Titles of Programme:

Hamilton Institute Structured PhD Programme	**Hamilton Institute Structured PhD** Minimum 30 credits. 15 of which must be obtained from Generic/Transferable skills modules and 15 from Subject Specific/Advanced Specialist Modules.	**Optional Modules in all years (all 5 ECTS credits)** HM801 (Advanced Specialist) HM802 (Advanced Specialist) HM803 (Advanced Specialist) HM804 (Advanced Specialist) HM806 (Advanced Specialist) HM807 (Advanced Specialist) HM811 (Transferable) GSE1 (Generic) GSE2 (Generic) CTL1 (Generic)

At the beginning of each year, the student decides in consultation with their supervisor or supervisory team on a suitable selection of modules for that year. The specialist modules taken by a student are determined by the needs of their research programme and chosen in consultation with the supervisor or supervisory team. Students from other departments and research institutes are welcome to attend any of the specialist modules on offer.

How will the programme be delivered (e.g. inter-institutional, summer-schools, lectures, placement, rotations, on-line etc.):

Advanced specialist modules will consist of 20 hours of lectures combined with approximately 100 hours of independent study. The generic and transferable skills modules are delivered in a variety of formats, including workshops, lectures, practical sessions and independent study.

Co-operating Departments and/or Institutions (if applicable):

Generic and Transferable skills modules are provided by the Graduate Studies Office, Commercialisation Office and the Centre for Teaching and Learning.

Progress Requirements in Each Year:

All graduate students at the Hamilton Institute have a primary supervisor and a progress committee assigned at registration. Where appropriate, a supervisory team is assigned to a student. The progress committee is typically comprised of the primary supervisor and two independent members of the institute staff. The annual evaluation consists of a presentation to the progress committee at which the student is questioned on their work and on topics relevant to it. The student is also required to submit a short written report on their work prior to the evaluation.

Marks & Standards in Each Year - Please specify any departures from the Framework document.

There are no departures from the framework document. All taught modules are graded as Pass, Did Not Complete.

Subject: Hamilton Institute Structured PhD Programme

Module name: Topics in Dynamics and Control

Module code: HM801

Module type: Advanced Specialist

Level: 8

Credit Weighting: 5

Semester: 1 week intensive module (schedule to be advertised)

Pre-requisite(s): Registered PhD student; Advanced Calculus; Basic Linear Algebra; Introductory Control Theory.

Co-requisite(s): None

Teaching Methods/Study Method: 20 hours of lectures and 100 hours of independent study and guided assignments.

Responsible Department: Hamilton Institute

Module Objective: To introduce the student to research topics in dynamics and control theory; to highlight the relevance of these topics to applications in ICT and Biology.

Module Content (indicative): Fundamental concepts – linear and nonlinear systems, discrete-time and continuous-time systems, autonomous and non-autonomous systems; equilibria - stability and stabilization; Lyapunov's direct and indirect method; switched and nonsmooth systems; positive systems; monotone dynamical systems.

Assessment: 100% - 2 hour examination.

Pass Standard and any Special Requirements for Passing Module: less than 40% - **DID NOT COMPLETE**; over 40% - **PASS**

Subject: Hamilton Institute Structured PhD Programme

Module name: Topics in Applied Linear Algebra and Linear Systems Theory

Module code: HM802

Module type: Advanced Specialist

Level: 8

Credit Weighting: 5

Semester: 1 week intensive module (schedule to be advertised)

Pre-requisite(s): Registered PhD student; Basic Linear Algebra; Basics of Linear Systems Theory.

Co-requisite(s): None

Teaching Methods/Study Method: 20 hours of lectures and 100 hours of independent study and guided assignments.

Responsible Department: Hamilton Institute

Module Objective: To increase the student's knowledge of advanced topics in applied linear algebra and their use in linear systems theory and contemporary applications.

Module Content (indicative): Review of fundamental linear algebra and matrix analysis; canonical forms; matrix norms; positive definite matrices; nonnegative matrices; finite Markov chains and web information retrieval; combinatorial matrix theory and applications; matrix stability theory and the Lyapunov equation; max algebra and idempotent linear algebra.

Assessment: 100% - 2 hour examination.

Pass Standard and any Special Requirements for Passing Module: less than 40% - **DID NOT COMPLETE**; over 40% - **PASS**

Subject: Hamilton Institute Structured PhD Programme

Module name: Convex Optimization and Introduction to Congestion Control

Module code: HM803

Module type: Advanced Specialist

Level: 8

Credit Weighting: 5

Semester: 1 week intensive module (schedule to be advertised)

Pre-requisite(s): Registered PhD student; Undergraduate multi-variable calculus and linear algebra, some knowledge of differential equations. All of the important mathematical concepts will be reviewed in class

Co-requisite(s): None

Teaching Methods/Study Method: 20 hours of lectures and 100 hours of independent study and guided assignments.

Responsible Department: Hamilton Institute

Module Objective: To present the fundamentals of convex optimization and modern algorithms for solving convex problems. To highlight the role of convex optimization in modern applications in congestion control and elsewhere.

Module Content (indicative): Convexity of sets and functions; convex optimization problems; duality in convex optimization; KKT conditions; computational methods for convex optimization; interior point methods and barrier functions; introduction to congestion control.

Assessment: 100% - 2 hour examination

Pass Standard and any Special Requirements for Passing Module: less than 40% - **DID NOT COMPLETE**; over 40% - **PASS**

Subject: Hamilton Institute Structured PhD Programme

Module name: Applied Probability and Information Theory

Module code: HM804

Module type: Advanced Specialist

Level: 8

Credit Weighting: 5

Semester: 2 – 1 week intensive module (schedule to be advertised)

Pre-requisite(s): Registered PhD student; undergraduate multi-variable calculus and linear algebra; some knowledge of real analysis and basic probability

Co-requisite(s): None

Teaching Methods/Study Method: 20 hours of lectures and 100 hours of independent study and guided assignments.

Responsible Department: Hamilton Institute

Module Objective: to present the basic concepts of probability theory, stochastic processes and information theory in an integrated format, and to provide students with the background to pursue independent research in these topics.

Module Content (indicative): Probability triples, events, conditional probability, random variables, expectation; Markov chains; applications; limit theorems including modes of convergence, Borel-Cantelli lemmas and 0-1 law, law of large numbers, central limit theorem; introduction to stochastic processes; applications of probability theory.

Entropy and mutual information; asymptotic equipartition property and typical sequences; data compression and applications; channel capacity; Gaussian channels; Sanov's theorem and applications in Statistics; Kolmogorov complexity

Assessment: 100% - 2 hour examination

Pass Standard and any Special Requirements for Passing Module: less than 40% - **DID NOT COMPLETE**; over 40% - **PASS**

Subject: Hamilton Institute Structured PhD Programme

Module name: Optimization Based Congestion Control and Networking

Module code: HM806

Module type: Advanced Specialist

Level: 8

Credit Weighting: 5

Semester: 1 week intensive module (schedule to be advertised)

Pre-requisite(s): Registered PhD/MSc student; first courses in convex optimization, linear systems and probability.

Co-requisite(s): None

Teaching Methods/Study Method: 20 hours of lectures and 100 hours of independent study and guided assignments.

Responsible Department: Hamilton Institute

Module Objective: To present the basic concepts of communication networks analysis and algorithms using optimization, control and stochastic network techniques, and to provide students with the background required to pursue independent research in these topics.

Module Content (indicative): Review of Convex Optimization; network utility maximization; notions of Fairness; quick review of Dynamical Systems and Stability Theory; Primal/Dual Congestion Control Algorithms; Relationship to Network Protocols; TCP Protocols and Non-Negative Matrices; A Quick Review of Discrete-Time Markov Chains; Large Deviations and Effective Bandwidths; Switch Scheduling: Throughput-Optimal Algorithms and Complexity Issues;

Cellular Networks: Opportunistic Scheduling and Throughput Optimality; Distributed Scheduling Algorithms for Ad Hoc Wireless Networks; Back to Network Utility Maximization: Decomposition, Layered Architecture and Cross-Layer Design

Assessment: 100% - 2 hour examination.

Pass Standard and any Special Requirements for Passing Module: less than 40% - **DID NOT COMPLETE**; over 40% - **PASS**

Subject: Hamilton Institute Structured PhD Programme

Module name: Topics in Applied Graph Theory

Module code: HM807

Module type: Advanced Specialist

Level: 8

Credit Weighting: 5

Semester: 1 week intensive module (schedule to be advertised)

Pre-requisite(s): Registered PhD/MSc student; an undergraduate course in linear algebra and one in elementary probability are recommended.

Co-requisite(s): None

Teaching Methods/Study Method: 20 hours of lectures and 100 hours of independent study and guided assignments.

Responsible Department: Hamilton Institute

Module Objective: To provide students with a foundation in modern graph theory and its use in contemporary applications.

Module Content (indicative): Fundamental definitions and concepts; connectivity and path algorithms; networks and flows; extremal graphs; coloring; spectral graph theory; random graphs and modeling complex networks; games and dynamics on graphs; selected applications.

Assessment: 100% - 2 hour examination.

Pass Standard and any Special Requirements for Passing Module: less than 40% - **DID NOT COMPLETE**; over 40% - **PASS**

Subject: Hamilton Institute Structured PhD Programme

Module name: Computational Tools for Research

Module code: HM811

Module type: Transferable

Level: 8

Credit Weighting: 5

Semester: 1 or 2

Pre-requisite(s): Registered PhD student

Co-requisite(s): None

Teaching Methods/Study Method: 20 hours of lectures and 100 hours of independent study and guided assignments.

Responsible Department: Hamilton Institute

Module Objective: To introduce students to the fundamentals of programming in MATLAB and C. If appropriate, the basics of other languages such as Perl and Mathematica will also be covered; to introduce some of the main toolboxes in MATLAB.

Module Content: Basic MATLAB programming; MATLAB toolboxes (such as Control Systems, Optimization, Systems Biology); fundamentals of programming in C; basic numerical methods in C; fundamentals of Perl programming; introduction to mathematica.

Assessment: 100% Assignments

Pass Standard and any Special Requirements for Passing Module: less than 40% - **DID NOT COMPLETE**; over 40% - **PASS**

Subject: Hamilton Institute Structured PhD Programme

Module name: Information Literacy and Communications

Module code: GSE1

Module type: Generic

Level: 8

Credit Weighting: 5

Semester: 1 or 2

Pre-requisite(s): Registered PhD student

Co-requisite(s): None

Teaching Methods/Study Method: The module will consist of 24 contact hours consisting of 8 workshops, each of which is 3 hours long.

Responsible Department: Graduate Studies

Module Objective: The primary objective of this module is to integrate Information Literacy and Communication Skills training into the research programme of the student.

Module Content: Information Literacy; writing for publication; writing for an interdisciplinary audience; presenting to an interdisciplinary audience.

Assessment: Production of a draft literature review; production of a document or poster aimed at an interdisciplinary audience; presentation at an appropriate forum and preparation of a draft research paper.

Pass Standard and any Special Requirements for Passing Module: less than 40% - **DID NOT COMPLETE**; over 40% - **PASS**

Subject: Hamilton Institute Structured PhD Programme

Module name: Innovation and Research Commercialisation

Module code: GSE2

Module type: Generic

Level: 8

Credit Weighting: 5

Semester: 1

Pre-requisite(s): Registered PhD student

Co-requisite(s): None

Teaching Methods/Study Method: The module will consist of 24 contact hours delivered over 4 days and a further 86 hours of independent study.

Responsible Department: Commercialisation Office

Module Objective: To equip researchers with the skills required to commercialise the outcome of their research, to provide them with know how to interact with industry and to improve their ability to innovate and act with an entrepreneurial mindset.

Module Content: Introduction to commercialisation of research and hi-tech enterprise; intellectual property; legal contracts; hi-tech spin-offs; technical marketing and product development; interacting with industry; business competition.

Assessment: Assignments and the development of a business plan.

Pass Standard and any Special Requirements for Passing Module: less than 40% - **DID NOT COMPLETE**; over 40% - **PASS**

Subject: Hamilton Institute Structured PhD Programme

Module name: Professional Certificate in Postgraduate Teaching & Learning: Tutors & Demonstrators

Module code: CTL

Module type: Generic

Level: 8

Credit Weighting: 5

Semester: 1

Pre-requisite(s): Registered PhD student engaged in small-group tutoring.

Co-requisite(s): None

Teaching Methods/Study Method: The module will consist of 24 contact hours, 10 hours of teaching and a further 66 hours of independent study.

Responsible Department: Centre for Teaching and Learning

Module Objective: To begin the process of professionalising the student's prospective academic career through introduction to pedagogy and the scholarship of teaching and learning. To develop generic and transferable skills. To improve the quality of tutoring and demonstrating to undergraduate students. To enhance the student's competitive ability through NUI course accreditation.

Module Content: Introduction to teaching in NUI Maynooth Structures, supports, ethos. Reflective teaching. How students learn. Use of learning outcomes. Review of students' first teaching sessions with mentors. Enquiry-based learning / Critical evidence based thinking /Evaluation of teaching. Active learning in small groups. Teaching methods: planning; content. Assessment design & feedback. Peer and self analysis: video recording session. Teaching for diversity. Course evaluation and assignment workshop

Assessment: Participants will be required to hand in a final, written, 3000 word Reflective Teaching Assignment. This will contain evidenced feedback on teaching from a variety of sources and provide the basis for reflection on experiences, feedback and note implications for practice.

Pass Standard and any Special Requirements for Passing Module: Satisfactory written assignment meeting stated criteria. There is a minimum attendance requirement of 70% but full attendance is expected. A Medical certificate and/or note from your Head of Department required in case of absence. Satisfactory participation in at least two teaching session with mentor in attendance.