizations" (in the Stern/Ross/Kellogg mold), it sounds like the ideal student is driven by a fundamental interest in entrepreneurship – and organizational research is simply a tool or disciplinary lens for exploring this core topical interest.

Recommendation

If the program's intention is not to place students into conventional jobs in organizational behavior/studies or strategic management, and if no clear evidence suggests that the "Entrepreneurship and Organization" label will be more attractive to prospective applicants, a more focused program name might be beneficial (e.g., *PhD in Entrepreneurship*).

2.2 Admission requirements

For the following Yes/No questions, if 'No', please explain.

- Are admission requirements appropriately aligned with the learning outcomes established for completion of the program? **NOT AS ORIGINALLY PROPOSED**

As a minor issue, **the exact GPA and GRE score requirements need to be specified.** We heard that part of this was that the exact score requirements might depend somewhat on students' desired area of focus and other training. We nonetheless encourage the program to be specific about its required minimum score or process for evaluation purposes.

We also heard about the consideration given in admission to **prior research experience through MBET RAships**. This is a very promising strategy for recruiting and admitting high quality applicants, since it offers a preview of the student's ability in conducting research. We encourage this practice to be clearly signalled to prospective applicants. *(While it is outside the scope of this review, we also suggest that this be advertised as a program, e.g., the "MBET Pre-Doctoral RAship" or something else that signals that this experience is a potential path into the PhD.)*

Recommendations
Clarify the specific GPA and GRE/GMAT requirements and add RA experience as a desired qualification.

A larger issue is that **admissions into this program come from a wide range of backgrounds and disciplines, from practitioner degrees like the MBET to quant-heavy taught programs like the MQF to research MAs in economics and psychology.** This will create a very wide distribution of student 'starting points' in the program. Some may come with significant research experience, and some with fewer; some might arrive with a solid foundation in research design, others not. This creates a challenge for curriculum since we cannot assume as much shared foundational knowledge – a challenge for admissions since some applicants may not have prior research experience to assess, and a challenge for student theses since they may not have a strong prior foundation of coursework in their field of research.

This is not an unusual problem, and we do not recommend changing the admission strategy. Other PhD programs in entrepreneurship also recruit from a wide variety of backgrounds. However, those programs also include considerably more coursework. **We offer recommendations about coursework in the section that follows.**

Recommendations
We recommend that additional coursework/training be added to the program. If it is not possible, we then recommend limiting admission to those from programs providing closely related prior training both in methods and the field of entrepreneurship.

- *For undergraduate programs, if applicable,* is there a meaningful path for entry outside of standard 1st year entry (e.g., 2+2 programs or programs that require prior study)? Are there appropriate alternate admission requirements, such as minimum grade point average, additional languages or portfolios, prior work or learning experience? **NA**

2.3 Curriculum

For the following Yes/No questions, if 'No', please explain.

- Does the curriculum reflect the current state of the discipline or area of study?
  NOT AS ORIGINALLY PROPOSED

In the section above, we described how the admissions process will draw a diverse group of students with uneven levels of prior training in the field and in methods. This creates a problem with the slim 5-course doctoral coursework requirement. We heard that 5 courses represent a fairly expansive program of coursework in the context of Waterloo's graduate programs, particularly in engineering. However, this program is different from other doctoral programs the University of Waterloo's School of Engineering offer, where **the typical path to admission includes an undergraduate and master's in the same field**. For instance, an applicant might do an undergraduate degree in civil engineering, then take a master's in water resources engineering, and then enroll in a Ph.D. Between the undergrad and master's, the students will have broad exposure to the discipline's foundations (e.g., hydrology, aquatic chemistry, surface water modelling, etc.). So, once they reach their Ph.D., it is sensible that they only require 3 additional courses before being prepared to carry out advanced research – particularly since bench research in a lab context comes with its own form of on-the-job training.

Here, by contrast, some applicants might come with relatively little prior training in some of the core technical skills or theoretical foundations required. An MBET graduate could have come from any undergraduate background and could arrive with no prior training in statistics. An MQF student could arrive having taken no prior coursework in entrepreneurship, either in theory or practice. On the other side of the equation, the type of journals that Conrad faculty aspire to publish in (e.g., ET&P, JBV, SEJ, etc.) require an increasing degree of methodological sophistication and depth of theoretical contribution, often with multi-method or mixed methods approaches. **It is difficult to imagine a student having the training required to generate this calibre of research with the 5-course sequence in the proposed Ph.D.**

We heard that additional coursework can be simply negotiated between the student and advisor on an ad-hoc basis. We do not think this is a sufficient solution. Students often avoid additional coursework if not required (particularly in methods), and such an ad hoc approach makes it difficult to anticipate and plan for staffing and availability of courses. We expect the likely outcome of such an approach will be that students with a weaker methodological foundation will choose dissertation topics and methods that require less methodological sophistication, which is inconsistent with the program's stated aims.

For instance,

- **Ivey (Western)** requires a statistics boot camp, a summer research project, and 10 other courses (3 methods and statistics, 5 field courses, 2 additional electives).
- **Haskayne (Calgary)** requires 12 courses, including a theory course, a summer research project, 5 methods courses, and 5 field courses.
- **Olin (WUSTL)** requires 9 courses, including 4 methods/econometrics courses and 5 field courses.
- **Whitman (Syracuse)** requires 14 courses plus a summer research project, including 4 methods courses, 7 major and supporting field courses, plus 3 MBA type practitioner courses.

Recommendation

We recommend that the program be revised to ensure a stronger foundation of training both in the foundations of the field and in research methods. This could involve a larger body of coursework with waivers for students who arrive with strong previous training (as a hypothetical example, everyone must take 4 methods courses, but those requirements can be waived if students have prior methods training in their master's degree). It could also involve required methods workshops or other forms of training (e.g., CARMA short courses) during or after the initial period of coursework.

In addition, we note that this program is designed to prepare students for careers as faculty in entrepreneurship-related fields. **Our experience suggests that high-quality teaching is an important requirement for hiring, even in research-intensive universities.** (The Conrad School clearly knows this, given that it has selected its faculty members in part on their excellence in the classroom). We encourage the proponents to integrate teaching training into the program curriculum. This could include a teaching requirement (e.g., TA for a course, and then teach it once as an instructor), or it could include a teaching development requirement (e.g., completing the Centre for Teaching Excellence's fundamentals or certificate program).

Recommendations

We recommend that the program be altered to include sufficient training and/or experience in teaching so that students will graduate with a teaching portfolio sufficient to the demands of the academic job market.

- Is there evidence of any significant innovation, distinctiveness or creativity in the content and/or delivery of the program relative to peer programs? **NOT AS ORIGINALLY PROPOSED**

The proposal sketches out what appears (except for the shorter coursework element) a fairly conventional doctoral program. **We heard about several innovations and points of distinction in our interviews, but they are not yet fully articulated in the proposal itself.** In the proposal, the proponents describe a doctoral program focused on entrepreneurship as a distinctive offering relative to competitors. **We encourage the proponents to conduct a fuller scan of the competitive landscape, and to identify what elements of the proposed program distinguish it from other entrepreneurship PhD programs offered by business schools.** The markets for Ph.D. admissions and the placement of Ph.D. graduates are both international, not local nor provincial.

A fuller competitive analysis is needed. For instance, the Foster School at the University of Washington offers a Ph.D. in Technology Entrepreneurship, with coursework open to doctoral students in Arts and Sciences, Engineering, and Medicine. They also combine OB, strategy, and entrepreneurship, and require students to complete a research methods minor (with two basic stats classes and four electives). In addition to the classroom elements, they partner with other schools (USC, Stanford, Alberta, and Oregon) to offer an annual conference that brings together doctoral students working on entrepreneurship-related issues. The proponents may find that there are innovations that can be borrowed or adapted from newer programs like Foster's.

During our meetings, the faculty and staff identified some interesting possibilities in conversation with us that would serve to enhance the distinctiveness of the program. One of the greatest strengths of the proposed program is its location in one of Canada's most vibrant startup ecosystems. We encourage the proponents to think about how to create structures in the program that take advantage of this location. Dr. Mark Weber described the idea of rotational tours through the entrepreneurial ecosystem – spending time in startups, incubators, or accelerators, with PE or VC firms, etc., allowing students to generate ideas for data collection and identify interesting research questions. Of course, Conrad faculty will help connect students with the broader ecosystem in an ad hoc way, but **we encourage the proponents to think about how that network and access can be formalized into the structure of the program itself.**

Recommendation
We encourage the proponents to introduce structured ways of integrating the program into the broader entrepreneurial ecosystem and network at Conrad to make the school's distinctive network a clearer part of the program structure.

- Are the modes of delivery appropriate and effective to meet with program's identified learning outcomes? **YES**

2.4 Teaching and Assessment

For the following Yes/No questions, if 'No', please explain.

All programs are expected to map the courses and related academic elements to the program learning outcomes and Degree Level Expectations (UDLEs or GDLEs). This section intends to evaluate these relationships.

- Are learning outcomes:
  - aligned with program goals? **YES**
  - achievable in the time allotted? **MAYBE**

This program, as described by the proponents, is focused on training students to take roles as faculty in research oriented postsecondary institutions. The training, teaching, research, and publishing needed to secure such roles is increasingly difficult to compress into a four-year program. At many institutions, there have been **moves toward a five-year funding model for doctoral students**. For instance, Maryland's Smith School of Business provides a 5-year doctoral

program in its Strategy and Entrepreneurship concentration. The risk if the modal time to completion is greater than the funding package is that students will end up in a "ABD trap", teaching full time, or taking work in industry, while failing to make sustained progress on their dissertation.

If most competitor programs have moved or are moving to a 5-year program, the proponents may want to consider options for the proposed program. This could be creating a 5-year structure, having a 4-year structure with the possibility of an additional year (e.g., with thesis completion funds), or creating structures to involve students earlier with research works in progress to build a suitable CV for the job market in the more compressed 4-year window.

Recommendation
We encourage that the proponents **perform a structured review of the academic job market in entrepreneurship to determine if a 4-year program is sufficient**. This might involve reviewing the CVs of those recently hired in the types of roles associated with this program's desired outcomes, then considering the duration of their studies and the contents of their CV.

- appropriately reinforced and measured through listed assessments? **MAYBE**

Please refer to the earlier comments about the sufficiency of coursework, and comments in the following section about the structure of the comprehensive exams.

- Is there a clear relationship between diverse academic elements: core courses, electives, and other program elements? **NOT AS ORIGINALLY PROPOSED**

There is only one elective course and the other program elements (comprehensive exam, exposure to the ecosystem, teaching preparation, etc.) require more detailed elaboration as described elsewhere in this report.

- Are majors, minors, options, specializations and fields sufficiently differentiated? **NA**

- For undergraduate programs, is there a well-defined progression from introductory level to proficiency in content, skills, and values across courses and years? **NA**

- For graduate programs, is there translation from foundational to program-level outcomes? **NOT AS ORIGINALLY PROPOSED**

We noted that there is a **missing piece between the foundations of the taught component of the program, and the independent research component** that will drive program-level outcomes. We note that **many doctoral programs include a "summer empirical project" or other early experience in self-directed research**. Maryland (Smith) requires that students submit at least one working paper to their department as a requirement for advancement to candidacy. Such structures also allow students an early start on the publishing pipeline, since the academic job

market increasingly demands publications or work under advanced review, which is difficult to do for students whose research work did not begin until their dissertation work started.

Given that many applicants may come with course-based master's degrees and no previous thesis experience, we encourage the proponents to **consider adding an early independent research experience element.** This could be integrated as part of the comprehensive exam structure, added as part of the coursework requirements (e.g., an independent research 'course' with an empirical paper as a deliverable), added as another program element (e.g., all students RA for a project or work-in-progress already underway, under the supervision of a faculty member), or some other approach.

Recommendation
Build independent research experiences (and the starting point for a publication pipeline) earlier in the structure of the program.

- Are the program's structure and regulations appropriate so that students are able to meet specified program learning outcomes and Degree Level Expectations? **MAYBE**

As described above, we feel that the program must:
1) Consider how it will provide sufficient training in the field and methods to drive the kind of high-quality, high-impact publication strategy the program envisions.
2) Include formal teaching training to meet the needs of the academic job market it is targeting with its graduates.
3) Create structures to take fuller advantage of the school's unique position in the entrepreneurial ecosystem.

With such changes, we feel the program will likely meet its specified learning outcomes and expectations.

- Do assessment methods appropriately and effectively show student achievement of program learning outcomes and Degree Level Expectations? **MAYBE**

We encourage the proponents to carefully consider **how (and how early) they can spot issues with the achievement of program learning outcomes and degree level expectations.** The courses themselves can be a first way of checking outcomes and whether expectations are met, but there can be two challenges. First, course outcomes may not identify students who have excellent skills in the coursework but struggle to apply those skills to independent research. Secondly, institutional pressures could inflate GPAs (since GPAs are a factor in OGS and other external scholarships). **We encourage the proponents to think innovatively about how the structure and format of the comprehensive exam might focus on the ability to apply the body of knowledge from the coursework to independent research.** This might involve (as described earlier) an empirical project that is a part of the comprehensive exam's process.

Recommendation
Build a means for evaluating students' ability to conduct independent research as early as possible, and prior to the dissertation proposal process

2.5 Resources

For the following Yes/No questions, if 'No', please explain.

- Is the academic unit's (or units') use of existing resources (e.g., human, physical) appropriate and effective in delivering its program? (*NOTE: Reviewers must articulate and demonstrate the value added of any suggested additional resources, such as faculty complement and/or space requirements, and how these are directly tied to issues of program quality or sustainability).* **YES, WITH APPROPRIATE STRUCTURE IN PLACE, SUSTAINED HIRING, STRUCTURES TO ASSURE COURSE AVAILABILITY, AND APPROPRIATE FUNDING**

The faculty have the capacity to effectively supervise and graduate students – but good structure is needed. In the earliest years of the program, the Conrad School may have some committees with limited PhD supervisory experience. Giving these faculty strong expectations, norms, processes, and routines to follow may help to ensure that these advisors and committees are well-positioned to guide their students through the program.

We note that the faculty are more experienced with training highly qualified personnel than the proposal table might otherwise indicate. **We encourage the Conrad School to create structures that allow more experienced faculty members to train, mentor, and share best practices with more novice supervisors**. There are multiple structures that could achieve this goal – from formal training to co-supervision arrangements, and from supervisory process 'checklists' to communities of practice that meet regularly to share advice. Traditional doctoral programs often take an apprentice-and-master approach where the capacity for supervision is conceived of as a property of the individual. We encourage Conrad faculty to think more broadly about building this capacity collectively as a group.

Recommendation
We recommend that the proponents **develop a process for strengthening the school's capacity for doctoral supervision** through training, mentorship, co-supervision, formal processes, or informal communities of practice.

We also heard that the expectation is that the teaching load of the program in its early years will be borne by the current faculty group entirely through **overload teaching**, and that graduate supervision will be added to the existing workload of the current faculty. While this is reasonable and perhaps unavoidable in the program's early years, **it is not sustainable in the long run – and could erode the Conrad School's enviable record of faculty retention.** Faculty who are successful at publishing, teaching, *and* training doctoral students will have a great deal of job market mobility. The Conrad School may therefore place itself at risk of poaching by institutions whose doctoral program offerings do not (for instance) require sustained overload teaching. Like any

entrepreneurial venture, in the early days, founders wear many hats and take on many tasks because it is the only way to grow. But eventually (again as with entrepreneurial ventures) hustle and passion must be supported with formalization and sustainable staffing and resources. The proposal indicates that "several" new faculty will be hired in the next four years, and later specifies that this number is 1-2 new hires in addition to its recent hiring. Our intuition is that such staffing additions would be a minimum to create a sustainable program.

While other Engineering doctoral programs likely have a much higher ratio of students to faculty members, it is important to recognize that bench sciences often have a 'lab' model where doctoral students, faculty, undergraduate RAs, postdocs, and others work in teams toward a single cohesive program of research. **In entrepreneurship, the norm tends to be far fewer students per advisor, because there are fewer 'scale economies' involved in supervising students** (without a lab format and a shared research program, the supervisory marginal labour for each student does not decline as steeply as it might in a traditional lab model). That said, we encourage the proponents to compare the ratio of doctoral students to supervising faculty at comparator schools to validate our perspective.

If the staffing increases are not assured or the student-faculty ratio is out of line with comparator institutions, we encourage the proponents to carefully revise the proposed structure with the aim of creating a model where the teaching and supervisory burden is reduced. This could take the form of alternating-year admissions, which would reduce the overload teaching burden and the necessity of offering every one of the classes in every year (or relying on other faculties to offer them each year).

Recommendation
We recommend that the School and University **commit to the 1-2 new hires specified in the proposal** as a minimum to sustain the program beyond its launch, and we recommend that the School **conduct a comparison of doctoral FFTE per supervising faculty member** at comparator institutions.

We note that course offerings are highly dependent on other faculties and schools' offerings – both in terms of scheduling and seats. What happens, for instance, if one year the SOC 716 Qualitative Methods course is either not offered or overenrolled and unable to take Conrad PhD students? Does that mean that students trained in that year must either teach themselves qualitative methods, or avoid qualitative or mixed-methods thesis designs?

Recommendation
We recommend that the proposal consider the risks associated with courses outside the department (i.e., dependence on outside faculties) and means of mitigating that risk (e.g., MOUs establishing guaranteed seats for Conrad PhD students in these courses).

Lastly, we note that the financial commitments in the proposal are likely insufficient to the program's needs. The proposal suggests that students will be provided with a minimum $23,500

stipend, plus tuition equalization for international students. Based on our experience, **we expect that the long term 5:1 domestic to international student ratio is unrealistic** (without a much clearer strategic recruitment and admission plan). Even in highly competitive, well-regarded doctoral programs, the ratio is often almost the opposite (5:1). If we are correct, the institution should **budget for substantially more in tuition equalization costs**.

The minimum stipend level will also, we expect, create issues with competitive recruitment. For instance, UBC Sauder offers its Ph.D. candidates a tuition and fee waiver, plus $30,000 per year for five years. Schulich offers $30,000 per year for five years. Queen's offers $34,000 for four years with partial funding for a fifth year. Alberta offers $35,000 a year for five years with a tuition waiver. These are only examples, but they are of Canadian schools likely competing for the same high-potential applicants. The proponents can point to the fact that these universities offer instead a PhD in "strategic management and organization" (Alberta) rather than in entrepreneurship per se, but these may not be germane differences to applicants.

We encourage the proponents to ask: **What financial resources are needed to support and sustain students' doctoral research?** The methods course mentions experiments, surveys, cases, and archival research. However, the proposal mentions $2,000 for conferences, but no dedicated funds to support the costs of carrying out the research itself – e.g., participant compensation, travel in the case of field work, access to proprietary datasets, etc. Is this dependent on faculty members' Tricouncil grant success? As an example of how other schools manage this, Ivey offers its students $3,000 in research funding in addition to a total of $8,000 in conference funding over the course of the program to each student.

Recommendation

We recommend that the proposal conduct a **comparative analysis of doctoral programs** related to entrepreneurship (including management programs) and establish funding projections appropriate to (1) the likely **mix of international and domestic students**, (2) the **competitive landscape for stipendary support** both in amount and duration, and (3) the **research funding** needed to support high-quality student dissertation work.

- Is there a sufficient number and quality of faculty effectively contributing to the program delivery through teaching and supervision? **YES, BUT…**

The **all-overload approach to staffing the doctoral courses is not sustainable** in the long run, and there needs to be hiring to support both teaching and supervision.

- Are the academic support services (e.g., library, co-op, technology, etc.), related to the program appropriate and effective? **YES, BUT…**

The collections, datasets, and library staffing seem appropriate to support the proposed program. Nonetheless, we encourage the proponents to integrate library skills (citations and bibliographic tools, search, etc.) into the curriculum in the form of workshops, labs, etc. We also encourage

the proponents to follow what sounds like a successful approach of tailored, scaffolded sessions from library staff used in the MBET.

2.6 Quality Indicators

Comment on the following measures program quality.

With regards to the faculty complement, comment on:

- Their qualifications, research and scholarly record
  NOTE: *Reviewers are urged to avoid using references to individuals. Rather, they are asked to assess the ability of the faculty as a whole to deliver the program in view of the expertise and scholarly productivity of the faculty.*

Overall, the faculty offers the necessary expertise and has been highly productive, especially recently. The faculty publishes in competitive outlets, with both high productivity and high quality. Both the established and recently hired faculty are productive scholars who have come together across disciplinary and methodological boundaries around a shared interest in entrepreneurship. This strategy – breadth with a single common thematic shared interest – can help a small faculty build national and even global profile (e.g., University of Alberta's niche in institutional theory).

We note, as above, the mix of experience and expertise around the supervision of highly qualified personnel. While many have graduate advising experience of various kinds, the number of faculty with a conventional track record of advising (i.e., primary advisor to doctoral students) is relatively low, which calls for structures to build effective advisory capacity in the school.

With regards to teaching, comment on:

- Evidence that the faculty scholarship is embedded in the program structure and delivery.
- Percentage of classes taught by permanent or non-permanent (contract) faculty, as well as the number, assignments and qualifications of part-time or temporary faculty.
- Class sizes
- Course evaluations

The primary challenge here is whether the spirit of the program (an interdisciplinary approach all centered around entrepreneurship) is reflected in the current state of the proposal. The course description for OB, for instance, reflects a generic OB survey course, not the promised course on the organizational psychology of entrepreneurial organizations.

Recommendation

The course proposals should place the study of entrepreneurship at the centre of each course, and reflect the underlying integrative approach to the program.

We also note that the class sizes could be as small as 2-3 students. Usually, the challenge of class sizes goes the other way (i.e., the class is too large). The issue could be whether classes as small as 2 students can effectively build the generative, dynamic intellectual environment that is

expected in a seminar class. The faculty seem to be confident that the more intimate class size will be an advantage, but we encourage you to monitor this aspect closely. (An alternating-year admission strategy, for instance, would create classes of 4-6 students, which tend to create a more vibrant seminar environment and contribute to a supportive 'cohort' environment).

With regards to students, comment on:

- Applications and registrations; attrition rates, times-to-completion; graduation rates; academic awards; and the quality of the student's academic experience.

Please see our comments above about application/recruitment, providing post-coursework 'offramps', the merits of 4- vs 5-year programs, funding packages, and course structure and size. We believe these matters have been comprehensively addressed in these previous sections of our report.

With regards to graduates of the program, comment on:

- Rates of graduation; employment after six months and two years after graduation; post graduate study; alumni reports on program quality (if available and permitted by FIPPA). **NA**

2.7 Additional Graduate Program Criteria

For the following Yes/No questions, if 'No', please explain.

- Are students' time-to-completion both monitored and managed in relation to the program's identified length and program requirements? **YES, WITH CHANGES**

We recognize that fit takes time to determine. Sometimes students have all the competencies needed to succeed in coursework but learn that an academic career path is not for them, or lack the competencies needed for independent research work. **This can lead to students staying in the program out of continuance commitment, perceived "sunk costs", or a lack of attractive alternatives.** Such students often fail to progress and do not contribute to the outcomes envisioned by the program proposal. We therefore encourage the proponents to **develop a mechanism for students to gracefully depart the program after completing the coursework**. For instance, Foster (Washington) confers a Master of Science in Business Administration (MSBA) upon completion of the Ph.D. coursework. This will help students from staying "locked in" to the program out of continuance commitment or perceived sunk costs.

We heard in our meetings that there may be 'offramp' degrees possible: a 6-course graduate diploma, or the Management Sciences course-based masters, or the Master in Management. The proponents should determine which of these (or what other potential credentials) would best reflect the coursework completed without deteriorating the positioning of these credentials in the market. Please also refer to our earlier note about the 4-year (vs. 5-year) program length as a time-to-completion risk.

Recommendations

Create an 'offramp' for students who have successfully completed the coursework requirements, in the case of misfit with the program, misalignment in career aspirations, or deficiencies in meeting degree level expectations (e.g., the comprehensive exam).

- Is the quality and availability of graduate supervision sufficient? **YES, SUBJECT TO THE PROVISOS MENTIONED EARLIER**

Comment on the following quality indicators used to provide evidence of faculty, students and program quality:

With regards to faculty, comment on:

- Funding; honours and awards; commitment to student mentoring.

We were very impressed with the Conrad School's record of faculty retention, and the faculty seem committed to introducing this program and mentoring its students. However, **this program is vulnerable to staffing disruptions**. This is a general 'small-program' problem, not one that is unique to the Conrad School. But if any given faculty member leaves, it might substantially change the funding available to students from faculty grants, the supervision available to existing students, the profile of the school to prospective applicants, and the staffing strategy for doctoral coursework, among others.

Recommendations

As a low-likelihood but high-impact risk, we encourage the proponents to design program structures and practices that reduce the school's vulnerability to faculty turnover if it does occur.

With regards to students, comment on:

- Grade-level for admission; scholarly output; success rates in provincial and national scholarships; competitions; awards and commitment to professional and transferable skills.

We have mentioned above the challenges of student recruitment for the top tier of applicant talent. We joked during our interviews that nothing enhances scholarly productivity like good graduate students, and nothing deteriorates productivity like bad graduate students. **The stakes are high to make sure that the program attracts world-class students**, especially in the early years as the program is establishing its reputation and profile. **The issue of offering competitive funding mentioned above is central to this question.**

So, too, is the recruitment strategy. **The small numbers involved can downplay the challenge of how to reach prospective students, how to assess their suitability, and how to establish their interest in the career path offered.** And, once you have found students with the magic combination of interest, qualifications, and fit, the question becomes how to attract them to your program in particular versus those of your competitors. Sometimes the answer to this question is to focus locally. We heard, for instance, that the MBET program may be one source of well-

suited applicants with an inclination to remain in the KW area. The challenge is that those who will choose a program based on geography may not have an interest in the job market anticipated by the program's proponents: The academic job market, where careers may require you to relocate with little control over your destination.

Recommendations

Even though this program is very small, we encourage the proponents to approach the question of recruitment strategy and demand analysis with the same rigour they might apply to a larger program.

2.8 Quality Enhancement

- Comment on initiatives taken to enhance the quality of the program and the associated learning and teaching environment, as reflected in 2.6 and 2.7.

There was no 2.7 in the proposal reviewed. 2.6 does describe the school's trajectory: Toward recruiting highly skilled, productive faculty with externally fundable research programs and output that lands in the field's top journals.

3. TOPICS FOR ADVICE

3.1 Advice on Identified Weaknesses and Challenges

- Please identify how the program could improve on their identified challenges/threats and weaknesses, as included in the 'Advice on Identified Weaknesses and Challenges' section at the end of the Self-Study.

There was no mention of 'Advice on Identified Weaknesses and Challenges' in the Proposed Brief (Vols I and II) received.

3.2 Insights from External Reviewers

- Please respond to the items listed under the 'Request for Insights from External Reviewers' section at the end of the self-study.

No such request for insights accompanied the proposal.

4. RECOMMENDATIONS*

List your recommendations, in priority order.

FOR THE STUDENTS

TRAINING

- Provide a **stronger foundation of training** both in the foundations of the field and in research methods (through more coursework, course requirements that can be waived with prior experience, a narrower set of admissions criteria for prior training, workshops or other additional training, etc.)
- Build **independent research experience** (and the starting point for a publication pipeline) earlier in the structure of the program.
- Require sufficient **training and/or experience in teaching** so that students will graduate with a teaching portfolio sufficient to the demands of the academic job market.
- Find ways of **exposing students in the program to the school's network and the region's entrepreneurial ecosystem**.
- **Integrate library skills** (citations and bibliographic tools, search, etc.) into the curriculum in the form of workshops, labs, etc., following the tailored, scaffolded approach used in the MBET program.

RECRUITMENT & EVALUATION

- Approach the question of **recruitment strategy and demand analysis** with the same rigour that might apply to a larger program.
- **Add RA experience as a desired qualification** for admission.
- Clarify the specific **GPA and GRE/GMAT requirements.**
- Create a structure for **evaluating students' ability to conduct independent research** as early as possible, and prior to the dissertation proposal process.

SUPPORT & EXIT

- **Set stipendary, research, and tuition equalization support levels based on a full comparative analysis** of doctoral programs in entrepreneurship to ensure competitive recruitment.
- Create an **'offramp' for students** who have successfully completed the coursework requirements, in the case of misfit with the program, misalignment in career aspirations, or deficiencies in meeting degree level expectations (e.g., for the comprehensive exam).

FOR THE FACULTY:

- **Commit to the 1-2 new hires specified** in the proposal as a minimum to sustain the program beyond its launch and **conduct a comparison of doctoral FFTE per supervising faculty**

member at comparator institutions to determine the long-term staffing required.

- Develop a process for **strengthening the school's capacity for doctoral supervision** through training, mentorship, co-supervision, formal processes, or informal communities of practice.

FOR THE PROGRAM:

- Perform a **structured review of the academic job market in entrepreneurship** to determine if a 4-year program is sufficient.
- Place the **study of entrepreneurship at the centre of each proposed course**, reflecting the underlying integrative approach to the program.
- Design program structures and practices that **reduce the school's vulnerability to faculty turnover** if it does occur.
- Consider the **risks associated with courses outside the department** (i.e., the dependence on outside faculties) and mitigate those risks (e.g., MOUs establishing guaranteed seats for Conrad PhD students in these courses).
- **Establish goals for the classroom environment** given the small (2-3) cohort size and **monitor** against faculty and student experiences.
- Focus the proposal's strategic justification on a **singular and clear strategic motivation, aligned with Waterloo's overall mission and strategy**, i.e., the program will increase the school's research intensity, assist faculty in advancing their research programs, and position the school as a centre for thought leadership in entrepreneurship.
- A more **focused program name** might be beneficial (e.g., PhD in Entrepreneurship).

Signature: **Date:** **02 Aug 2022**

Signature: **Date:** **05 Aug 2022**

*** NOTE:** A *minimum* of three recommendations for specific steps to be taken that will lead to the continuous improvement of the program, distinguishing between those the program can itself take and those that require external action, must be included.

New Program Response to External Reviewers' Report

Entrepreneurship and Organization (PhD)

September 2022

General Commentary

We are grateful to the reviewers for their excellent suggestions. We have made concerted efforts to incorporate their suggestions or address their concerns.

Program and Dean's Responses to External Reviewers' Recommendations

FOR THE STUDENTS

1. ***TRAINING***

a) Provide a **stronger foundation of training** both in the foundations of the field and in research methods (through more coursework, course requirements that can be waived with prior experience, a narrower set of admissions criteria for prior training, workshops or other additional training, etc.)

Program Response

We have increased the course requirement to include an additional method/statistics course. In the revised curriculum, along with the four courses on Entrepreneurship Theory, Organizational Behavior, Business Strategy and Business Research Methods, students will opt for two additional method courses from the available courses. However, students who have taken an earlier graduate-level statistics course or a data analysis course can opt for only one of the additional method courses. We have made this change on page 9 of our proposal.

Having considered the question of a narrower set of admission criteria, we again consulted the admissions criteria of comparable programs, finding them to be similarly broad. We think this makes sense, given the idiosyncrasies of faculty member interest, research expertise and research programs. We have, however, added the requirement of elaboration with respect to applicants' research experience to augment our understanding of their skills and likelihood for program success.

Dean's Response

PhD programs within the Faculty of Engineering have slightly varying coursework requirements depending on the academic unit. As such Conrad School of Entrepreneurship and Business will have sufficient flexibility, through established processes, to modify coursework requirement of their program(s) and recognize prior experience and training.

b) Build **independent research experience** (and the starting point for a publication pipeline) earlier in the structure of the program.

Program Response

We looked at other Ph.D. programs and found that our timeline allows students to start independent research earlier than other programs. Most of these programs have five or six semesters of courses and then a comprehensive exam, so the earliest that students begin to work on independent research is the start of the third year (e.g., see the Ph.D. program at UBC Sauder School of Business). In our timeline, the students will complete their comprehensive exam by the end of the fourth term, so they will start their independent research (working on their thesis proposal) at the start of their fifth term (before the end of the second year). By maintaining a good balance of course requirements for students, we can initiate students towards independent research earlier than in other Ph.D. programs in Business. In addition, several seminar courses, such as Business Strategy and Organizational Behaviour, will require students to write independent research essays/papers as part of their deliverables.

Dean's Response

In general, doctoral students in the Faculty of Engineering get introduced to, and progressively engage in research at an early stage, mostly right from the start of their program. This happens through interaction with the supervisor, exploration of research topic(s) and methods, and building background knowledge.

c) Require sufficient **training and/or experience in teaching** so that students will graduate with a teaching portfolio sufficient to the demands of the academic job market.

Program Response

We have now included Teaching Assistantship as a mandatory part of student training in the program. Each student will be offered a Teaching Assistantship during the second and the third year of the program and where possible, an opportunity to teach a course during the third or the fourth year. We have incorporated this change on page 14 of the proposal.

Dean's response

Faculty of Engineering has put in place a unique training program called ExpecTAtions, which is mandatory for all teaching assistants. The program covers a range of topics including skills development, roles & responsibilities, professional ethics, and wellness. At the University level, the Centre for Teaching Excellence (CTE) offers teacher training which is open to all PhD students who can receive a Certificate in University Teaching (CUT).

d) Find ways of **exposing students in the program to the school's network and the region's entrepreneurial ecosystem**.

Program Response

We have included several modifications to expose students to the Kitchener-Waterloo entrepreneurial ecosystem.

a. During the three-day orientation event, we will invite representatives from Velocity, Communitech and Grand Innovations to talk about their centers and share information on their data hubs and data collection opportunities at their centers.
b. In the first year, introduce site visits at Velocity, Communitech and Grand Innovations for PhD students to meet the startup community in Kitchener-Waterloo.
c. Invite entrepreneurs from the Kitchener-Waterloo region to give talks to both our PhD and MBET students, where they discuss their struggles and success as an entrepreneur. This will provide expose our PhD students to interesting research questions they can pursue as part of the course term papers or for their thesis.

We have incorporated these changes on pages 24-25 of the proposal.

Dean's Response

The Engineering faculty has active relationships with 800 external corporate partners. In addition to the kinds of initiatives noted by the department, the Engineering Research Office will be well positioned to help connect students with potential data collection opportunities in the business world.

e) **Integrate library skills** (citations and bibliographic tools, search, etc.) into the curriculum in the form of workshops, labs, etc., following the tailored, scaffolded approach used in the MBET program.

Program Response

During the first term of the student's Ph.D. program, we will host a citation and bibliography workshop through the University of Waterloo's writing and communication center (included on page 25 of the proposal).

2. ***RECRUITMENT & EVALUATION***

a) Approach the question of **recruitment strategy and demand analysis** with the same rigour that might apply to a larger program.

Program Response

We appreciate the reviewers' concern that it can be difficult to recruit high quality applicants, and especially high quality domestic applicants, to doctoral programs in Canada. It is our belief that a significant investment in a "demand analysis" is not merited, and it is not clear how this would be effectively done. We have anecdotal reason to believe that even our own programs will generate some worthy applicants; two of our recent MBET students are doing PhDs at U. of Toronto and were clear they would have done them with us if we had had a program. A third recent MBET student continues to watch our progress on this. A fourth has recently applied to Calgary. Given that we are targeting a small intake of PhD students, we feel confident we will have enough of a pool of strong applicants. Moreover, the risk that we would not have enough good applicants does not represent much material risk to the university, given the nature of our proposal. If that were the case, we simply would not take students or run the program. This is a luxury we enjoy given that course offerings are planned as "overload" teaching and no faculty lines are supported by the proposed program.

However, we are clearly highly motivated to see the program succeed, and for that reason the reviewers' other comment here is highly worthwhile: we need a rigorous approach to recruitment strategy. We will utilize our own alumni base and broader networks to spread news of the program. We will capitalize on the popularity of our professors to encourage interest among strong UW undergraduates. Faculty will tap into their broad professional networks. And we are fortunate to have our own marketing team, which can deploy social media strategies to get the word out. The uniqueness of our program (one of the only "Entrepreneurship" PhD programs in the country), the Waterloo brand, and the unique opportunity to study our ecosystem all leave us confident we can generate the interest required to recruit two to three very good students a year.

Dean's Response

Conrad School of Entrepreneurship and Business being part of the Faculty of Engineering makes our Faculty unique, and we consider it to be one of our key strengths. We are committed to ensuring the continued growth and success of the School's new PhD program.

b) **Add RA experience as a desired qualification** for admission.

Program Response

We have included explicitly that applicants should highlight any prior research or research assistantship experience in their applications (see page 6).

c) Clarify the specific **GPA and GRE/GMAT requirements.**

Program Response

We do mention a minimum overall average of 75% or equivalent in the previous degree. Regarding specific GRE/GMAT requirements, most schools do not post specific GMAT/GRE scores in their admission criteria. Some schools may post their average GMAT/GRE scores for the last three years' incoming class. We do not think it's necessary to include these specific scores at this stage of our program. However, we think presenting historical data, once available, is appropriate and desirable.

Deans Response

The other departments in Engineering have similar minimum GPA requirement.

d) Create a structure for **evaluating students' ability to conduct independent research** as early as possible, and prior to the dissertation proposal process.

Program Response

As we mentioned in our response to 1b above, the students will write independent research/term papers in their core courses. In addition, we have slightly modified our comprehensive exam format allowing us to clearly evaluate the student's ability to conduct independent research earlier in the program. In the comprehensive exam, the examination committee, consisting of faculty members that have taught the core courses, will assign three research questions to the students. The students will select one of these questions or suggest a slightly modified version of one of the questions. In all cases the question(s) must serve to require the substantive breadth covering different courses. The students will write a research study that will address this question. The research study will include relevant background information, literature review, hypotheses, discussion of potential methods to test the hypotheses, a description of how results will be interpreted, and a discussion of possible problems in implementing the method and how those problems could be addressed. The students will submit the written study 10-14 days before the oral examination with the comprehension examination committee. We have elaborated our comprehensive exam format on page 12 of the proposal.

Dean's Response
Please refer to the response to recommendation 1b.

3. ***SUPPORT & EXIT***
   a) **Set stipendary, research, and tuition equalization support levels based on a full comparative analysis** of doctoral programs in entrepreneurship to ensure competitive recruitment.

Program Response
The revised faculty of engineering Ph.D. support is now $25,000/year. However, this amount does not include a teaching assistantship. Along with a teaching assistantship, Ph.D. students will earn around $32,000/year. Based on our interaction with Ph.D. students in other programs, this seems a highly competitive amount (also see funding amount at Ivey and Haskayne, both of which offer specialization in Entrepreneurship).

Dean's Response
Successful applicants for Conrad's PhD program will be automatically screened for the Doctoral Engineering Excellence Fellowship (EEF-D). Also, the Faculty of Engineering is currently exploring ways to increasing the finding level of our PhD students.

   b) Create an **'offramp' for students** who have successfully completed the coursework requirements, in the case of misfit with the program, misalignment in career aspirations, or deficiencies in meeting degree level expectations (e.g., for the comprehensive exam).

Program Response
This is a good suggestion. There are two possible offramps, one existing currently, and two in discussion. The first is the Conrad School's Graduate Diploma in Entrepreneurship and Business. It requires six approved courses or equivalents. Students who complete their course work would be eligible for this credential. The Conrad School will further investigate possible transfers to the MMASc and MMSc degrees offered by the Department of Management Sciences. It is also possible that the Conrad School may offer its own research-based masters program in the future.

Dean's Response
Rigorous screening of the applications at the admissions stage can help minimize such occurrences as we see in our other doctoral programs.

FOR THE FACULTY:

4. **Commit to the 1-2 new hires specified** in the proposal as a minimum to sustain the program beyond its launch and **conduct a comparison of doctoral FFTE per supervising faculty member at comparator institutions** to determine the long-term staffing required.

   Program Response

   Since we plan a smaller intake of Ph.D. students, we feel comfortable launching the program with our current faculty. We have seven faculty members who have research grants and are qualified to supervise students. However, we are scheduled to hire at least five new faculty members over the next three years. We are confident that once the program reaches full capacity (five years from now), with approximately 10 students at various stages of completion, we will have more than enough supervisory capacity. Further, students will only be admitted when supervisory capacity is available and appropriate faculty are willing to take on new students.

   Dean's Response

   Engineering will continue to support new faculty hires in the Conrad School as per existing commitments.

5. Develop a process for **strengthening the school's capacity for doctoral supervision** through training, mentorship, co-supervision, formal processes, or informal communities of practice.

   Program Response

   We will organize mentoring sessions by inviting outside faculty with significant doctoral supervisory experience. We can start these sessions in Fall 2022 by inviting UW faculty, especially from the departments of Psychology and Economics, who have supervised Ph.D. students for a considerable time. Further, it is anticipated that at least two of the new faculty hires in the coming three years will be mid-career scholars with doctoral supervision experience. Indeed, their supervision success will be a criterion for their selection.

   Dean's Response

   New faculty members can participate in a workshop series on graduate supervision offered by the Office of the Associate Vice-President, Graduate Studies and Postdoctoral Affairs (GSPA). This can help the faculty member achieve the Approved Doctoral Dissertation Supervisor (ADDS) status.

FOR THE PROGRAM:

6. Perform a **structured review of the academic job market in entrepreneurship** to determine if a 4-year program is sufficient.

Program Response

We looked at the Academy of Management job site (the most important job portal for faculty openings in management) for current openings in Entrepreneurship and other important management disciplines. We found that there are currently 164 advertised faculty openings in Entrepreneurship and Innovation, while there are 111 positions in Strategy, 99 in Organizational Behavior, and 113 in Human Resource Management. This shows that there are substantially more openings in Entrepreneurship than in other major management disciplines. Also, since we had looked at these numbers last year (reported in the proposal), the number of openings in Entrepreneurship has increased by 6.5 percent. We have updated this information in our proposal on page 3.

In terms of hosting a 4-year Ph.D. program, we looked at other Ph.D. programs offering Entrepreneurship as a specialization, and these programs also commit to 4-year funding for their students (see Ivey and Haskayne). There is a definite move among Ph.D. programs to graduate students towards the end of their fourth year.

It is not uncommon for doctoral students in four-year programs to require a fifth year to complete their programs, or to position themselves for success in the job market. There are also some doctoral programs in Canada (e.g., Schulich and Rotman) that offer five years of guaranteed support, but they are in the minority. Expanding program offerings under development at the Conrad School heighten the likelihood that combinations of research support, TA'ships, targeted scholarships from existing resources, and sessional teaching could support such program extensions for some students.

Dean's Response

I support the Program's response and have no further comment

7. Place the **study of entrepreneurship at the centre of each proposed course**, reflecting the underlying integrative approach to the program.

Program Response

As we indicate in our proposal, our program will apply an entrepreneurial lens, therefore, in courses such as Organizational Behaviour and Business Strategy, while the instructors will cover important theories in these fields, they will also specifically discuss how these

theories are currently applied in the entrepreneurial space. Similarly, in the Research Methods course, the instructor will cover important research method techniques in entrepreneurship literature.

Dean's Response

I support the Program's response and have no further comment

8. Design program structures and practices that **reduce the school's vulnerability to faculty turnover** if it does occur.

Program Response

We have made provisions for co-supervisory teams, where a student can be jointly supervised by two Conrad faculty members. In addition, each Thesis Committee will have at least two additional faculty members from Conrad (other than the Supervisor). These faculty members will be involved with the students from the start of their thesis proposal. Both these provisions reduce any adverse effect on students in the event of a faculty turnover.

Dean's Response

I support the Program's response and have no further comment

9. Consider the **risks associated with courses outside the department** (i.e., the dependence on outside faculties) and mitigate those risks (e.g., MOUs establishing guaranteed seats for Conrad PhD students in these courses).

Program Response

We have spoken directly to the Ph.D. program directors at other departments (Economics, Psychology, Sociology, and Management Science), and they have all agreed to allow our students to take graduate method courses in their departments. Also, since we will have a small intake of students, accommodating our students in graduate courses in these departments will not be a problem. We will pursue written confirmation of these commitments.

Dean's Response

I support the Program's response and have no further comment

10. **Establish goals for the classroom environment** given the small (2-3) cohort size and

monitor against faculty and student experiences.

Program Response

Doctoral seminar courses will be intimate, to be certain, but we see that as a strength. Indeed, one of the richest learning environments in post-secondary education – The Oxford tutorial – is directed reading, discussion and engagement between a faculty member and 2-3 students. Even if there is an addition of 2-3 students from other disciplines or departments, this will make for extremely high-quality, high-expectation learning environments. The Associate Director, doctoral studies and research, will be responsible to be in regular contact with teachers, students, and faculty advisors, to continuously monitor the quality of the experience for all involved.

Dean's Response

I support the Program's response and have no further comment

11. Focus the proposal's strategic justification on a **singular and clear strategic motivation, aligned with Waterloo's overall mission and strategy**, i.e., the program will increase the school's research intensity, assist faculty in advancing their research programs, and position the school as a centre for thought leadership in entrepreneurship.

Program Response

We appreciate this excellent suggestion – it aligns with our motivation. We have included this in our proposal (page 3).

Dean's Response

I support the Program's response and have no further comment

12. A more **focused program name** might be beneficial (e.g., PhD in Entrepreneurship).

Program Response

We understand the appeal of the more focused name. Our chosen name – PhD in Entrepreneurship and Organizations – captures the greater breadth of faculty's interests and expertise, and may help graduates position themselves not only for "entrepreneurship" jobs, but also for those in fields like Strategy, or departments of "Management and Organizations" which have become the norm among top tier business schools. The inclusion of "Organizations" is a signal of the kind of theoretical frameworks to which students are likely to be exposed and in which they will have expertise.

Dean's Response

I support the Program's response and have no further comment

Recommendations Not Selected for Implementation

We have provided our rationale for recommendations that we did not select in our responses above.

Signature of Approval

Chair/Director

Date

Mary Wells Digitally signed by Mary Wells Date: 2022.09.20 14:09:51 -04'00'

Dean's

Date

Faculty of Mathematics – Program changes

Pure Math

Motion to remove the part-time option from:

- Master of Mathematics in Pure Mathematics
- Master of Mathematics in Pure Mathematics – Quantum Information
- Doctor of Philosophy in Pure Mathematics
- Doctor of Philosophy in Pure Mathematics - Quantum Information

Motion to identify the process for students to enter the thesis study option for:

- Master of Mathematics in Pure Mathematics
- Master of Mathematics in Pure Mathematics – Quantum Information

Motion to remove the requirement for a personal statement during admission for:

- Doctor of Philosophy in Pure Mathematics
- Doctor of Philosophy in Pure Mathematics - Quantum Information

Combinatorics & Optimization

Motion to add transfer entry internship option for:

- Doctor of Philosophy in Combinatorics and Optimization
- Doctor of Philosophy in Combinatorics and Optimization - Quantum Information

Motion to revise length of program information for: Decision-SGRC

- Master of Mathematics in Combinatorics and Optimization
- Master of Mathematics in Combinatorics and Optimization - Co-operative Program
- Master of Mathematics in Combinatorics and Optimization - Quantum Information
- Doctor of Philosophy in Combinatorics and Optimization
- Doctor of Philosophy in Combinatorics and Optimization - Quantum Information

Motion to remove the requirement for GRE during admission for: Decision-SGRC

- Master of Mathematics in Combinatorics and Optimization
- Master of Mathematics in Combinatorics and Optimization - Co-operative Program
- Master of Mathematics in Combinatorics and Optimization - Quantum Information
- Doctor of Philosophy in Combinatorics and Optimization
- Doctor of Philosophy in Combinatorics and Optimization - Quantum Information

Motion to add presentation component to thesis and update the display period Decision-SGRC

- Master of Mathematics in Combinatorics and Optimization
- Master of Mathematics in Combinatorics and Optimization - Co-operative Program
- Master of Mathematics in Combinatorics and Optimization - Quantum Information

Data Science

Motion to add research paper option

- MMath program in Data Science

New courses

Motion to create new math courses: Decision-SGRC

- Math 685: Math and Peace for Teachers
- Math 900: University Mathematics Teaching Techniques

These have been approved by the Mathematics Faculty Council on September 20th, 2022.

Graduate Studies
Program Revision Template

Prior to form submission, review the content revision instructions and information regarding major/minor modifications. For questions about the form submission, contact Trevor Clews, Graduate Studies and Postdoctoral Affairs (GSPA).

Faculty: Mathematics

Program: 1) Master of Mathematics (MMath) in Pure Mathematics

2) Master of Mathematics (MMath) in Pure Mathematics - Quantum Information

Program contact name(s): Barbara Csima

Form completed by: Barbara Csima

Description of proposed changes:
Note: changes to courses and milestones also require the completion/submission of the SGRC Graduate Studies Course/Milestone Form.

1) *Removing the part-time option from the programs.*
2) *Identifying the process for students to enter the thesis study option.*

Is this a major modification to the program? Yes

Rationale for change(s):

1) *The programs are structured for full-time study. We have not been admitting students to part-time, so listing it as an option is misleading. The possibility for full-time students to change to part-time as part of an accommodation could still be evaluated/approved on a case-by-case basis.*

2) For most students the Research Paper option is the best fit, so we are currently only admitting students to the Research Paper option, allowing a transfer to the Thesis Option only after a strong first term and a willing Supervisor. In the past, we had a bit of an issue with students trying for the Thesis Option in an attempt to avoid courses, when in fact it is intended for students who have already taken many graduate courses as an undergraduate, and are ready for a larger research component. We've found that admitting everyone to Research Paper has solved this problem. We now would like the process stated in the calendar.

Proposed effective date: Term: Winter Year: 2023

Current Graduate Studies Academic Calendar (GSAC) page (include the link to the web page where the changes are to be made):

https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/department-pure-mathematics/master-mathematics-mmath-pure-mathematics

https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/department-pure-mathematics/master-mathematics-mmath-pure-mathematics-quantum-information

Current Graduate Studies Academic Calendar content:	**Proposed Graduate Studies Academic Calendar content**:
Program information	**Program information**

Current Graduate Studies Academic Calendar content:	**Proposed Graduate Studies Academic Calendar content**:

• Admit term(s)
  ○ Fall
  ○ Winter
 	
• Delivery mode
  ○ On-campus
 	
• Program type
  ○ Master's
  ○ Research
 	
• Registration option(s)
  ○ Full-time
  ~~○ Part-time~~
 	
• Study option(s)
  ○ Thesis
  ○ Master's Research Paper
 	
Degree requirements
	• Admit term(s)
	  ○ Fall
	  ○ Winter
	
	• Delivery mode
	  ○ On-campus
	
	• Program type
	  ○ Master's
	  ○ Research
	
	• Registration option(s)
	  ○ Full-time
	
	• Study option(s)
	  ○ Thesis
	  ○ Master's Research Paper
	
	Degree requirements
	
	All students are admitted to the Master's Research Paper study option. Students can apply to transfer to the Thesis study option after completing at least one academic term. The transfer must be approved by the Department Graduate Officer.

How will students currently registered in the program be impacted by these changes?

1) *No impact*
2) *No impact*

Department/School approval date (12/14/21):
Reviewed by GSPA (for GSPA use only) ☒ date (03/03/22):
Faculty approval date (mm/dd/yy): 09/20/22
Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):
Senate approval date (mm/dd/yy) (if applicable):

Graduate Studies
Program Revision Template

Prior to form submission, review the content revision instructions and information regarding major/minor modifications. For questions about the form submission, contact Trevor Clews, Graduate Studies and Postdoctoral Affairs (GSPA).

Faculty: Mathematics

Program: 1) Doctor of Philosophy (PhD) in Pure Mathematics

2) Doctor of Philosophy (PhD) in Pure Mathematics - Quantum Information

Program contact name(s): Barbara Csima

Form completed by: Barbara Csima

Description of proposed changes:
Note: changes to courses and milestones also require the completion/submission of the SGRC Graduate Studies Course/Milestone Form.

1) *Removing the part-time option from the programs.*
2) *Removing the personal statement from the list of minimum admission requirements.*

Is this a major modification to the program? Yes

Rationale for change(s):

1) *The programs are structured for full-time study. We have not been admitting students to part-time, so listing it as an option is misleading. The possibility for full-time students to change to part-time as part of an accommodation could still be evaluated/approved on a case-by-case basis.*
2) *We no longer require a personal statement. We are instead asking for a research proposal or summary of recently completed project, but this is part of the supplemental information form.*

Proposed effective date: Term: Winter Year: 2023

Current Graduate Studies Academic Calendar (GSAC) page (include the link to the web page where the changes are to be made):

https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/department-pure-mathematics/doctor-philosophy-phd-pure-mathematics

https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/department-pure-mathematics/doctor-philosophy-phd-pure-mathematics-quantum-information

Current Graduate Studies Academic Calendar content:	**Proposed Graduate Studies Academic Calendar content**:

Program information
 	
• Admit term(s)
  ○ Fall
  ○ Winter
	Program information
	
	• Admit term(s)
	  ○ Fall
	  ○ Winter

Current Graduate Studies Academic Calendar content:	**Proposed Graduate Studies Academic Calendar content**:
○ Spring • Delivery mode ○ On-campus • Program type ○ Doctoral ○ Research • Registration option(s) ○ Full-time ~~○ Part-time~~ • Study option(s) ○ Thesis **Admission requirements** • Minimum requirements ○ A Master's degree (or equivalent) in Mathematics with at least a 78% standing. Exceptions may be made for students with an Honours Bachelor degree who demonstrate a very high level of background preparation and research potential. ~~○ A one-page personal statement.~~ • Application materials ○ Supplementary information form ○ Transcript(s) • References ○ Number of references: 3 ○ Type of references: at least 2 academic • English language proficiency (ELP) (if applicable)	○ Spring • Delivery mode ○ On-campus • Program type ○ Doctoral ○ Research • Registration option(s) ○ Full-time • Study option(s) ○ Thesis **Admission requirements** • Minimum requirements ○ A Master's degree (or equivalent) in Mathematics with at least a 78% standing. Exceptions may be made for students with an Honours Bachelor degree who demonstrate a very high level of background preparation and research potential. • Application materials ○ Supplementary information form ○ Transcript(s) • References ○ Number of references: 3 ○ Type of references: at least 2 academic • English language proficiency (ELP) (if applicable)

How will students currently registered in the program be impacted by these changes?

1) *No impact*
2) *No impact*

Department/School approval date (12/14/21):
Reviewed by GSPA (for GSPA use only) ☐ date (mm/dd/yy): 03/03/22
Faculty approval date (mm/dd/yy): 09/20/22
Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):

Senate approval date (mm/dd/yy) (if applicable):

Graduate Studies
Program Revision Template

Prior to form submission, review the content revision instructions and information regarding major/minor modifications. For questions about the form submission, contact Trevor Clews, Graduate Studies and Postdoctoral Affairs (GSPA).

Faculty: Mathematics

Program: Doctor of Philosophy (PhD) in Combinatorics and Optimization

Program contact name(s): Karen Yeats

Form completed by: Karen Yeats

Description of proposed changes:
Note: changes to courses and milestones also require the completion/submission of the SGRC Graduate Studies Course/Milestone Form.

1) *Adding a transfer entry internship option to the PhD in* Combinatorics and Optimization *program, in addition to keeping the regular existing PhD program.*
   Note: Other than the internship requirement and the fact that this not a direct-entry program, the PhD in Combinatorics and Optimization - Internship program option is identical to the PhD in Combinatorics and Optimization program. The program name that appears on diplomas and transcripts will be identical for both options.
2) *Revising the length of program information.*

Is this a major modification to the program? Yes

Rationale for change(s):

1) *By enrolling in this new PhD program option with a required internship, international students will be able to obtain a work permit to do an internship and work full-time hours at the internship in any term, subject to the conditions stated in the motion.*
2) *The length of program information was misleading and did not follow current practice. Both maximum and minimums are specified elsewhere in the Calendar. Parallel changes to the regular PhD programs are underway.*

Proposed effective date: Term: Winter Year: 2023

Current Graduate Studies Academic Calendar (GSAC) page (include the link to the web page where the changes are to be made):

https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/department-combinatorics-and-optimization

Current PhD in Combinatorics and Optimization Graduate Studies Academic Calendar content:	**Proposed PhD in Combinatorics and Optimization - Internship Graduate Studies Academic Calendar content**:

Current PhD in Combinatorics and Optimization Graduate Studies Academic Calendar content:	**Proposed PhD in Combinatorics and Optimization - Internship Graduate Studies Academic Calendar content**:

DOCTOR OF PHILOSOPHY (PHD) IN COMBINATORICS AND OPTIMIZATION
 	
Graduate research fields
 	
• Algebraic Combinatorics
• Continuous Optimization
• Cryptography
• Discrete Optimization
• Graph Theory
• Quantum Computing
 	
Program information
 	
• **Admit term(s)**
  ○ Fall
  ○ Winter
  ○ Spring
 	
• **Delivery mode**
  ○ On-campus
 	
• **Length of program**
  ○ ~~The normal period of registration for the PhD degree is 6 terms from a Master's degree. One year of credit may be granted by the Faculty Graduate Committee for work done towards the PhD degree at another institution, provided that the relevance of the previous work to the student's proposed program is clearly established.~~
 	
• **Program type**
  ○ Doctoral
  ○ Research
 	
• **Registration option(s)**
  ○ Full-time
  ○ Part-time
 	
• **Study option(s)**
  ○ Thesis
 	
Admission requirements
 	
• **Minimum requirements**
  ○ A Master's degree in combinatorics and optimization, or in a closely related field, with a minimum 89% average in Master's level coursework.
	DOCTOR OF PHILOSOPHY (PHD) IN COMBINATORICS AND OPTIMIZATION - INTERNSHIP
	
	Graduate research fields
	
	• Algebraic Combinatorics
	• Continuous Optimization
	• Cryptography
	• Discrete Optimization
	• Graph Theory
	• Quantum Computing
	
	Program information
	
	• **Admit term(s)**
	  ○ Fall
	  ○ Winter
	  ○ Spring
	
	• **Delivery mode**
	  ○ On-campus
	
	• **Length of program**
	  ○ Students are required to complete the program in accordance with the University program time limits.
	
	• **Program type**
	  ○ Doctoral
	  ○ Research
	
	• **Registration option(s)**
	  ○ Full-time
	  ○ Part-time
	
	• **Study option(s)**
	  ○ Thesis
	
	Admission requirements
	
	• **Minimum requirements**
	  ○ Students in the Doctor of Philosophy (PhD) in Combinatorics and Optimization program can apply to transfer into the Doctor of Philosophy (PhD) in Combinatorics and Optimization - Internship program option after completing at least one academic term. Admittance will be decided based on the student's

Current PhD in Combinatorics and Optimization Graduate Studies Academic Calendar content:	**Proposed PhD in Combinatorics and Optimization - Internship Graduate Studies Academic Calendar content**:
○ Completion of a master's thesis. ○ It is essential that the application for admission into the PhD program contains evidence of research ability or potential. ○ Students in the PhD program are regarded as being on probation during their first year in the Department, and their performance during this first year determines whether they are allowed to continue in the program. In particular, failure in any one course, or an unsatisfactory performance in the comprehensive examination, automatically results in a review of the student's progress by the Department Graduate Committee. PhD students' progress will be reviewed at least once per year. ○ A student who is enrolled in the Master of Mathematics (MMath) program in the Department of Combinatorics and Optimization and wishes to continue in the PhD program has to apply for admission into the program. In exceptional cases, a graduate student enrolled in a MMath (Thesis) program in the Department of Combinatorics and Optimization may, through the Graduate Officer and with the consent of the Supervisor, petition the Graduate Committee to be transferred into a PhD program. The guidelines for such a transfer are as follows: ▪ The student has been enrolled in the MMath (Thesis) program for at least two terms. ▪ The student has made considerable progress in the research project (of the type that would warrant the MMath degree) and is committed to carrying the project to completion in a PhD program. ▪ The student gives a seminar presentation of the work carried out so far, and answers related questions to the satisfaction of an examining committee consisting of the supervisor and two other faculty members.	<u>progress to date, and is subject to approval by the student's supervisor(s) and the Associate Chair, Graduate Studies in the Department of Combinatorics and Optimization.</u> **Degree requirements** **Thesis option:** • **Graduate Academic Integrity Module (Graduate AIM)** • **Courses** ○ Students must complete 8 courses, including 4 core courses and at least 1 other CO course. The remaining 3 courses must be graduate courses in the Faculty of Mathematics, or courses approved by the CO Graduate Committee. ○ At least 6 courses should normally be completed within the first 6 terms. ○ Core courses: ▪ CO 630 Algebraic Enumeration ▪ CO 642 Graph Theory ▪ CO 650 Combinatorial Optimization ▪ CO 663 Convex Optimization and Analysis ▪ CO 681 Quantum Information Processing ▪ CO 685 The Mathematics of Public-Key Cryptography ○ If students have credit for a course deemed equivalent to a particular core course by the Department Graduate Committee, then that part of the core requirement may be waived. ○ The Department may require additional coursework in cases where this is judged to be necessary; for instance, when a student is admitted to the PhD program without having been granted credit for a Master's degree. • **<u>PhD Internship</u>** ○ <u>Students are required to complete one or more 3-4 month internships working on a topic related to their program. The internships will normally be arranged by the student, possibly with assistance from the supervisor. The internship</u>

Current PhD in Combinatorics and Optimization Graduate Studies Academic Calendar content:	**Proposed PhD in Combinatorics and Optimization - Internship Graduate Studies Academic Calendar content**:
○ Students applying to the PhD program who hold a Master's degree from another university may, in some cases, be admitted initially into the MMath program. In such cases the Graduate Committee will decide, within three terms, whether to transfer the student into the PhD program. • **Application materials** ○ Supplementary information form ○ Transcript(s) • **References** ○ Number of references: 3 ○ Type of references: normally from academic sources. • **English language proficiency (ELP)** (if applicable) **Degree requirements** **Thesis option:** • **Graduate Academic Integrity Module (Graduate AIM)** • **Courses** ○ Students must complete 8 c ourses, including 4 core courses and at least 1 other CO course. The remaining 3 courses must be graduate courses in the Faculty of Mathematics, or courses approved by the CO Graduate Committee. ○ At least 6 courses should normally be completed within the first 6 terms. ○ Core courses: ▪ CO 630 Algebraic Enumeration ▪ CO 642 Graph Theory ▪ CO 650 Combinatorial Optimization ▪ CO 663 Convex Optimization and Analysis ▪ CO 681 Quantum Information Processing ▪ CO 685 The Mathematics of Public-Key Cryptography ○ If students have credit for a course deemed equivalent to a particular core course by the Department Graduate	must be approved by the supervisor and the Associate Chair, Graduate Studies in the Department of Combinatorics and Optimization. At most two consecutive terms can be taken for an internship. An internship may not be taken in the student's final term. • **Graduate Studies Research Skills Seminar** ○ Required for PhD students unless the student satisfied this requirement as a MMath student at the Department of Combinatorics and Optimization. • **PhD Lecturing Requirement** ○ Every PhD student will be required to lecture under supervision during the program of studies. If a PhD student gives a scheduled course on a regular basis, the same two faculty members will attend three of the lectures and make a confidential, constructive critique of the student's performance to the student. ○ The PhD Lecturing Requirement should normally be completed within the first eight terms of the student's PhD program. Students may not put their thesis on display until at least the term following that in which the Lecturing Requirement was successfully completed. • **PhD Comprehensive Examination** ○ This requirement consists of 2 written examinations covering the fundamentals of combinatorics and optimization. These are usually offered once a year, in the spring term. The student must write one exam from two of the following three categories: ▪ Combinatorial Enumeration, Graph Theory ▪ Continuous Optimization, Discrete Optimization ▪ Cryptography, Quantum Computing ○ The choice of exams is made by the student, in consultation with their supervisor. The exams must be taken

Current PhD in Combinatorics and Optimization Graduate Studies Academic Calendar content:	**Proposed PhD in Combinatorics and Optimization - Internship Graduate Studies Academic Calendar content**:
Committee, then that part of the core requirement may be waived. o The Department may require additional coursework in cases where this is judged to be necessary; for instance, when a student is admitted to the PhD program without having been granted credit for a Master's degree. • **Graduate Studies Research Skills Seminar** o Required for PhD students unless the student satisfied this requirement as a MMath student at the Department of Combinatorics and Optimization. • **PhD Lecturing Requirement** o Every PhD student will be required to lecture under supervision during the program of studies. If a PhD student gives a scheduled course on a regular basis, the same two faculty members will attend three of the lectures and make a confidential, constructive critique of the student's performance to the student. o The PhD Lecturing Requirement should normally be completed within the first eight terms of the student's PhD program. Students may not put their thesis on display until at least the term following that in which the Lecturing Requirement was successfully completed. • **PhD Comprehensive Examination** o This requirement consists of 2 written examinations covering the fundamentals of combinatorics and optimization. These are usually offered once a year, in the spring term. The student must write one exam from two of the following three categories: ▪ Combinatorial Enumeration, Graph Theory ▪ Continuous Optimization, Discrete Optimization ▪ Cryptography, Quantum Computing o The choice of exams is made by the student, in consultation with their supervisor. The exams must be taken	within the first four terms of the student's PhD program. o The PhD Comprehensive Examination requirement is satisfied by passing both examinations. • **PhD Thesis Proposal** o The PhD Thesis Proposal is an oral exam at which the student is expected to give a brief description of the questions they propose to work on for the PhD and a summary of the main results in this area. This exam should normally be taken within the first six terms of the student's PhD program. The student should provide a short written version of their thesis proposal to their committee one week before the oral presentation. The PhD Thesis Proposal requirement is satisfied by successful completion of this exam. o Advisory Committee: each student has an Advisory Committee, which normally consists of the student's supervisor and two other department members with expertise in the area of the student's research interests. The Advisory Committee acts as the examining committee at the student's PhD Thesis Proposal, and is usually formed at this time. The members of the advisory committee will also usually act as examiners at the student's PhD defence. The Advisory Committee is selected by the Graduate Officer, who will consult the student and their supervisor. • **PhD Thesis** o Students must prepare a thesis, embodying the results of original research, of a standard that would warrant publication in a research journal of the field. The thesis must be acceptable to the student's supervisor, to two professors in the Department and one professor outside the Department, and to an external examiner familiar with the student's research field. The student is required to defend the thesis at an oral examination. This requirement is met

Current PhD in Combinatorics and Optimization Graduate Studies Academic Calendar content:	Proposed PhD in Combinatorics and Optimization - Internship Graduate Studies Academic Calendar content:
within the first four terms of the student's PhD program. o The PhD Comprehensive Examination requirement is satisfied by passing both examinations. • **PhD Thesis Proposal** o The PhD Thesis Proposal is an oral exam at which the student is expected to give a brief description of the questions they propose to work on for the PhD and a summary of the main results in this area. This exam should normally be taken within the first six terms of the student's PhD program. The student should provide a short written version of their thesis proposal to their committee one week before the oral presentation. The PhD Thesis Proposal requirement is satisfied by successful completion of this exam. o Advisory Committee: each student has an Advisory Committee, which normally consists of the student's supervisor and two other department members with expertise in the area of the student's research interests. The Advisory Committee acts as the examining committee at the student's PhD Thesis Proposal, and is usually formed at this time. The members of the advisory committee will also usually act as examiners at the student's PhD defence. The Advisory Committee is selected by the Graduate Officer, who will consult the student and their supervisor. • **PhD Thesis** o Students must prepare a thesis, embodying the results of original research, of a standard that would warrant publication in a research journal of the field. The thesis must be acceptable to the student's supervisor, to two professors in the Department and one professor outside the Department, and to an external examiner familiar with the student's research field. The student is required to defend the thesis at an oral examination. This requirement is met	when the thesis has been successfully defended and accepted.

Current PhD in Combinatorics and Optimization Graduate Studies Academic Calendar content:	**Proposed PhD in Combinatorics and Optimization - Internship Graduate Studies Academic Calendar content**:
when the thesis has been successfully defended and accepted.	

How will students currently registered in the program be impacted by these changes?

This is a new, non-direct-entry program option that is being created, so there are no students currently registered in this program. Once created, students registered in the Doctor of Philosophy (PhD) in Combinatorics and Optimization program can transfer to this program option in order to avail of internship opportunities. Other than the internship requirement and the fact that this not a direct-entry program, the PhD in Combinatorics and Optimization – Internship program option is identical to the PhD in Combinatorics and Optimization program.

Department/School approval date (mm/dd/yy): 03/07/22
Reviewed by GSPA (for GSPA use only) ☒ date (mm/dd/yy): 01/25/22
Faculty approval date (mm/dd/yy): 09/20/22
Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):
Senate approval date (mm/dd/yy) (if applicable):

Graduate Studies
Program Revision Template

Prior to form submission, review the content revision instructions and information regarding major/minor modifications. For questions about the form submission, contact Trevor Clews, Graduate Studies and Postdoctoral Affairs (GSPA).

Faculty: Mathematics

Program: Doctor of Philosophy (PhD) in Combinatorics and Optimization - Quantum Information

Program contact name(s): Karen Yeats

Form completed by: Karen Yeats

Description of proposed changes:
Note: changes to courses and milestones also require the completion/submission of the SGRC Graduate Studies Course/Milestone Form.

1) *Adding a transfer entry internship option to the PhD in* Combinatorics and Optimization - *Quantum Information program, in addition to keeping the regular existing PhD program.*
   Note: Other than the internship requirement and the fact that this not a direct-entry program, the PhD in Combinatorics and Optimization - Quantum Information - Internship program option is identical to the PhD in Combinatorics and Optimization - Quantum Information program. The program name that appears on diplomas and transcripts will be identical for both options.
2) *Revising the length of program information.*

Is this a major modification to the program? Yes

Rationale for change(s):

1) *By enrolling in this new PhD program option with a required internship, international students will be able to obtain a work permit to do an internship and work full-time hours at the internship in any term, subject to the conditions stated in the motion.*
2) *The length of program information was misleading and did not follow current practice. Both maximum and minimums are specified elsewhere in the Calendar. Parallel changes to the regular PhD programs are underway.*

Proposed effective date: Term: Winter Year: 2023

Current Graduate Studies Academic Calendar (GSAC) page (include the link to the web page where the changes are to be made):

https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/department-combinatorics-and-optimization

Current PhD in Combinatorics and Optimization - Quantum Information Graduate Studies Academic Calendar content:	**Proposed PhD in Combinatorics and Optimization - Quantum Information - Internship Graduate Studies Academic Calendar content**:

Current PhD in Combinatorics and Optimization - Quantum Information Graduate Studies Academic Calendar content:	Proposed PhD in Combinatorics and Optimization - Quantum Information - Internship Graduate Studies Academic Calendar content:
DOCTOR OF PHILOSOPHY (PHD) IN COMBINATORICS AND OPTIMIZATION - QUANTUM INFORMATION **Program information** • **Admit term(s)** o Fall o Winter o Spring • **Delivery mode** o On-campus • **Length of program** o ~~The normal period of registration for the PhD degree is 6 terms from a Master's degree. One year of credit may be granted by the Faculty Graduate Committee for work done towards the PhD degree at another institution, provided that the relevance of the previous work to the student's proposed program is clearly established~~. • **Program type** o Collaborative o Doctoral o Research • **Registration option(s)** o Full-time o Part-time • **Study option(s)** o Thesis **Admission requirements** • **Minimum requirements** o A Master's degree in combinatorics and optimization, or in a closely related field, with a minimum 89% average in Master's level coursework. o Completion of a master's thesis. o It is essential that the application for admission into the PhD program contains evidence of research ability or potential. o Students in the PhD program are regarded as being on probation during	**DOCTOR OF PHILOSOPHY (PHD) IN COMBINATORICS AND OPTIMIZATION - QUANTUM INFORMATION <u>- INTERNSHIP</u>** **Program information** • **Admit term(s)** o Fall o Winter o Spring • **Delivery mode** o On-campus • **Length of program** o <u>Students are required to complete the program in accordance with the University program time limits.</u> • **Program type** o Collaborative o Doctoral o Research • **Registration option(s)** o Full-time o Part-time • **Study option(s)** o Thesis **Admission requirements** • **Minimum requirements** o <u>Students in the Doctor of Philosophy (PhD) in Combinatorics and Optimization - Quantum Information program can apply to transfer into the Doctor of Philosophy (PhD) in Combinatorics and Optimization - Quantum Information - Internship program option after completing at least one academic term. Admittance will be decided based on the student's progress to date, and is subject to approval by the student's supervisor(s) and the Associate Chair, Graduate Studies in the Department of Combinatorics and Optimization.</u> **Degree requirements**

Current PhD in Combinatorics and Optimization - Quantum Information Graduate Studies Academic Calendar content:	Proposed PhD in Combinatorics and Optimization - Quantum Information - Internship Graduate Studies Academic Calendar content:
their first year in the Department, and their performance during this first year determines whether they are allowed to continue in the program. In particular, failure in any one course, or an unsatisfactory performance in the comprehensive examination, automatically results in a review of the student's progress by the Department Graduate Committee. PhD students' progress will be reviewed at least once per year. ○ A student who is enrolled in the Master of Mathematics (MMath) program in the Department of Combinatorics and Optimization and wishes to continue in the PhD program has to apply for admission into the program. In exceptional cases, a graduate student enrolled in a MMath (Thesis) program in the Department of Combinatorics and Optimization may, through the Graduate Officer and with the consent of the Supervisor, petition the Graduate Committee to be transferred into a PhD program. The guidelines for such a transfer are as follows: ▪ The student has been enrolled in the MMath (Thesis) program for at least two terms. ▪ The student has made considerable progress in the research project (of the type that would warrant the MMath degree) and is committed to carrying the project to completion in a PhD program. ▪ The student gives a seminar presentation of the work carried out so far, and answers related questions to the satisfaction of an examining committee consisting of the supervisor and two other faculty members. ○ Students applying to the PhD program who hold a Master's degree from another university may, in some cases, be admitted initially into the MMath program. In such cases the Graduate Committee will decide, within three terms, whether to transfer the student	**Thesis option:** • **Graduate Academic Integrity Module (Graduate AIM)** • **Courses** ○ Students must complete 8 courses, including the 2 Quantum Information core courses, and 3 other CO core courses. At least 5 of the courses taken should be CO courses and at least 4 should be QI courses (note that jointly offered or cross-listed courses, like CO681/QIC710, are regarded as both CO and QIC courses). The remaining course (if any) must be a graduate course in the Faculty of Mathematics, or a course approved by the CO Graduate Committee. ○ At least 6 courses should normally be completed within the first 6 terms. ○ Combinatorics and Optimization core courses: ▪ CO 630 Algebraic Enumeration ▪ CO 642 Graph Theory ▪ CO 650 Combinatorial Optimization ▪ CO 663 Convex Optimization and Analysis ▪ CO 681 Quantum Information Processing ▪ CO 685 The Mathematics of Public-Key Cryptography ○ Quantum Information core courses: ▪ QIC 710 Quantum Information Processing (equivalent to CO 681 Quantum Information Processing) ▪ QIC 750 Quantum Information Processing Devices ○ If students have credit for a course deemed equivalent to a particular core course by the Department Graduate Committee, then that part of the core requirement may be waived. ○ The Department may require additional coursework in cases where this is judged to be necessary; for instance, when a student is admitted to the PhD program without having been granted credit for a Master's degree.

Current PhD in Combinatorics and Optimization - Quantum Information Graduate Studies Academic Calendar content:	**Proposed PhD in Combinatorics and Optimization - Quantum Information - Internship Graduate Studies Academic Calendar content**:

into the PhD program.
 	
• **Application materials**
  ○ Supplementary information form
  ○ Transcript(s)
 	
• **References**
  ○ Number of references: 3
  ○ Type of references: normally from academic sources.
 	
• **English language proficiency (ELP)** (if applicable)
 	
Degree requirements
Thesis option:
 	
• **Graduate Academic Integrity Module (Graduate AIM)**
 	
• **Courses**
  ○ Students must complete 8 courses, including the 2 Quantum Information core courses, and 3 other CO core courses. At least 5 of the courses taken should be CO courses and at least 4 should be QI courses (note that jointly offered or cross-listed courses, like CO681/QIC710, are regarded as both CO and QIC courses). The remaining course (if any) must be a graduate course in the Faculty of Mathematics, or a course approved by the CO Graduate Committee.
  ○ At least 6 courses should normally be completed within the first 6 terms.
  ○ Combinatorics and Optimization core courses:
  ▪ CO 630 Algebraic Enumeration
  ▪ CO 642 Graph Theory
  ▪ CO 650 Combinatorial Optimization
  ▪ CO 663 Convex Optimization and Analysis
  ▪ CO 681 Quantum Information Processing
  ▪ CO 685 The Mathematics of Public-Key Cryptography
  ○ Quantum Information core courses:
  ▪ QIC 710 Quantum Information Processing (equivalent to CO
	• **PhD Internship**
	  ○ Students are required to complete one or more 3-4 month internships working on a topic related to their program. The internships will normally be arranged by the student, possibly with assistance from the supervisor. The internship must be approved by the supervisor and the Associate Chair, Graduate Studies in the Department of Combinatorics and Optimization. At most two consecutive terms can be taken for an internship. An internship may not be taken in the student's final term.
	
	• **Graduate Studies Research Skills Seminar**
	  ○ Required for PhD students unless the student satisfied this requirement as a MMath student at the Department of Combinatorics and Optimization.
	
	• **PhD Quantum Information Seminar**
	  ○ Students must successfully complete a seminar milestone consisting of 1 Institute for Quantum Computing (IQC) seminar, and 1 seminar on a Quantum Information (QI) topic. If appropriate, lectures given as part of the Lecturing Requirement may also be used to satisfy the seminar requirement.
	
	• **PhD Lecturing Requirement**
	  ○ Every PhD student will be required to lecture under supervision during the program of studies. If a PhD student gives a scheduled course on a regular basis, the same two faculty members will attend three of the lectures and make a confidential, constructive critique of the student's performance to the student.
	  ○ The PhD Lecturing Requirement should normally be completed within the first eight terms of the student's PhD program. Students may not put their thesis on display until at least the term following that in which the Lecturing Requirement was successfully completed.
	
	• **PhD Comprehensive Examination**

Current PhD in Combinatorics and Optimization - Quantum Information Graduate Studies Academic Calendar content:	**Proposed PhD in Combinatorics and Optimization - Quantum Information - Internship Graduate Studies Academic Calendar content**:
681 Quantum Information Processing) ▪ QIC 750 ~~Implementation of~~ Quantum Information Processing o If students have credit for a course deemed equivalent to a particular core course by the Department Graduate Committee, then that part of the core requirement may be waived. o The Department may require additional coursework in cases where this is judged to be necessary; for instance, when a student is admitted to the PhD program without having been granted credit for a Master's degree. • **Graduate Studies Research Skills Seminar** o Required for PhD students unless the student satisfied this requirement as a MMath student at the Department of Combinatorics and Optimization. • **PhD Quantum Information Seminar** o Students must successfully complete a seminar milestone consisting of 1 Institute for Quantum Computing (IQC) seminar, and 1 seminar on a Quantum Information (QI) topic. If appropriate, lectures given as part of the Lecturing Requirement may also be used to satisfy the seminar requirement. • **PhD Lecturing Requirement** o Every PhD student will be required to lecture under supervision during the program of studies. If a PhD student gives a scheduled course on a regular basis, the same two faculty members will attend three of the lectures and make a confidential, constructive critique of the student's performance to the student. o The PhD Lecturing Requirement should normally be completed within the first eight terms of the student's PhD program. Students may not put their thesis on display until at least the term following that in which the Lecturing Requirement was successfully completed.	o This requirement consists of 2 written examinations covering the fundamentals of combinatorics and optimization. These are usually offered once a year, in the Spring term. The student must write one exam from two of the following three categories: ▪ Combinatorial Enumeration, Graph Theory ▪ Continuous Optimization, Discrete Optimization ▪ Cryptography, Quantum Computing o The choice of exams is made by the student, in consultation with their supervisor. The exams must be taken within the first four terms of the student's PhD program. o The PhD Comprehensive Examination requirement is satisfied by passing both examinations. • **PhD Thesis Proposal** o The PhD Thesis Proposal is an oral exam at which the student is expected to give a brief description of the questions they propose to work on for the PhD and a summary of the main results in this area. This exam should normally be taken within the first six terms of the student's PhD program. The student should provide a short written version of their thesis proposal to their committee one week before the oral presentation. The PhD Thesis Proposal requirement is satisfied by successful completion of this exam. o Advisory Committee: each student has an Advisory Committee, which normally consists of the student's supervisor and two other department members with expertise in the area of the student's research interests. The Advisory Committee acts as the examining committee at the student's PhD Thesis Proposal, and is usually formed at this time. The members of the advisory committee will also usually act as examiners at the student's PhD defence. The Advisory Committee is selected by the Graduate Officer, who will consult the student and their

Current PhD in Combinatorics and Optimization - Quantum Information Graduate Studies Academic Calendar content:	Proposed PhD in Combinatorics and Optimization - Quantum Information - Internship Graduate Studies Academic Calendar content:

• **PhD Comprehensive Examination**
  ○ This requirement consists of 2 written examinations covering the fundamentals of combinatorics and optimization. These are usually offered once a year, in the Spring term. The student must write one exam from two of the following three categories:
  ▪ Combinatorial Enumeration, Graph Theory
  ▪ Continuous Optimization, Discrete Optimization
  ▪ Cryptography, Quantum Computing
  ○ The choice of exams is made by the student, in consultation with their supervisor. The exams must be taken within the first four terms of the student's PhD program.
  ○ The PhD Comprehensive Examination requirement is satisfied by passing both examinations.
 	
• **PhD Thesis Proposal**
  ○ The PhD Thesis Proposal is an oral exam at which the student is expected to give a brief description of the questions they propose to work on for the PhD and a summary of the main results in this area. This exam should normally be taken within the first six terms of the student's PhD program. The student should provide a short written version of their thesis proposal to their committee one week before the oral presentation. The PhD Thesis Proposal requirement is satisfied by successful completion of this exam.
  ○ Advisory Committee: each student has an Advisory Committee, which normally consists of the student's supervisor and two other department members with expertise in the area of the student's research interests. The Advisory Committee acts as the examining committee at the student's PhD Thesis Proposal, and is usually formed at this time. The members of the advisory committee will also usually act as examiners at the student's PhD defence. The Advisory Committee is selected by the Graduate Officer, who
	supervisor.
	
	• **PhD Thesis**
	  ○ Students must prepare a thesis in Quantum Information, embodying the results of original research, of a standard that would warrant publication in a research journal of the field. The thesis must be acceptable to the student's supervisor, to two professors in the Department and one professor outside the Department, and to an external examiner familiar with the student's research field. The student is required to defend the thesis at an oral examination. This requirement is met when the thesis has been successfully defended and accepted.

Current PhD in Combinatorics and Optimization - Quantum Information Graduate Studies Academic Calendar content:	Proposed PhD in Combinatorics and Optimization - Quantum Information - Internship Graduate Studies Academic Calendar content:
will consult the student and their supervisor. • **PhD Thesis** ○ Students must prepare a thesis in Quantum Information, embodying the results of original research, of a standard that would warrant publication in a research journal of the field. The thesis must be acceptable to the student's supervisor, to two professors in the Department and one professor outside the Department, and to an external examiner familiar with the student's research field. The student is required to defend the thesis at an oral examination. This requirement is met when the thesis has been successfully defended and accepted.	

How will students currently registered in the program be impacted by these changes?

This is a new, non-direct-entry program option that is being created, so there are no students currently registered in this program. Once created, students registered in the Doctor of Philosophy (PhD) in Combinatorics and Optimization - Quantum Information program can transfer to this program option in order to avail of internship opportunities. Other than the internship requirement and the fact that this not a direct-entry program, the PhD in Combinatorics and Optimization - Quantum Information - Internship program option is identical to the PhD in Combinatorics and Optimization - Quantum Information program.

Department/School approval date (mm/dd/yy): 03/07/22
Reviewed by GSPA (for GSPA use only) ☒ date (mm/dd/yy): 01/25/22
Faculty approval date (mm/dd/yy): 09/20/22
Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):
Senate approval date (mm/dd/yy) (if applicable):

Senate Graduate & Research Council
Graduate Studies Course/Milestone Form

Prior to form submission, review the content revision instructions. For questions about the form submission, contact Trevor Clews, Graduate Studies and Postdoctoral Affairs (GSPA).

Faculty: Mathematics

Effective date: Term: Winter Year: 2023

Milestone

Note: milestone changes also require the completion/submission of the Graduate Studies Program Revision Template.

☒ New: PhD Internship

☐ Inactivate: Choose an item.

☐ Revise: from Choose an item. to Choose an item.

Course

Note: some course changes also require the completion/submission of the Graduate Studies Program Revision Template.

☐ New: Complete all course elements below

☐ Inactivate: Complete the following course elements:
Course subject code, Course number, Course ID, Course title

☐ Revise: Complete all course elements below to reflect the proposed change(s) and identify the course elements being revised (*e.g. Course description, Course title*):

Course elements (complete as indicated above. Review the glossary of terms for details on course elements)

Course subject code: Choose an item.

Course number:

Course ID:

Course title (max. 100 characters including spaces):

Course short title (max. 30 characters including spaces):

Grading basis: Choose an item.

Course credit weight: Choose an item.

Course consent required: Choose an item.

Course description:

Meet type(s): Choose an item. Choose an item. Choose an item. Choose an item.

Primary meet type: Choose an item.

Delivery mode: Choose an item.

Requisites:

Special topics course: Yes ☐ No ☐

Cross-listed course: Yes ☐ No ☐

Course subject code(s) and number(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request:

The milestone should be applied to the following programs:

1) Doctor of Philosophy (PhD) in Combinatorics and Optimization - Internship
2) Doctor of Philosophy (PhD) in Combinatorics and Optimization - Quantum Information - Internship

Form completed by: Karen Yeats
Department/School approval date (mm/dd/yy): 03/07/22
Reviewed by GSPA (for GSPA use only) ☒ date (mm/dd/yy): 01/25/22
Faculty approval date (mm/dd/yy): 09/20/22
Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):

Graduate Studies
Program Revision Template

Prior to form submission, review the content revision instructions and information regarding major/minor modifications. For questions about the form submission, contact Trevor Clews, Graduate Studies and Postdoctoral Affairs (GSPA).

Faculty: Mathematics

Programs: 1) Master of Mathematics (MMath) in Combinatorics and Optimization

2) Master of Mathematics (MMath) in Combinatorics and Optimization - Co-operative Program

3) Master of Mathematics (MMath) in Combinatorics and Optimization - Quantum Information

Program contact name(s): Karen Yeats, Melissa Cambridge

Form completed by: Karen Yeats

Description of proposed changes:
Note: changes to courses and milestones also require the completion/submission of the SGRC Graduate Studies Course/Milestone Form.

1) *Revising the length of program information.*
2) *Revising the Graduate Record Examinations (GRE) requirement text.*

Is this a major modification to the program? No

Rationale for change(s):

1) *The length of program information was misleading and did not follow current practice. Both maximum and minimums are specified elsewhere in the calendar.*
2) *Students were unclear on how strictly the GRE was required. This clarifies that it is not required but is recommended, and means it does not need to be included in the GSAC as a formal requirement that we then waive under some circumstances giving us more flexibility.*

Proposed effective date: Term: Winter Year: 2023

Current Graduate Studies Academic Calendar (GSAC) page (include the link to the web page where the changes are to be made):

https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/department-combinatorics-and-optimization/master-mathematics-mmath-combinatorics-and-optimization

https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/department-combinatorics-and-optimization/master-mathematics-mmath-combinatorics-and-optimization-co-operative-program-direct-entry

https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/department-combinatorics-and-optimization/master-mathematics-mmath-combinatorics-and-optimization-quantum-information

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
Program information	**Program information**

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
• Admit term(s) o Fall o Winter o Spring • Delivery mode o On-campus • Length of program o ~~At least two terms of full-time registration. Students should normally complete the MMath degree in one year (three semesters).~~ • Program type o Master's o Research • Registration option(s) o Full-time o Part-time • Study option(s) o Thesis o Master's Research Paper **Admission requirements** • Minimum requirements o A four-year Honours Bachelor degree or its equivalent in mathematics or in a closely related field with a 78% overall average or its equivalent for undergraduate work. o **Applicants ~~from foreign countries must normally take~~ the Graduate Record Examinations (GRE) General Test and Subject Tests.** • Application materials o Supplementary information form o Transcript(s) • References o **Number of references: 3** o Type of references: normally from academic sources.	• Admit term(s) o Fall o Winter o Spring • Delivery mode o On-campus • Length of program o Students are required to complete the program in accordance with the University program time limits • Program type o Master's o Research • Registration option(s) o Full-time o Part-time • Study option(s) o Thesis o Master's Research Paper **Admission requirements** • Minimum requirements o A four-year Honours Bachelor degree or its equivalent in mathematics or in a closely related field with a 78% overall average or its equivalent for undergraduate work. o Applicants educated outside of Canada, including those from the United States, are recommended to submit scores from the Graduate Record Examinations (GRE) subject test in mathematics. Neither the GRE general test nor the GRE subject test is required. • Application materials o Supplementary information form o Transcript(s) • References o Number of references: 3 o Type of references: normally from

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
• English language proficiency (ELP) (if applicable)	academic sources. • English language proficiency (ELP) (if applicable)

How will students currently registered in the program be impacted by these changes?

Time limit change reflects current practice. The University time limits are the limits that have been enforced. Consequently the only change to currently registered students is that the practice already in effect is now consistent with the calendar description.

GRE change impacts admission only so currently registered students are unaffected.

Department/School approval date (mm/dd/yy): 03/18/22

Reviewed by GSPA (for GSPA use only) ☐ date (mm/dd/yy): 01/19/22

Faculty approval date (mm/dd/yy): 09/20/22

Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):

Senate approval date (mm/dd/yy) (if applicable):

Graduate Studies
Program Revision Template

Prior to form submission, review the content revision instructions and information regarding major/minor modifications. For questions about the form submission, contact Trevor Clews, Graduate Studies and Postdoctoral Affairs (GSPA).

Faculty: Mathematics

Programs: 1) Doctor of Philosophy (PhD) in Combinatorics and Optimization

2) Doctor of Philosophy (PhD) in Combinatorics and Optimization - Quantum Information

Program contact name(s): Karen Yeats, Melissa Cambridge

Form completed by: Karen Yeats

Description of proposed changes:
Note: changes to courses and milestones also require the completion/submission of the SGRC Graduate Studies Course/Milestone Form.

1) *Revising the length of program information.*
2) *Adding a Graduate Record Examinations (GRE) requirement to the admission requirements.*

Is this a major modification to the program? No

Rationale for change(s):

1) *The length of program information was misleading and did not follow current practice. Both maximum and minimums are specified elsewhere in the calendar.*
2) *Students were unclear on whether the GRE was required or not. This clarifies that it is not required but is recommended.*

Proposed effective date: Term: Winter Year: 2023

Current Graduate Studies Academic Calendar (GSAC) page (include the link to the web page where the changes are to be made):

https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/department-combinatorics-and-optimization/doctor-philosophy-phd-combinatorics-and-optimization

https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/department-combinatorics-and-optimization/doctor-philosophy-phd-combinatorics-and-optimization-quantum-information

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
Program information • Admit term(s) o Fall o Winter o Spring	**Program information** • Admit term(s) o Fall o Winter o Spring

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
• Delivery mode o On-campus • **Length of program** o ~~**The normal period of registration for the PhD degree is 6 terms from a Master's degree. One year of credit may be granted by the Faculty Graduate Committee for work done towards the PhD degree at another institution, provided that the relevance of the previous work to the student's proposed program is clearly established.**~~ • Program type o Collaborative o Doctoral o Research • Registration option(s) o Full-time o Part-time • Study option(s) o Thesis **Admission requirements** • Minimum requirements o A Master's degree in combinatorics and optimization, or in a closely related field, with a minimum 89% average in Master's level coursework. o Completion of a master's thesis. o It is essential that the application for admission into the PhD program contains evidence of research ability or potential. o Students in the PhD program are regarded as being on probation during their first year in the Department, and their performance during this first year determines whether they are allowed to continue in the program. In particular, failure in any one course, or an unsatisfactory performance in the comprehensive examination, automatically results in a review of the student's progress by the Department	• Delivery mode o On-campus • Length of program o Students are required to complete the program in accordance with the University program time limits • Program type o Collaborative o Doctoral o Research • Registration option(s) o Full-time o Part-time • Study option(s) o Thesis **Admission requirements** • Minimum requirements o A Master's degree in combinatorics and optimization, or in a closely related field, with a minimum 89% average in Master's level coursework. o Completion of a master's thesis. o It is essential that the application for admission into the PhD program contains evidence of research ability or potential. o Students in the PhD program are regarded as being on probation during their first year in the Department, and their performance during this first year determines whether they are allowed to continue in the program. In particular, failure in any one course, or an unsatisfactory performance in the comprehensive examination, automatically results in a review of the student's progress by the Department Graduate Committee. PhD students' progress will be reviewed at least once per year. o A student who is enrolled in the Master of Mathematics (MMath) program in the Department of Combinatorics and Optimization and wishes to continue in

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
Graduate Committee. PhD students' progress will be reviewed at least once per year. o A student who is enrolled in the Master of Mathematics (MMath) program in the Department of Combinatorics and Optimization and wishes to continue in the PhD program has to apply for admission into the program. In exceptional cases, a graduate student enrolled in a MMath (Thesis) program in the Department of Combinatorics and Optimization may, through the Graduate Officer and with the consent of the Supervisor, petition the Graduate Committee to be transferred into a PhD program. The guidelines for such a transfer are as follows: ▪ The student has been enrolled in the MMath (Thesis) program for at least two terms. ▪ The student has made considerable progress in the research project (of the type that would warrant the MMath degree) and is committed to carrying the project to completion in a PhD program. ▪ The student gives a seminar presentation of the work carried out so far, and answers related questions to the satisfaction of an examining committee consisting of the supervisor and two other faculty members. o Students applying to the PhD program who hold a Master's degree from another university may, in some cases, be admitted initially into the MMath program. In such cases the Graduate Committee will decide, within three terms, whether to transfer the student into the PhD program. • Application materials o Supplementary information form o Transcript(s) • References o **Number of references: 3** o Type of references: normally from academic sources.	the PhD program has to apply for admission into the program. In exceptional cases, a graduate student enrolled in a MMath (Thesis) program in the Department of Combinatorics and Optimization may, through the Graduate Officer and with the consent of the Supervisor, petition the Graduate Committee to be transferred into a PhD program. The guidelines for such a transfer are as follows: ▪ The student has been enrolled in the MMath (Thesis) program for at least two terms. ▪ The student has made considerable progress in the research project (of the type that would warrant the MMath degree) and is committed to carrying the project to completion in a PhD program. ▪ The student gives a seminar presentation of the work carried out so far, and answers related questions to the satisfaction of an examining committee consisting of the supervisor and two other faculty members. o Students applying to the PhD program who hold a Master's degree from another university may, in some cases, be admitted initially into the MMath program. In such cases the Graduate Committee will decide, within three terms, whether to transfer the student into the PhD program. o <u>Applicants educated outside of Canada, including those from the United States, are recommended to submit scores from the Graduate Record Examinations (GRE) subject test in mathematics. Neither the GRE general test nor the GRE subject test is required.</u> • Application materials o Supplementary information form o Transcript(s) • References o Number of references: 3 o Type of references: normally from

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
• English language proficiency (ELP) (if applicable)	academic sources. • English language proficiency (ELP) (if applicable)

How will students currently registered in the program be impacted by these changes?

Time limit change reflects current practice. The University time limits are the limits that have been enforced. Consequently the only change to currently registered students is that the practice already in effect is now consistent with the calendar description.

GRE change impacts admission only so currently registered students are unaffected.

Department/School approval date (mm/dd/yy): 03/18/22

Reviewed by GSPA (for GSPA use only) ☐ date (mm/dd/yy): 01/19/22

Faculty approval date (mm/dd/yy): 09/20/22

Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):

Senate approval date (mm/dd/yy) (if applicable):

Graduate Studies
Program Revision Template

Prior to form submission, review the content revision instructions and information regarding major/minor modifications. For questions about the form submission, contact Trevor Clews, Graduate Studies and Postdoctoral Affairs (GSPA).

Faculty: Mathematics

Programs: 1) Master of Mathematics (MMath) in Combinatorics and Optimization

2) Master of Mathematics (MMath) in Combinatorics and Optimization - Co-operative Program

3) Master of Mathematics (MMath) in Combinatorics and Optimization - Quantum Information

Program contact name(s): Karen Yeats, Melissa Cambridge

Form completed by: Karen Yeats

Description of proposed changes:
Note: changes to courses and milestones also require the completion/submission of the SGRC Graduate Studies Course/Milestone Form.

Updating the thesis requirements/milestone description to include a presentation component. Updating the display period.

Is this a major modification to the program? No

Rationale for change(s):

Other units in the faculty have a presentation or a defense for MMath theses. Our research paper MMath requires a presentation, but our thesis MMath had not previously. Supervisors often informally required a presentation for MMath theses. By making this a formal requirement, but leaving the details flexible, our students will get the valuable professional experience of presenting their results and we increase consistency without causing undue rigidification.

The display period is being changed from three weeks to two weeks in accordance with standard practice in the faculty.

Proposed effective date: Term: Fall Year: 2023

Current Graduate Studies Academic Calendar (GSAC) page (include the link to the web page where the changes are to be made):

https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/department-combinatorics-and-optimization/master-mathematics-mmath-combinatorics-and-optimization

https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/department-combinatorics-and-optimization/master-mathematics-mmath-combinatorics-and-optimization-co-operative-program-direct-entry

https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/department-combinatorics-and-optimization/master-mathematics-mmath-combinatorics-and-optimization-quantum-information

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
Degree requirements **Thesis option:** • **Master's Thesis** o **The thesis requirement consists of the writing of an expository or research thesis. The thesis topic is to be arranged with a faculty member who serves as the Thesis Supervisor. This requirement is met, and credit assigned, when the Thesis Supervisor and two additional readers approve the thesis. In addition to distributing a copy of the MMath thesis to the supervisor and readers, the thesis should also be deposited in the Mathematics Graduate Office for display for a period of ~~three~~ weeks.**	**Degree requirements** **Thesis option:** • **Master's Thesis** o **The thesis requirement consists of <u>two parts:</u> the writing of an expository or research thesis <u>and giving an oral presentation on their work.</u> The thesis topic is to be arranged with a faculty member who serves as the Thesis Supervisor. This requirement is met, and credit assigned, <u>when the presentation is complete to the satisfaction of the Thesis Supervisor and</u> when the Thesis Supervisor and two additional readers approve the thesis. In addition to distributing a copy of the MMath thesis to the supervisor and readers, the thesis should also be deposited in the Mathematics Graduate Office for display for a period of <u>two</u> weeks.**

How will students currently registered in the program be impacted by these changes?

Many supervisors ask their students to give a presentation currently even though it is not required. Students currently in the program when the changes come into effect will have the choice to follow the old rules or the new rules; students newly entering the program will be required to follow the new rules.

The decreased display period has only positive impacts, a student can still have it on display for the longer time if they want to.

Department/School approval date (mm/dd/yy): 07-22-22

Reviewed by GSPA (for GSPA use only) ☐ date (mm/dd/yy): 05-24-22

Faculty approval date (mm/dd/yy): 09/20/22

Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):

Senate approval date (mm/dd/yy) (if applicable):

Graduate Studies
Program Revision Template

Prior to form submission, review the content revision instructions and information regarding major/minor modifications. For questions about the form submission, contact Trevor Clews, Graduate Studies and Postdoctoral Affairs (GSPA).

Faculty: Mathematics

Program: Master of Mathematics (MMath) in Data Science

Program contact name(s): Mu Zhu, Silvana Shamuon, Ryan McGuinness

Form completed by: Mu Zhu

Description of proposed changes:
Note: changes to courses and milestones also require the completion/submission of the SGRC Graduate Studies Course/Milestone Form.

Adding a Master's Research Paper study option to the MMath in Data Science program.

Is this a major modification to the program? Yes

Rationale for change(s):

We are adding a Master's Research Paper option to the program to be consistent with other MMath programs within the Faculty.

Proposed effective date: Term: Winter Year: 2023

Current Graduate Studies Academic Calendar (GSAC) page (include the link to the web page where the changes are to be made):

https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/data-science/master-mathematics-mmath-data-science

Current Graduate Studies Academic Calendar content:	**Proposed Graduate Studies Academic Calendar content**:

Program information
 	
• Admit term(s)
  ○ Fall
• Delivery mode
  ○ On-campus
• Length of program
  ○ 4 to 6 terms
• Program type
  ○ Master's
  ○ Research
• Registration option(s)
  ○ Full-time
	Program information
	
	• Admit term(s)
	  ○ Fall
	• Delivery mode
	  ○ On-campus
	• Length of program
	  ○ 4 to 6 terms
	• Program type
	  ○ Master's
	  ○ Research
	• Registration option(s)
	  ○ Full-time

Current Graduate Studies Academic Calendar content:	**Proposed Graduate Studies Academic Calendar content**:
○ Part-time • Study option(s) ○ Thesis **Admission requirements** • Minimum requirements ○ A four-year Honours Bachelor's degree or equivalent in data science, computer science, statistics, mathematics or a related field, with a minimum overall average of 78%. ○ Experience at the senior level in computer science or statistics. • Application materials ○ Résumé/Curriculum Vitae ○ Supplementary information form ○ Transcript(s) • References ○ Number of references: 3 ○ Type of references: at least 2 academic • English language proficiency (ELP) (if applicable) **Degree requirements** **Thesis option:** • Graduate Academic Integrity Module (Graduate AIM) • Courses ○ Students must complete at least 4 courses. Students lacking adequate background in computer science may be required to take CS 600 Fundamentals of Computer Science for Data Science, and students lacking adequate background in statistics may be required to take STAT 845 Statistical Concepts for Data Science. Neither of these courses may be counted toward the 4 course requirement. The 4 courses must normally include: ▪ 1. STAT 847 Exploratory Data Analysis ▪ 2. Exactly 1 of: ▪ CS 631 Data-Intensive Distributed Analytics, or ▪ CS 651 Data-Intensive Distributed Computing	○ Part-time • Study option(s) ○ Thesis ○ <u>Master's Research Paper</u> Admission requirements • Minimum requirements ○ A four-year Honours Bachelor's degree or equivalent in data science, computer science, statistics, mathematics or a related field, with a minimum overall average of 78%. ○ Experience at the senior level in computer science or statistics. • Application materials ○ Résumé/Curriculum Vitae ○ Supplementary information form ○ Transcript(s) • References ○ Number of references: 3 ○ Type of references: at least 2 academic • English language proficiency (ELP) (if applicable) **Degree requirements** <u>All students are admitted to the Thesis study option. Students can transfer to the Master's Research Paper study option with approval from their thesis supervisor and the Graduate Director.</u> **Thesis option:** • Graduate Academic Integrity Module (Graduate AIM) • Courses ○ Students must complete at least 4 courses. Students lacking adequate background in computer science may be required to take CS 600 Fundamentals of Computer Science for Data Science, and students lacking adequate background in statistics may be required to take STAT 845 Statistical Concepts for Data Science. Neither of these courses may be counted toward the 4 course requirement. The 4 courses must normally include: ▪ 1. STAT 847 Exploratory Data Analysis

Current Graduate Studies Academic Calendar content:	**Proposed Graduate Studies Academic Calendar content**:
▪ 3. At least 1 of: ▪ CS 680 Introduction to Machine Learning ▪ CS 685 Machine Learning: Statistical and Computational Foundations ▪ CS 686 Introduction to Artificial Intelligence ▪ CS 795 / CO 602 / CM 740 Fundamentals of Optimization ▪ CS 794 / CO 673 Optimization for Data Science ▪ CO 650 Combinatorial Optimization ▪ CO 663 Convex Optimization and Analysis ▪ CS 786 Probabilistic Inference and Machine Learning ▪ CS 886 Advanced Topics in Artificial intelligence ▪ STAT 840 / CM 761 Computational Inference ▪ STAT 841 / CM 763 Statistical Learning - Classification ▪ STAT 844 / CM 764 Statistical Learning - Advanced Regression ▪ STAT 946 Topics in Probability and Statistics(*) ▪ 4. The fourth course is normally chosen from the following list: ▪ Machine learning / statistical learning / optimization ▪ CS 680 Introduction to Machine Learning ▪ CS 685 Machine Learning: Statistical and Computational Foundations ▪ CS 686 Introduction to Artificial Intelligence ▪ CS 795 / CO 602 / CM 740 Fundamentals of Optimization	▪ 2. Exactly 1 of: ▪ CS 631 Data-Intensive Distributed Analytics, or ▪ CS 651 Data-Intensive Distributed Computing ▪ 3. At least 1 of: ▪ CS 680 Introduction to Machine Learning ▪ CS 685 Machine Learning: Statistical and Computational Foundations ▪ CS 686 Introduction to Artificial Intelligence ▪ CS 795 / CO 602 / CM 740 Fundamentals of Optimization ▪ CS 794 / CO 673 Optimization for Data Science ▪ CO 650 Combinatorial Optimization ▪ CO 663 Convex Optimization and Analysis ▪ CS 786 Probabilistic Inference and Machine Learning ▪ CS 886 Advanced Topics in Artificial intelligence ▪ STAT 840 / CM 761 Computational Inference ▪ STAT 841 / CM 763 Statistical Learning - Classification ▪ STAT 844 / CM 764 Statistical Learning - Advanced Regression ▪ STAT 946 Topics in Probability and Statistics(*) ▪ 4. The fourth course is normally chosen from the following list: ▪ Machine learning / statistical learning / optimization ▪ CS 680 Introduction to Machine Learning ▪ CS 685 Machine Learning: Statistical and Computational Foundations

Current Graduate Studies Academic Calendar content:	**Proposed Graduate Studies Academic Calendar content**:
▪ CS 794 / CO 673 Optimization for Data Science ▪ CO 650 Combinatorial Optimization ▪ CO 663 Convex Optimization and Analysis ▪ CO 769 Topics in Continuous Optimization(*) ▪ CS 786 Probabilistic Inference and Machine Learning ▪ CS 885 Advanced Topics in Computational Statistics(*) ▪ CS 886 Advanced Topics in Artificial intelligence ▪ STAT 840 / CM 761 Computational Inference ▪ STAT 841 / CM 763 Statistical Learning - Classification ▪ STAT 844 / CM 764 Statistical Learning - Advanced Regression ▪ STAT 946 Topics in Probability and Statistics(*) ▪ Computer systems and databases ▪ CS 638 Principles of Database Management and Use ▪ CS 648 Database Systems Implementation ▪ CS 656 Computer Networks ▪ CS 657 System Performance Evaluation ▪ CS 658 Computer Security and Privacy ▪ CS 740 Database Engineering ▪ CS 741 Non-Traditional Databases ▪ CS 742 Parallel and Distributed Database Systems	▪ CS 686 Introduction to Artificial Intelligence ▪ CS 795 / CO 602 / CM 740 Fundamentals of Optimization ▪ CS 794 / CO 673 Optimization for Data Science ▪ CO 650 Combinatorial Optimization ▪ CO 663 Convex Optimization and Analysis ▪ CO 769 Topics in Continuous Optimization(*) ▪ CS 786 Probabilistic Inference and Machine Learning ▪ CS 885 Advanced Topics in Computational Statistics(*) ▪ CS 886 Advanced Topics in Artificial intelligence ▪ STAT 840 / CM 761 Computational Inference ▪ STAT 841 / CM 763 Statistical Learning - Classification ▪ STAT 844 / CM 764 Statistical Learning - Advanced Regression ▪ STAT 946 Topics in Probability and Statistics(*) ▪ Computer systems and databases ▪ CS 638 Principles of Database Management and Use ▪ CS 648 Database Systems Implementation ▪ CS 656 Computer Networks ▪ CS 657 System Performance Evaluation ▪ CS 658 Computer Security and Privacy ▪ CS 740 Database Engineering ▪ CS 741 Non-Traditional Databases

Current Graduate Studies Academic Calendar content:	**Proposed Graduate Studies Academic Calendar content**:
▪ CS 743 Principles of Database Management and Use ▪ CS 755 Systems and Network Architectures and Implementation ▪ CS 848 Advanced Topics in Databases(*) ▪ Distributed computing ▪ CS 654 Distributed Systems ▪ CS 856 Advanced Topics in Distributed Computing(*) ▪ Data exploration ▪ STAT 842 / CM 762 Data Visualization ▪ Other ▪ CS 798 Advanced Research Topics(*) ▪ At the discretion of the Data Science Committee, substitutions may be allowed. ▪ (*) Note: CO 769, CS 798, CS courses at the 800 level, and STAT courses at the 900 level should be on a topic in Data Science; they are subject to the approval of the Graduate Director. • Ethics Workshop o Students must complete a 3-day workshop on “Ethics in Data Science and Artificial Intelligence” that will be offered in the Fall term. Alternatively, students can complete the course CS 798 Advanced Research Topics on “Artificial Intelligence: Law, Ethics, and Policy’’. • Master’s Thesis o Students must complete a thesis containing original work under the supervision of a faculty member. The thesis Examining Committee consists of the thesis supervisor and two additional readers. The supervisor and first reader should be members of the Data Science program; the second reader may be any regular faculty member of the University. The student must make an oral presentation on the thesis before Examining Committee members following the regulations for	▪ CS 742 Parallel and Distributed Database Systems ▪ CS 743 Principles of Database Management and Use ▪ CS 755 Systems and Network Architectures and Implementation ▪ CS 848 Advanced Topics in Databases(*) ▪ Distributed computing ▪ CS 654 Distributed Systems ▪ CS 856 Advanced Topics in Distributed Computing(*) ▪ Data exploration ▪ STAT 842 / CM 762 Data Visualization ▪ Other ▪ CS 798 Advanced Research Topics(*) ▪ At the discretion of the Data Science Committee, substitutions may be allowed. ▪ (*) Note: CO 769, CS 798, CS courses at the 800 level, and STAT courses at the 900 level should be on a topic in Data Science; they are subject to the approval of the Graduate Director. • Ethics Workshop o Students must complete a 3-day workshop on “Ethics in Data Science and Artificial Intelligence” that will be offered in the Fall term. Alternatively, students can complete the course CS 798 Advanced Research Topics on “Artificial Intelligence: Law, Ethics, and Policy’’. • Master’s Thesis o Students must complete a thesis containing original work under the supervision of a faculty member. The thesis Examining Committee consists of the thesis supervisor and two additional readers. The supervisor and first reader should be members of the Data Science program; the second reader may be any regular faculty member of the University. The student

Current Graduate Studies Academic Calendar content:	**Proposed Graduate Studies Academic Calendar content**:

the MMath degree by the Faculty of Mathematics. Committee members should receive a copy of the thesis at least two weeks prior to presentation.	must make an oral presentation on the thesis before Examining Committee members following the regulations for the MMath degree by the Faculty of Mathematics. Committee members should receive a copy of the thesis at least two weeks prior to presentation.
	
	Master's Research paper option:
	
	• Graduate Academic Integrity Module (Graduate AIM)
	• Courses
	  ○ Students must complete at least 6 courses. Students lacking adequate background in computer science may be required to take CS 600 Fundamentals of Computer Science for Data Science, and students lacking adequate background in statistics may be required to take STAT 845 Statistical Concepts for Data Science. Neither of these courses may be counted toward the 6 course requirement. The 6 courses must normally include:
	  ▪ 1. STAT 847 Exploratory Data Analysis
	  ▪ 2. Exactly 1 of:
	  ▪ CS 631 Data-Intensive Distributed Analytics, or
	  ▪ CS 651 Data-Intensive Distributed Computing
	  ▪ 3. At least 1 of:
	  ▪ CS 680 Introduction to Machine Learning
	  ▪ CS 685 Machine Learning: Statistical and Computational Foundations
	  ▪ CS 686 Introduction to Artificial Intelligence
	  ▪ CS 795 / CO 602 / CM 740 Fundamentals of Optimization
	  ▪ CS 794 / CO 673 Optimization for Data Science
	  ▪ CO 650 Combinatorial Optimization
	  ▪ CO 663 Convex Optimization and Analysis

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
	▪ CS 786 Probabilistic Inference and Machine Learning ▪ CS 886 Advanced Topics in Artificial intelligence ▪ STAT 840 / CM 761 Computational Inference ▪ STAT 841 / CM 763 Statistical Learning - Classification ▪ STAT 844 / CM 764 Statistical Learning - Advanced Regression ▪ STAT 946 Topics in Probability and Statistics(*) ▪ 4. The 3 additional courses are normally chosen from the following list: ▪ Machine learning / statistical learning / optimization ▪ CS 680 Introduction to Machine Learning ▪ CS 685 Machine Learning: Statistical and Computational Foundations ▪ CS 686 Introduction to Artificial Intelligence ▪ CS 795 / CO 602 / CM 740 Fundamentals of Optimization ▪ CS 794 / CO 673 Optimization for Data Science ▪ CO 650 Combinatorial Optimization ▪ CO 663 Convex Optimization and Analysis ▪ CO 769 Topics in Continuous Optimization(*) ▪ CS 786 Probabilistic Inference and Machine Learning ▪ CS 885 Advanced Topics in Computational Statistics(*) ▪ CS 886 Advanced Topics in Artificial intelligence

Current Graduate Studies Academic Calendar content:	**Proposed Graduate Studies Academic Calendar content**:
	▪ STAT 840 / CM 761 Computational Inference ▪ STAT 841 / CM 763 Statistical Learning - Classification ▪ STAT 844 / CM 764 Statistical Learning - Advanced Regression ▪ STAT 946 Topics in Probability and Statistics(*) ▪ Computer systems and databases ▪ CS 638 Principles of Database Management and Use ▪ CS 648 Database Systems Implementation ▪ CS 656 Computer Networks ▪ CS 657 System Performance Evaluation ▪ CS 658 Computer Security and Privacy ▪ CS 740 Database Engineering ▪ CS 741 Non-Traditional Databases ▪ CS 742 Parallel and Distributed Database Systems ▪ CS 743 Principles of Database Management and Use ▪ CS 755 Systems and Network Architectures and Implementation ▪ CS 848 Advanced Topics in Databases(*) ▪ Distributed computing ▪ CS 654 Distributed Systems ▪ CS 856 Advanced Topics in Distributed Computing(*) ▪ Data exploration ▪ STAT 842 / CM 762 Data Visualization ▪ Other ▪ CS 798 Advanced Research Topics(*)

Current Graduate Studies Academic Calendar content:	**Proposed Graduate Studies Academic Calendar content**:
	▪ At the discretion of the Data Science Committee, substitutions may be allowed. ▪ (*) Note: CO 769, CS 798, CS courses at the 800 level, and STAT courses at the 900 level should be on a topic in Data Science; they are subject to the approval of the Graduate Director. • Ethics Workshop o Students must complete a 3-day workshop on “Ethics in Data Science and Artificial Intelligence” that will be offered in the Fall term. Alternatively, students can complete the course CS 798 Advanced Research Topics on “Artificial Intelligence: Law, Ethics, and Policy’’. • Master’s Research Paper o Students must complete a research paper under the supervision of a faculty member. The supervisor plus one additional regular faculty member of the University must assess and approve the paper. Students must also present their research paper topic in a publicly announced seminar.

How will students currently registered in the program be impacted by these changes?

The new option will become available to all currently registered students immediately after these changes take effect.

Department/School approval date (mm/dd/yy): 07/13/22 CS; 07/22/22 S&AS; 07/26/22 C&O
Reviewed by GSPA (for GSPA use only) ☐ date (mm/dd/yy): 07/28/22
Faculty approval date (mm/dd/yy): 09/20/22
Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):
Senate approval date (mm/dd/yy) (if applicable):

Prior to form submission, review the content revision instructions. For questions about the form submission, contact Trevor Clews, Graduate Studies and Postdoctoral Affairs (GSPA).

Faculty: Mathematics

Effective date: Term: Winter Year: 2023

Milestone

Note: milestone changes also require the completion/submission of the Graduate Studies Program Revision Template.

☐ New: Choose an item.

☐ Inactivate: Choose an item.

☐ Revise: from Choose an item. to Choose an item.

Course

Note: some course changes also require the completion/submission of the Graduate Studies Program Revision Template.

☒ New: Complete all course elements below

☐ Inactivate: Complete the following course elements:
Course subject code, Course number, Course ID, Course title

☐ Revise: Complete all course elements below to reflect the proposed change(s) and identify the course elements being revised (*e.g. Course description, Course title*):

Course elements (complete as indicated above. Review the glossary of terms for details on course elements)

Course subject code: MATH

Course number: 685

Course ID:

Course title (max. 100 characters including spaces): Math and Peace for Teachers

Course short title (max. 30 characters including spaces): Math and Peace for Teachers

Grading basis: Numerical

Course credit weight: 0.50

Course consent required: Not required

Course description:

Following a brief introduction to Peace Studies, the social implications of math and computer science are explored through a lens of peace theory. We examine how math and computer science can influence poverty, democracy, policing, environment, health and more. Participants in this course will articulate how to help their own students see math and computer science as a tool for good or evil.

Meet type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary meet type: Lecture

Delivery mode: Only offered online

Requisites: MATH 600 and 692 are co-requisites

Special topics course: Yes ☐ No ☒

Cross-listed course: Yes ☐ No ☒

Course subject code(s) and number(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request:

Many high school students see math as abstract and unrelated to “the real world”. For example, hundreds of Grade 9-10 students applying to the CEMC’s workshops in Computer Science have included text along the lines of “I want to make a difference in the world, so I am going to be a doctor, and doctors need to know how to use a computer”. Rarely do even the most math-engaged high school students see math/CS as influential in their own right. Teachers bear the brunt of portraying math as a discipline with relevant applications, and teachers often have only a few examples to draw on.

There is another course, MATH 674 (topic 6) “Math for Global Citizens (MGC)”, that was launched in 2015 with similar issues in mind. However, MGC actually teaches the in-depth mathematics of those examples. As a result, MGC covers a few topics in depth, and those topics were hand-picked because they both include mathematics at an appropriate level AND have concrete social implications. The topics covered in MGC are cartography and GPS, Game Theory and Fair Division, Travelling Salesman Problem, Proofiness. The assignments in the MGC focus on doing mathematics more so than considering social implications. People taking this course speak very positively about creating connections between HS curriculum and MGC course content.

The proposed course, “Math and Peace for Teachers (MPT)” also aims to equip teachers with a deep understanding of many real-world applications of mathematics. However, where MGC covers a few topics in depth, MPT will cover a broad range of examples. MPT will include an introduction to peace theory, and will look at many applications of mathematics through a peace theory lens. Participants of MPT will engage with these applications differently – through reading, writing and discussion, in lieu of any mathematical calculation. This different scope will allow MPT to examine literally dozens of examples.

MPT will draw much of its content from the related undergraduate course PACS 302 “Math for Good and Evil” (* see appendix for details). PACS 302 was co-developed by Conrad Grebel peace scholar Lowell Ewert and CEMC lecturer Judith Koeller. It was vetted in detail by numerous math faculty members, including Byron Weber Becker (CS), Katherine Hare (PM), Peter Wood (Math Business), Steve Furino (CEMC), Ross Willard (PM). It has been offered in Fall 2019, Winter 2020, Winter 2021, Winter 2022, with enthusiastic participation from students in Math, CS, PACS and students from many other programs.

MPT will be like PACS 302 in including an introduction to peace theory and in using many similar examples and readings. Additionally, MPT will ask teachers to connect the real-world math applications explored in the course to the high school math/CS curriculum taught by its participants.

In spring 2021, students in MATH 690 viewed a presentation about the prospect of a course like MPT, and they reacted enthusiastically to the prospect of this kind of course.

Form completed by: J.P. Pretti
Department/School approval date (mm/dd/yy): 06/24/22
Reviewed by GSPA (for GSPA use only) ☒ date (mm/dd/yy): 05/30/22
Faculty approval date (mm/dd/yy): 09/20/22
Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):

Senate Graduate & Research Council
Graduate Studies Course/Milestone Form

Prior to form submission, review the content revision instructions. For questions about the form submission, contact Trevor Clews, Graduate Studies and Postdoctoral Affairs (GSPA).

Faculty: Mathematics

Effective date: Term: Winter Year: 2023

Milestone

Note: milestone changes also require the completion/submission of the Graduate Studies Program Revision Template.

☐ New: Choose an item.

☐ Inactivate: Choose an item.

☐ Revise: from Choose an item. to Choose an item.

Course

Note: some course changes also require the completion/submission of the Graduate Studies Program Revision Template.

☒ New: Complete all course elements below

☐ Inactivate: Complete the following course elements:
Course subject code, Course number, Course ID, Course title

☐ Revise: Complete all course elements below to reflect the proposed change(s) and identify the course elements being revised (*e.g. Course description, Course title*):

Course elements (complete as indicated above. Review the glossary of terms for details on course elements)

Course subject code: MATH

Course number: 900

Course ID: TBD

Course title (max. 100 characters including spaces): University Mathematics Teaching Techniques

Course short title (max. 30 characters including spaces): Math Teaching Techniques

Grading basis: Credit/No Credit

Course credit weight: 0.25

Course consent required: Not required

Course description: The purpose of this course is to provide an introduction to teaching mathematics at the post-secondary level. Students will learn about effective course design, lecture delivery, assessment design, active learning, and how to handle common situations in the classroom. Multiple opportunities to gain practical teaching experience will be provided.

Meet type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary meet type: Seminar

Delivery mode: On-campus

Requisites: Mathematics graduate students only. Not open to MMT students.

Special topics course: Yes ☐ No ☒

Cross-listed course: Yes ☐ No ☒

Course subject code(s) and number(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request:

Students generally come into a graduate program with limited to no experience teaching an undergraduate course in mathematics. This course will help these research candidates to be able to structure a course from start to end. The hope is that this course will not only improve Master and Ph.D. students' teaching abilities but also their presentation skills which will be necessary skills in their academic careers. We have run the seminar four times since 2018 and the students have universally reported learning a lot and feeling much more confident stepping into the classroom. This course is meant to be complementary to, not replace, the CTE Certificate in University Teaching.
Note: the course is not intended to reduce the number of courses a student takes towards their PhD. The only unit that currently has grad-level 0.25 credit courses is SAS, and its PhD programs specify that courses must be ACTSC or STAT label, so this MATH course would not count and could not be paired with another to replace a full course.

Form completed by:
Department/School approval date (mm/dd/yy):
Reviewed by GSPA (for GSPA use only) ☒ date (mm/dd/yy): 05/06/22
Faculty approval date (mm/dd/yy): 09/20/22
Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):