Data Science
(Collaborative Specialization)

This section presents the requirements for programs in:

- M.Sc. Biology with Collaborative Specialization in Data Science
- M.A.Sc. Biomedical Engineering with Collaborative Specialization in Data Science
- M.Eng. Biomedical Engineering with Collaborative Specialization in Data Science
- M.Sc. in Chemistry with Collaborative Specialization in Data Science
- M.Sc. in Geography with Collaborative Specialization in Data Science
- M.A. Communication with Collaborative Specialization in Data Science
- M.C.S. Computer Science with Specialization in Data Science
- M.A. Economics with Collaborative Specialization in Data Science
- M.A.Sc. Electrical and Computer Engineering with Collaborative Specialization in Data Science
- M.Eng. Electrical and Computer Engineering with Collaborative Specialization in Data Science
- M.A. Geography with Collaborative Specialization in Data Science
- M.Sc. Geography with Collaborative Specialization in Data Science
- M.Sc. Health Sciences with Collaborative Specialization in Data Science
- M.A. History with Collaborative Specialization in Data Science
- M.A. International Affairs with Collaborative Specialization in Data Science
- Master of Information Technology: Digital Media with Collaborative Specialization in Data Science
- M.Sc. Physics Medical Physics Stream with Collaborative Specialization in Data Science
- M.Sc. Physics Particle Physics Stream with Collaborative Specialization in Data Science
- M.A. Psychology with Collaborative Specialization in Data Science
- Master of Public Policy and Administration with Collaborative Specialization in Data Science

Program Requirements

Students enrolled in the Collaborative Program in Data Science must meet the requirements of their respective home units as well as those of the Collaborative Program. The requirements of the Collaborative Program do not, however, add to the number of credits students are required to accumulate by their home unit and the credit value of the degree remains the same. Consult the individual programs for detailed program requirements.

M.Sc. Biology with Collaborative Specialization in Data Science (5.0 credits)

Requirements:

1. 0.5 credit in approved coursework
2. 0.5 credit in:
   - DATA 5000 [0.5] Data Science Seminar
3. 4.0 credits in:

Total Credits 5.0

M.A.Sc. Biomedical Engineering with Collaborative Specialization in Data Science (5.0 credits)

Requirements:

1. 0.5 credit in:
   - BIOM 5010 [0.5] Introduction to Biomedical Engineering
2. 0.5 credit in:
   - DATA 5000 [0.5] Data Science Seminar
3. 1.0 credit in BIOM (BMG) courses
4. 0.5 credit in elective courses taken either at Carleton University or University of Ottawa with the approval of the OCIBME Director or Associate Director
5. 2.5 credits in:
6. 0.0 credit in:
   - BIOM 5800 [0.0] Biomedical Engineering Seminar

Total Credits 5.0

Note: for the course work Item 3 and Item 4 above, one 0.5 credit data science elective course must be taken (one of BIOM 5202, BIOM 5400, BIOM 5405, COMP 5100, COMP 5101, COMP 5107, COMP 5108, COMP 5111, COMP 5112, COMP 5204, COMP 5209, COMP 5305, COMP 5306, COMP 5307, COMP 5308, COMP 5401, COMP 5703, COMP 5704, PHYS 5002, SYSC 5001, SYSC 5003, SYSC 5004, SYSC 5007, SYSC 5101, SYSC 5102, SYSC 5103, SYSC 5108, SYSC 5201, SYSC 5207, SYSC 5300, SYSC 5303, SYSC 5306, SYSC 5401, SYSC 5404, SYSC 5405, SYSC 5407, SYSC 5500, SYSC 5703, SYSC 5706).

M.A.Sc. Biomedical Engineering with Collaborative Specialization in Data Science (5.0 credits)

Requirements - by coursework:

1. 0.5 credit in:
   - BIOM 5010 [0.5] Introduction to Biomedical Engineering
2. 0.5 credit in:
   - DATA 5000 [0.5] Data Science Seminar
3. 2.0 credits in BIOM (BMG) courses
4. 2.0 credits in elective courses at either Carleton University or University of Ottawa with the approval of the OCIBME Director or Associate Director

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5. 0.0 credit in:
   BIOM 5800 [0.0] Biomedical Engineering Seminar

Total Credits 5.0

Note: for the course work Item 3 and Item 4 above, three 0.5-credit data science elective courses must be taken (three of BIOM 5400, BIOM 5405, COMP 5100, COMP 5101, COMP 5107, COMP 5108, COMP 5111, COMP 5112, COMP 5204, COMP 5209, COMP 5305, COMP 5306, COMP 5307, COMP 5308, COMP 5401, COMP 5703, COMP 5704, PHYS 5002, SYSC 5001, SYSC 5003, SYSC 5004, SYSC 5007, SYSC 5101, SYSC 5102, SYSC 5103, SYSC 5108, SYSC 5201, SYSC 5207, SYSC 5300, SYSC 5303, SYSC 5306, SYSC 5401, SYSC 5404, SYSC 5405, SYSC 5407, SYSC 5500, SYSC 5703, SYSC 5706)

Requirements - by project:
1. 0.5 credit in:
   BIOM 5010 [0.5] Introduction to Biomedical Engineering
2. 0.5 credit in:
   DATA 5000 [0.5] Data Science Seminar
3. 1.5 credits in BIOM (BMG) courses 1.5
4. 1.0 credit in elective courses at either Carleton University or University of Ottawa with the approval of the OCIBME Director or Associate Director 1.0
5. 0.0 credit in:
   BIOM 5800 [0.0] Biomedical Engineering Seminar
6. 1.5 credit in:
   BIOM 5900 [1.5] Biomedical Engineering Project (in the specialization)

Total Credits 5.0

Note: for the course work Item 3 and Item 4 above, three 0.5-credit data science elective courses must be taken (three of BIOM 5400, BIOM 5405, COMP 5100, COMP 5101, COMP 5107, COMP 5108, COMP 5111, COMP 5112, COMP 5204, COMP 5209, COMP 5305, COMP 5306, COMP 5307, COMP 5308, COMP 5401, COMP 5703, COMP 5704, PHYS 5002, SYSC 5001, SYSC 5003, SYSC 5004, SYSC 5007, SYSC 5101, SYSC 5102, SYSC 5103, SYSC 5108, SYSC 5201, SYSC 5207, SYSC 5300, SYSC 5303, SYSC 5306, SYSC 5401, SYSC 5404, SYSC 5405, SYSC 5407, SYSC 5500, SYSC 5703, SYSC 5706)

M.Sc. in Chemistry with Collaborative Specialization in Data Science (5.0 credits)

Requirements
1. 0.5 credit in:
   DATA 5000 [0.5] Data Science Seminar
2. 0.5 credit in:
   CHEM 5810 [0.5] Seminar I
3. 0.5 credit in:
   CHEM 5804 [0.5] Modern Scientific Communication
4. 0.5 credit in CHEM at the graduate level, which may include up to 0.5 credit in another discipline, with permission of the department 0.5
5. 3.0 credits in:

Total Credits 5.0

Master of Cognitive Science with Collaborative Specialization in Data Science (5.0 credits)

Requirements - Thesis pathway (5.0 credits)
1. 0.5 credit in:
   DATA 5000 [0.5] Data Science Seminar
2. 0.5 credit in:
   CGSC 5100 [0.5] Issues in Cognitive Science
3. 0.5 credit in:
   CGSC 5101 [0.5] Experimental Methods and Statistics
4. 1.0 credit in CGSC or other approved courses, from two different cognitive disciplines, selected in consultation with the graduate supervisor 1.0
5. 2.5 credits in:
   CGSC 5909 [2.5] M. Cog. Thesis (The thesis must be approved as fulfilling the data science requirement and be supervised by a faculty member working in a data science related field.)
6. Preparation of research for presentation at the Carleton Cognitive Science Spring Conference.

Total Credits 5.0

Requirements - Research Project Option (5.0 credits)
1. 0.5 credit in:
   DATA 5000 [0.5] Data Science Seminar
2. 0.5 credit in:
   CGSC 5100 [0.5] Issues in Cognitive Science
3. 0.5 credit in:
   CGSC 5101 [0.5] Experimental Methods and Statistics
4. 1.5 credits from:
   CGSC 5001 [0.5] Cognition and Artificial Cognitive Systems
   CGSC 5002 [0.5] Experimental Research in Cognition
   CGSC 5003 [0.5] Language and Cognition
   CGSC 5004 [0.5] Cognition and Conceptual Issues
   CGSC 5005 [0.5] Cognition and Neuroscience
5. 1.0 credit in CGSC or other approved courses selected in consultation with the graduate supervisor 1.0
6. 1.0 credit in:
   CGSC 5908 [1.0] Research Project (Project must be approved as fulfilling the data science requirement and be supervised by a faculty member working in a data science related field.)
7. Preparation of research for presentation at the Cognitive Science Spring Conference.

Total Credits 5.0
### M.A. Communication with Collaborative Specialization in Data Science (5.0 credits)

#### Requirements - Coursework pathway (5.0 credits)

1. 0.5 credit in:
   - DATA 5000 [0.5] Data Science Seminar
2. 1.0 credit in:
   - COMS 5101 [1.0] Foundations of Communication Studies
3. 0.5 credit in:
   - COMS 5605 [0.5] Approaches to Communication Research
4. 0.5 credit in:
   - COMS 5225 [0.5] Critical Data Studies
5. 0.5 credit from:
   - COMS 5203 [0.5] Communication, Technology, Society
   - COMS 5221 [0.5] Science and the Making of Knowledge
   - COMS 5224 [0.5] Internet, Infrastructure, Materialities
6. 2.0 credits in electives

**Total Credits** 5.0

#### Requirements - Research essay pathway (5.0 credits)

1. 0.5 credit in:
   - DATA 5000 [0.5] Data Science Seminar
2. 1.0 credit in:
   - COMS 5101 [1.0] Foundations of Communication Studies
3. 0.5 credit in:
   - COMS 5605 [0.5] Approaches to Communication Research
4. 0.5 credit in:
   - COMS 5225 [0.5] Critical Data Studies
5. 1.0 credit in:
   - COMP 5905 [2.0] M.C.S. Thesis

Research Essay on a Data Science topic approved by the Advisory Board representative from Communication in consultation with the graduate Committee of the Institute of Data Science.

**Total Credits** 5.0

#### Requirements - Thesis pathway (5.0 credits)

1. 0.5 credit in:
   - DATA 5000 [0.5] Data Science Seminar
2. 2.0 credits in course work. Course work must include a minimum of 1.5 credits of OCICS courses in at least three different research areas. See OCICS course listing by research areas.
3. 2.5 credits in:

M.C.S. Thesis must be in an area of Data Science and requires approval from the Institute of Data Science. Each candidate submitting a thesis will be required to undertake an oral defence of the thesis.

**Total Credits** 5.0

### M.C.S. Computer Science with Specialization in Data Science (5.0 credits)

#### Requirements - Thesis pathway (5.0 credits)

1. 0.5 credit in:
   - DATA 5000 [0.5] Data Science Seminar
2. 2.0 credits in course work. Course work must include a minimum of 1.5 credits of OCICS courses in at least three different research areas. See OCICS course listing by research areas.
3. 2.5 credits in:

M.C.S. Thesis must be in an area of Data Science and requires approval from the Institute of Data Science. Each candidate submitting a thesis will be required to undertake an oral defence of the thesis.

**Total Credits** 5.0

### M.A. Economics with Collaborative Specialization in Data Science (4.0 credits)

#### Requirements - Coursework pathway (4.0 credits)

1. 1.5 credits in:
   - ECON 5020 [0.5] Microeconomic Theory
   - ECON 5021 [0.5] Macroeconomic Theory
   - ECON 5027 [0.5] Econometrics I

2. 0.5 credit in:
   - DATA 5000 [0.5] Data Science Seminar

3. 0.5 credit in:
   - ECON 5290 [0.5] Methods of Economic Research including a research paper on a data science related topic

4. 0.5 credit from:
   - ECON 5055 [0.5] Financial Econometrics
   - ECON 5361 [0.5] Labour Economics I
   - ECON 5362 [0.5] Labour Economics II
   - ECON 5700 [0.5] Social and Economic Measurement
   - ECON 5712 [0.5] Micro-Econometrics
   - ECON 5713 [0.5] Time-Series Econometrics

5. 0.5 credit in ECON approved by the M.A. Supervisor of the Department of Economics

6. 0.5 credit in Data Science elective (which may be an additional course from the preceding list) approved by the M.A. Supervisor of the Department of Economics

**Total Credits** 4.0

#### Requirements - Thesis option (4.0 credits)

1. 1.5 credits in:
   - ECON 5020 [0.5] Microeconomic Theory
   - ECON 5021 [0.5] Macroeconomic Theory
   - ECON 5027 [0.5] Econometrics I

2. 0.5 credit in:
   - DATA 5000 [0.5] Data Science Seminar

3. 1.5 credit in:
   - ECON 5909 [1.5] M.A. Thesis

M.A. Thesis on a Data Science topic approved by the Advisory Board representative from Communication in consultation with the Graduate Committee of the Institute of Data Science.
on a data science topic approved by the Data Science governance committee

4. **0.5 credit from:**
   - ECON 5055 [0.5] Financial Econometrics
   - ECON 5361 [0.5] Labour Economics I
   - ECON 5362 [0.5] Labour Economics II
   - ECON 5700 [0.5] Social and Economic Measurement
   - ECON 5712 [0.5] Micro-Econometrics
   - ECON 5713 [0.5] Time-Series Econometrics

**Total Credits** 4.0

M.A.Sc. Electrical and Computer Engineering with Collaborative Specialization in Data Science (5.0 credits)

**Requirements - by Thesis (5.0 credits)**

1. **0.5 credit in:**
   - DATA 5000 [0.5] Data Science Seminar

2. **0.5 credit from** data science elective courses:
   - SYSC 5001 [0.5] Simulation and Modeling
   - SYSC 5003 [0.5] Discrete Stochastic Models
   - SYSC 5004 [0.5] Optimization for Engineering Applications
   - SYSC 5101 [0.5] Design of High Performance Software
   - SYSC 5103 [0.5] Software Agents
   - SYSC 5104 [0.5] Methodologies For Discrete-Event Modeling And Simulation
   - SYSC 5201 [0.5] Computer Communication
   - SYSC 5207 [0.5] Distributed Systems Engineering
   - SYSC 5300 [0.5] Advanced Health Care Engineering
   - SYSC 5303 [0.5] Interactive Networked Systems and Telemedicine
   - SYSC 5306 [0.5] Mobile Computing Systems
   - SYSC 5401 [0.5] Adaptive and Learning Systems
   - SYSC 5404 [0.5] Multimedia Compression, Scalability, and Adaptation
   - SYSC 5405 [0.5] Pattern Classification and Experiment Design
   - SYSC 5407 [0.5] Planning and Design of Computer Networks
   - SYSC 5500 [0.5] Designing Secure Networking and Computer Systems
   - SYSC 5703 [0.5] Integrated Database and Cloud Systems
   - SYSC 5706 [0.5] Analytical Performance Models of Computer Systems

3. **2.5 credits in** courses, which may include up to an additional 0.5 credit in project

4. **0.5 credit in:**
   - SYSC 5900 [0.5] Systems Engineering Project in the area of data science

**Total Credits** 4.5

**Requirements - by Coursework (4.5 credits)**

1. **0.5 credit in:**
   - DATA 5000 [0.5] Data Science Seminar

2. **1.5 credits from** data science elective courses:
   - SYSC 5001 [0.5] Simulation and Modeling
   - SYSC 5003 [0.5] Discrete Stochastic Models
   - SYSC 5004 [0.5] Optimization for Engineering Applications
   - SYSC 5101 [0.5] Design of High Performance Software
   - SYSC 5103 [0.5] Software Agents
   - SYSC 5104 [0.5] Methodologies For Discrete-Event Modeling And Simulation
   - SYSC 5201 [0.5] Computer Communication
   - SYSC 5207 [0.5] Distributed Systems Engineering
   - SYSC 5300 [0.5] Advanced Health Care Engineering
   - SYSC 5303 [0.5] Interactive Networked Systems and Telemedicine
   - SYSC 5306 [0.5] Mobile Computing Systems
   - SYSC 5401 [0.5] Adaptive and Learning Systems
   - SYSC 5404 [0.5] Multimedia Compression, Scalability, and Adaptation

3. **1.5 credits in** courses

4. **2.5 credits in:**
   - SYSC 5909 [2.5] M.A.Sc. Thesis in the area of data science (each candidate submitting a thesis will be required to undertake an oral defence of the thesis)

**Total Credits** 5.0

M.Eng. Electrical and Computer Engineering with Collaborative Specialization in Data Science (4.5 credits)

**Requirements - by Project (4.5 credits)**

1. **0.5 credit in:**
   - DATA 5000 [0.5] Data Science Seminar

2. **1.0 credit from** data science elective courses:
   - SYSC 5001 [0.5] Simulation and Modeling
   - SYSC 5003 [0.5] Discrete Stochastic Models
   - SYSC 5004 [0.5] Optimization for Engineering Applications
   - SYSC 5101 [0.5] Design of High Performance Software
   - SYSC 5103 [0.5] Software Agents
   - SYSC 5104 [0.5] Methodologies For Discrete-Event Modeling And Simulation
   - SYSC 5201 [0.5] Computer Communication
   - SYSC 5207 [0.5] Distributed Systems Engineering
   - SYSC 5300 [0.5] Advanced Health Care Engineering
   - SYSC 5303 [0.5] Interactive Networked Systems and Telemedicine
   - SYSC 5306 [0.5] Mobile Computing Systems
   - SYSC 5401 [0.5] Adaptive and Learning Systems
   - SYSC 5404 [0.5] Multimedia Compression, Scalability, and Adaptation

3. **2.5 credits in** courses, which may include up to an additional 0.5 credit in project

4. **0.5 credit in:**
   - SYSC 5900 [0.5] Systems Engineering Project in the area of data science

**Total Credits** 4.5

**Requirements - by Coursework (4.5 credits)**

1. **0.5 credit in:**
   - DATA 5000 [0.5] Data Science Seminar

2. **1.5 credits from** data science elective courses:
   - SYSC 5001 [0.5] Simulation and Modeling
   - SYSC 5003 [0.5] Discrete Stochastic Models
   - SYSC 5004 [0.5] Optimization for Engineering Applications
   - SYSC 5101 [0.5] Design of High Performance Software
   - SYSC 5103 [0.5] Software Agents
   - SYSC 5104 [0.5] Methodologies For Discrete-Event Modeling And Simulation
   - SYSC 5201 [0.5] Computer Communication
   - SYSC 5207 [0.5] Distributed Systems Engineering
   - SYSC 5300 [0.5] Advanced Health Care Engineering
   - SYSC 5303 [0.5] Interactive Networked Systems and Telemedicine
   - SYSC 5306 [0.5] Mobile Computing Systems
   - SYSC 5401 [0.5] Adaptive and Learning Systems
   - SYSC 5404 [0.5] Multimedia Compression, Scalability, and Adaptation

3. **1.5 credits in** courses

4. **2.5 credits in:**
   - SYSC 5909 [2.5] M.A.Sc. Thesis in the area of data science (each candidate submitting a thesis will be required to undertake an oral defence of the thesis)

**Total Credits** 5.0
SYSC 5405 [0.5]
Pattern Classification and Experiment Design
SYSC 5407 [0.5]
Planning and Design of Computer Networks
SYSC 5500 [0.5]
Designing Secure Networking and Computer Systems
SYSC 5703 [0.5]
Integrated Database and Cloud Systems
SYSC 5706 [0.5]
Analytical Performance Models of Computer Systems

3. 0.5 credit in:  0.5
SYSC 5902 [0.5] Research Methods for Engineers

4. 2.0 credits in courses  2.0

Total Credits  4.5

M.A. Geography
with Collaborative Specialization in Data Science (5.0 credits)

Requirements:
1. 0.5 credit in:  0.5
DATA 5000 [0.5] Data Science Seminar
2. 0.5 credit in:  0.5
GEOG 5000 [0.5] Approaches to Geographical Inquiry
3. 2.5 credits in:  2.5
GEOG 5909 [2.5] M.A. Thesis (in the specialization and including oral examination of the thesis)
4. 0.5 credit in:  0.5
GEOG 5905 [0.5] Masters Research Workshop
5. 1.0 credit in approved graduate-level electives  1.0

6. In addition to the formal requirements, M.A. students are required to attend the Departmental Seminar series, and the Graduate Field Camp.

Total Credits  5.0

M.Sc. Health Sciences
with Collaborative Specialization in Data Science (5.5 credits)

Requirements (5.5 credits):
1. 1.0 credit in:  1.0
HLTH 5901 [0.5] Advanced Topics in Interdisciplinary Health Sciences
HLTH 5902 [0.5] Seminars in Interdisciplinary Health Sciences for MSc
2. 0.5 credits in:  0.5
DATA 5000 [0.5] Data Science Seminar
3. Completion of:
HLTH 5905 [0.0] Final Research Seminar Presentation for MSc (must be completed within one month of the thesis defence)
4. 4.0 credits in:  4.0
HLTH 5909 [4.0] MSc Thesis

5. Twice-yearly meetings with the thesis Graduate Advisory Committee, with students meeting a level of progress as determined by the Committee.

Total Credits  5.5

M.A. History
with Collaborative Specialization in Data Science (5.0 credits)

Requirements:
1. 0.5 credit in:  0.5
HIST 5003 [0.5] Historical Theory and Method
2. 1.5 credits in:  1.5
GEOG 5000 [0.5] Data Science Seminar

3. 0.5 credit in:  0.5
HIST 5706 [0.5] Digital History
4. 0.5 credit in:  0.5
DATA 5000 [0.5] Data Science Seminar
5. 0.5 credit in:  0.5
HIST 5900 [0.5] Directed Research
6. 1.0 credit in:  1.0
HIST 5908 [1.0] M.A. Research Essay (in the specialization)

Total Credits  4.5
M.A. International Affairs
with Collaborative Specialization in Data Science (5.0 credits)

### Requirements - Thesis pathway:

1. 0.5 credit in: **DATA 5000 [0.5]** Data Science Seminar
2. 1.0 credit in: **INAF 5016 [0.5]** Statistical Analysis for International Affairs
   **INAF 5017 [0.25]** International Policymaking in Canada: Structure and Process
   **INAF 5018 [0.25]** Law and International Affairs
3. 0.5 credit in **Economics, successfully completed by the end of the second term from:** (see Note 1, below)
   **INAF 5009 [0.5]** International Aspects of Economic Development
   **INAF 5205 [0.5]** Economics of Conflict
   **INAF 5214 [0.5]** Economics for Defence and Security
   **INAF 5308 [0.5]** International Trade: Theory and Policy
   **INAF 5309 [0.5]** International Finance: Theory and Policy
   **INAF 5600 [0.5]** The Economics of Human Development
   **INAF 5703 [0.5]** International Public Economics
4. 2.0 credits in:
   **INAF 5900 [2.0]** M.A. Thesis (in the specialization)
5. 1.0 credit in **Field or Elective courses**
6. Successful completion of second language proficiency examination (See Note 4, below)

**Total Credits** 5.0

### Requirements - Coursework pathway:

1. 0.5 credit in: **DATA 5000 [0.5]** Data Science Seminar
2. 1.0 credit in: **INAF 5016 [0.5]** Statistical Analysis for International Affairs
   **INAF 5017 [0.25]** International Policymaking in Canada: Structure and Process
   **INAF 5018 [0.25]** Law and International Affairs
3. 0.5 credit in **specialization: (see Note 1, below)**
   **INAF 5009 [0.5]** International Aspects of Economic Development
   **INAF 5205 [0.5]** Economics of Conflict
   **INAF 5214 [0.5]** Economics for Defence and Security
   **INAF 5308 [0.5]** International Trade: Theory and Policy
   **INAF 5309 [0.5]** International Finance: Theory and Policy
   **INAF 5600 [0.5]** The Economics of Human Development
   **INAF 5703 [0.5]** International Public Economics
4. 0.5 credit in **Economics, successfully completed by the end of the second term, from:** (see Note 2, below)
   **INAF 5009 [0.5]** International Aspects of Economic Development
   **INAF 5205 [0.5]** Economics of Conflict
   **INAF 5214 [0.5]** Economics for Defence and Security
   **INAF 5308 [0.5]** International Trade: Theory and Policy
   **INAF 5309 [0.5]** International Finance: Theory and Policy
   **INAF 5600 [0.5]** The Economics of Human Development
   **INAF 5703 [0.5]** International Public Economics
5. 2.5 credits in **Field or Elective Courses (See Note 3, below)**
6. Successful completion of second language proficiency examination (See Note 4, below)

**Total Credits** 5.0

### Notes:

1. The course must include at least one major assignment with a significant data science component. The selected course must be approved by the School and Institute for Data Science. An accepted data science specialization course from outside the School can be used for this requirement with approval.
2. All students must complete the 0.5 credit economics course for their designated field, or an approved alternate economics course. For students in the IEP field both INAF 5308 and INAF 5309, or approved equivalent, must be completed.
3. For elective courses, 1.5 credits of the total required 5.0 credits may be selected from courses offered in other departments, with a maximum of 1.0 credit from a single department and a maximum of 1.0 credit selected from fourth year undergraduate courses. Any course not identified as an INAF 5000-level course must be approved by the M.A. Program Supervisor.
4. Students must successfully complete an examination in second language proficiency administered by Carleton University’s School of Linguistics and...
Language Studies, or meet the equivalent standard as determined by the School of Linguistics and Language Studies. Details of the language requirement are provided on the School website.

Master of Information Technology: Digital Media with Collaborative Specialization in Data Science (5.0 credits)

Requirements:
1. 0.5 credit in:  
   DATA 5000 [0.5] Data Science Seminar  
2. 0.5 credit in:  
   ITEC 5002 [0.5] Fundamentals of Information Technology Research  
3. 1.0 credit from core courses:  
   ITEC 5010 [0.5] Applied Programming I  
   ITEC 5200 [0.5] Entertainment Technologies  
   ITEC 5201 [0.5] Computer Animation Technologies  
   ITEC 5202 [0.5] Visual Effects Technologies  
   ITEC 5203 [0.5] Game Design and Development Technologies  
   ITEC 5204 [0.5] Emerging Interaction Techniques  
   ITEC 5205 [0.5] Design and Development of Data-Intensive Applications  
   ITEC 5206 [0.5] Data Protection and Rights Management  
   ITEC 5207 [0.5] Data Interaction Techniques  
   ITEC 5208 [0.5] Virtual and Augmented Reality Technology  
   ITEC 5920 [0.5] Selected Topics in Digital Media  
4. 0.5 credit in electives, which may include up to 0.5 credit from a 4000-level course, or a 0.5 credit graduate course from another discipline, with permission from their graduate supervisor or the Associate Director of Graduate Studies in the School.  
5. 2.5 credits in:  

Total Credits 5.0

Note: No additional IT seminar requirements for this stream.

M.Sc. Physics

Particle Physics Stream with Collaborative Specialization in Data Science (5.0 credits)

Requirements:
1. 0.5 credit in:  
   DATA 5000 [0.5] Data Science Seminar  
2. 0.5 credit in:  
   PHYS 5002 [0.5] Statistical Data Analysis Techniques for Physics (or equivalent course in computing physics)  
3. 1.5 credit in:  
   PHYS 5602 [0.5] Physics of Elementary Particles  
   PHYS 5701 [0.5] Intermediate Quantum Mechanics with Applications  
   PHYS 5702 [0.5] Relativistic Quantum Mechanics  
4. 2.5 credits in:  
   PHYS 5909 [2.5] M.Sc. Thesis (on a data science topic approved by the Data Science governance committee and defended at an oral examination)  
5. Participation in the seminar series of the Ottawa-Carleton Institute of Physics  

Total Credits 5.0

M.A. Psychology

with Collaborative Specialization in Data Science (5.0 credits)

Requirements:
1. 1.0 credit in:  
   PSYC 5410 [0.5] Advanced Analysis of Variance  
   PSYC 5411 [0.5] Advanced Regression  
2. 0.5 credit in:  
   DATA 5000 [0.5] Data Science Seminar  
3. 0.5 credit in PSYC at the 5000 level, excluding the professional development courses listed in Item 4 and excluding the elective statistics courses listed below.  
4. 0.5 credit from the following professional development courses:  
   PSYC 5000 [0.5] Introduction to Program Evaluation  
   PSYC 5002 [0.5] Ethics in Psychology  
   PSYC 5003 [0.5] Open Science and Methodological Improvements  
   PSYC 5004 [0.5] Knowledge Mobilization  
   PSYC 5802 [0.5] Special Topics: Professional Development  
   PSYC 5903 [0.5] Practicum in Psychology  

Total Credits 5.0
5. Completion of: 0.0
   PSYC 5906 [0.0] Pro-Seminar in Psychology

6. 2.5 credits in: 2.5
   PSYC 5909 [2.5] M.A. Thesis (in the area of Data Science, which must be defended at an oral examination)

| Total Credits | 5.0 |

Notes:
1. Students must receive a minimum grade of A in each of the courses included in the Specialization.
2. Courses for each research area are listed on the departmental website: carleton.ca/psychology.

Master of Public Policy and Administration with Collaborative Specialization in Data Science (7.0 credits)

Requirements - Coursework pathway:

1. 4.5 credits in core courses: 4.5
   - PADM 5120 [0.5] Modern Challenges to Governance
   - PADM 5121 [0.5] Policy Analysis: The Practical Art of Change
   - PADM 5122 [0.5] Public Management: Principles and Approaches
   - PADM 5123 [0.5] Public Management in Practice
   - PADM 5124 [0.5] Law and Ethics
   - PADM 5125 [0.5] Qualitative Methods for Public Policy
   - PADM 5127 [0.5] Microeconomics for Policy Analysis
   - PADM 5128 [0.5] Macroeconomics for Policy Analysis
   - PADM 5129 [0.5] Capstone Course

2. 1.5 credits in data science core courses: 1.5
   - DATA 5000 [0.5] Data Science Seminar
   - PADM 5126 [0.5] Quantitative Methods for Public Policy
   - PADM 5218 [0.5] Analysis of Socio-economic Data

3. 0.5 credit from data science electives: 0.5
   - COMP 5111 [0.5] Data Management for Business Intelligence
   - COMP 5209 [0.5] Visual Analytics
   - COMP 5305 [0.5] Advanced Database Systems
   - COMP 5306 [0.5] Data Integration
   - PADM 5219 [0.5] Advanced Statistical Policy Analysis
   - PADM 5372 [0.5] Policy Seminar (Data Science Specialization)
   - PADM 5391 [0.5] Directed Studies (Data Science Specialization)

4. 0.5 credit in approved elective: 0.5

| Total Credits | 7.0 |

Requirements - Research essay pathway:

1. 4.5 credits in core courses: 4.5
   - PADM 5120 [0.5] Modern Challenges to Governance
   - PADM 5121 [0.5] Policy Analysis: The Practical Art of Change
   - PADM 5122 [0.5] Public Management: Principles and Approaches
   - PADM 5123 [0.5] Public Management in Practice
   - PADM 5124 [0.5] Law and Ethics
   - PADM 5125 [0.5] Qualitative Methods for Public Policy
   - PADM 5127 [0.5] Microeconomics for Policy Analysis
   - PADM 5128 [0.5] Macroeconomics for Policy Analysis
   - PADM 5129 [0.5] Capstone Course

2. 1.0 credit from data science core courses: 1.0
   - DATA 5000 [0.5] Data Science Seminar
   - PADM 5126 [0.5] Quantitative Methods for Public Policy
   - PADM 5218 [0.5] Analysis of Socio-economic Data

3. 0.5 credit from data science electives: 0.5
   - COMP 5111 [0.5] Data Management for Business Intelligence
   - COMP 5209 [0.5] Visual Analytics
   - COMP 5305 [0.5] Advanced Database Systems
   - COMP 5306 [0.5] Data Integration
   - PADM 5219 [0.5] Advanced Statistical Policy Analysis
   - PADM 5372 [0.5] Policy Seminar (Data Science Specialization)
   - PADM 5391 [0.5] Directed Studies (Data Science Specialization)

4. 0.5 credit in approved elective: 0.5

Note:
Additional credits may be required, as specified on offer of admission.

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<tr>
<th>Total Credits</th>
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<tbody>
<tr>
<td>Requirements - Research essay pathway (Advanced completion, 5.0 credits - See Note, below):</td>
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<tr>
<td>1. 3.0 credits from core courses:</td>
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<tr>
<td>PADM 5120 [0.5] Modern Challenges to Governance</td>
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<td>2. 1.0 credit from data science core courses:</td>
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<td>3. 1.0 credit in:</td>
<td>1.0</td>
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<tr>
<td>PADM 5908 [1.0] Research Essay (on a Data Science topic approved by the MPPA Graduate Supervisor and the Data Science governance committee)</td>
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Note:
Additional credits may be required, as specified on offer of admission.

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Regulations
See the General Regulations section of this Calendar, as well as regulations pertaining to the specific collaborative programs offering the data science specialization.

Admission
Students who are enrolled in a master's program in one of the participating units may apply to the Data Science governance committee for admission to the Collaborative Program. Admission to the program is determined by the governance committee and will normally take place before the end of October the year of admittance in one of the participating master's programs.

Admission requirements to the Collaborative Master's with Specialization in Data Science are:

- Registration in the master's program of one of the participating units
- Approval of a student's program of study by the Data Science governance committee and the student's home department. Students in a thesis program will be expected to choose a thesis topic that is directly related to Data Science. Students in an approved course work program will be required to take some elective courses in designated or approved courses with significant Data Science content.

Data Science (DATA) Courses

DATA 5000 [0.5 credit]
Data Science Seminar
Cloud based distributed systems, statistics, machine learning, use of complex ecosystems of tools and platforms, data ethics, and communication skills to explain advanced analytics. Students choose a project in Big Data management and/or analysis, deliver a paper and give a class presentation on their findings.

DATA 5001 [0.5 credit] (MAT 5818)
Fundamentals in Data Science and Analytics
Ethics in Data Science and Analytics, visualization and knowledge discovery in massive datasets; unsupervised learning: clustering algorithms; dimension reduction; supervised learning; pattern recognition, smoothing techniques, classification. Precludes additional credit for STAT 5703.

DATA 5908 [1.0 credit]
Project - MSc
DATA 5909 [2.5 credits]
Thesis - MSc
DATA 5918 [1.0 credit]
Project - MIT
DATA 5919 [2.5 credits]
Thesis - MIT
DATA 5928 [1.0 credit]
Project - MEng
DATA 5929 [2.5 credits]
Thesis - MASc
DATA 5939 [2.5 credits]
Thesis - MCS
DATA 6909 [9.0 credits]
Thesis - PhD