Mechanical and Aerospace Engineering

This section presents the requirements for programs in:

- **M.A.Sc. Aerospace Engineering**
- **M.A.Sc. Materials Engineering**
- **M.A.Sc. Mechanical Engineering**
- **M.A.Sc. Aerospace Engineering with Collaborative Specialization in Climate Change**
- **M.A.Sc. Materials Engineering with Collaborative Specialization in Climate Change**
- **M.A.Sc. Mechanical Engineering with Collaborative Specialization in Climate Change**
- **M. Eng. Aerospace**
- **M. Eng. Materials**
- **M. Eng. Mechanical**
- **Ph.D. Aerospace Engineering**
- **Ph.D. Mechanical Engineering**

Program Requirements

Students are expected to complete the master's program within the maximum limits outlined in the Section 13.2 of the General Regulations section of this Calendar.

M.A.Sc. Aerospace Engineering (5.0 credits)

M.A.Sc. Materials Engineering (5.0 credits)

M.A.Sc. Mechanical Engineering (5.0 credits)

Requirements:

1. 2.5 credits in courses offered by the OCIMAE.		2.5
2. Participation in the Mechanical and Aerospace Engineering seminar series		
3. 2.5 credits in:		2.5
MECH 5909 [2.5]	M.A.Sc. Thesis	
Total Credits		**5.0**

M.A.Sc. Aerospace Engineering with Collaborative Specialization in Climate Change (5.0 credits)

Requirements:

1. 1.0 credit in:		1.0
CLIM 5000 [1.0]	Climate Collaboration	
2. 0.0 credit in:		
CLIM 5800 [0.0]	Climate Seminar Series	
3. 1.5 credits in courses offered by the OCIMAE.		1.5
4. Participation in the Mechanical and Aerospace Engineering seminar series		
5. 2.5 credits in:		2.5
MECH 5909 [2.5]	M.A.Sc. Thesis (in the specialization)	
Total Credits		**5.0**

M.A.Sc. Materials Engineering with Collaborative Specialization in Climate Change (5.0 credits)

Requirements:

1. 1.0 credit in:		1.0
CLIM 5000 [1.0]	Climate Collaboration	
2. 0.0 credit in:		
CLIM 5800 [0.0]	Climate Seminar Series	
3. 1.5 credits in courses offered by the OCIMAE.		1.5
4. Participation in the Mechanical and Aerospace Engineering seminar series		
5. 2.5 credits in:		2.5
MECH 5909 [2.5]	M.A.Sc. Thesis (in the specialization)	
Total Credits		**5.0**

M.A.Sc. Mechanical Engineering with Collaborative Specialization in Climate Change (5.0 credits)

Requirements:

1. 1.0 credit in:		1.0
CLIM 5000 [1.0]	Climate Collaboration	
2. 0.0 credit in:		
CLIM 5800 [0.0]	Climate Seminar Series	
3. 1.5 credits in courses offered by the OCIMAE.		1.5
4. Participation in the Mechanical and Aerospace Engineering seminar series		
5. 2.5 credits in:		2.5
MECH 5909 [2.5]	M.A.Sc. Thesis (in the specialization)	
Total Credits		**5.0**

M. Eng. Aerospace (5.0 credits)

Requirements:

1. 1.5 credits from the Aerospace Engineering Courses listed below. Up to 1.0 credit can be completed by taking courses in AERO at the 4000 level with the approval of the Associate Chair for Graduate Studies.	1.5
2. 3.5 credits from any graduate level course offered by the OCIMAE	3.5
Total Credits	**5.0**

Requirements by Project (Independent Study) (5.0 credits)

1. 1.5 credits in:		1.5
MECH 5908 [1.5]	Independent Engineering Study	
2. 1.5 credits from the Aerospace Engineering Courses listed below. Up to 1.0 credit can be completed by taking courses in AERO at the 4000 level and MAAE at the 4000 level with the approval of the Associate Chair for Graduate Studies.		1.5
3. 2.0 credits from any graduate level course offered by the OCIMAE		2.0
Total Credits		**5.0**

M. Eng. Materials (5.0 credits)

Requirements:

1. 1.5 credits from the Materials Engineering Courses listed below. Up to 1.0 credit can be completed by taking courses in materials oriented MECH at the 4000 level and MAAE at the 4000 level with the approval of the Associate Chair for Graduate Studies.	1.5
2. 3.5 credits from any graduate level course offered by the OCIMAE	3.5
Total Credits	**5.0**

Requirements by Project (Independent Study) (5.0 credits)	
1. 1.5 credits in:	1.5
MECH 5908 [1.5] Independent Engineering Study	
2. 1.5 credits from the Materials Engineering Courses listed below. Up to 1.0 credit can be completed by taking courses in materials oriented MECH at the 4000 level and MAAE at the 4000 level with the approval of the Associate Chair for Graduate Studies.	1.5
3. 2.0 credits from any graduate level course offered by the OCIMAE	2.0
Total Credits	**5.0**

M. Eng. Mechanical (5.0 credits)

Requirements:	
1. 5.0 credits from any graduate level course offered by the OCIMAE. Up to 1.0 credit can be completed by taking courses in MECH at the 4000 level and MAAE at the 4000 with the approval of the Associate Chair for Graduate Studies.	5.0
Total Credits	**5.0**

Requirements by Project (Independent Study) (5.0 credits)	
1. 1.5 credits in:	1.5
MECH 5908 [1.5] Independent Engineering Study	
2. 3.5 credits from any graduate level course offered by the OCIMAE. Up to 1.0 credit can be completed by taking courses in MECH at the 4000 level and MAAE at the 4000 level with the approval of the Associate Chair for Graduate Studies.	3.5
Total Credits	**5.0**

Ph.D. Aerospace Engineering (1.5 credits)

Ph.D. Mechanical Engineering (1.5 credits)

Requirements (from the master's degree):	
(from the master's degree)	
1. 1.5 credits in courses	1.5
2. Participation in the Mechanical and Aerospace Engineering seminar series	
3. Successful completion of the comprehensive examination according to section 9.4 and 9.5 of the General Regulations section of this Calendar	
4. 0.0 credits in thesis.	0.0
MECH 6909 [0.0] Ph.D. Thesis	
Total Credits	**1.5**

Graduate Courses

In addition, graduate courses offered by departments in other disciplines may be taken for credit with approval by the department in which the student is registered.

The full list of MECH and MAAJ courses can be found in the course inventory tab. Not all of the following courses are offered in a given year.

The following codes identify the department offering the course:

- 'MECH' Department of Mechanical and Aerospace Engineering, Carleton University
- 'MAAJ' Department of Mechanical Engineering, University of Ottawa

CARLETON UNIVERSITY	
Aerospace Engineering Courses	
MECH 5005 (MCG 5305)	Uninhabited Aircraft Systems Design
MECH 5101 (MCG 5311)	Dynamics and Aerodynamics of Flight
MECH 5103 (MCG 5328)	3D Machine Vision: From Robots to the Space Station
MECH 5105 (MCG 5315)	Orbital Mechanics and Space Control
MECH 5106 (MCG 5121)	Space Mission Analysis and Design
MECH 5301 (MCG 5331)	Aeroacoustics
Materials Engineering Courses	
MECH 5604 (AMM 5364)	Computational Metallurgy
MECH 5609 (AMM 5123)	Microstructure and Properties of Materials
MECH 5700 (AMM 5345)	Surfaces and Coatings
MECH 5701 (AMM 5369)	Metallic Phases and Transformations
With the approval of the Department, the following courses can be placed in one of the above categories:	
MECH 5800 (MCG 5480)	Special Topics in Mechanical and Aerospace Engineering
MECH 5801 (MCG 5489)	Special Topics in Mechanical and Aerospace Engineering
MECH 5802 (MCG 5483)	Special Topics in Mechanical and Aerospace Engineering
MECH 5803 (MCG 5488)	Special Topics in Mechanical and Aerospace Engineering
MECH 5804 (MCG 5384)	Special Topics in Mechanical and Aerospace Engineering
MECH 5805 (MCG 5482)	Special Topics in Mechanical and Aerospace Engineering
MECH 5806 (MCG 5486)	Special Topics in Mechanical and Aerospace Engineering
MECH 5807 (MCG 5487)	Special Topics in Mechanical and Aerospace Engineering
MECH 5808 (MCG 5376)	Special Topics in Mechanical and Aerospace Engineering
MECH 5809 (MCG 5382)	Special Topics in Mechanical and Aerospace Engineering
UNIVERSITY OF OTTAWA	
Aerospace Engineering Courses	
MAAJ 5010 (MCG 5310)	Performance and Economics of V/Stol Aircraft
MAAJ 5031 (MCG 5331)	Aero-Acoustics
MAAJ 5053 (AMM 5124)	Fatigue and Damage Tolerance in Aircraft
MAAJ 5157 (MCG 5121)	Space Mission Analysis and Design
Materials Engineering Courses	
MAAJ 5003 (MCG 5103)	Theory Perfectly Plastic Solid
MAAJ 5012 (AMM 5364)	Computational Metallurgy

MAAJ 5052 (AMM 5122)	Failure Analysis of High-Temperature Protective Coatings for Aerospace Applications
MAAJ 5100 (MCG 5110)	Micromechanics of Solids
MAAJ 5107 (AMM 5117)	Intro to Composite Materials
MAAJ 5108 (AMM 5118)	Introduction to Plasticity
MAAJ 5206 (AMM 5126)	Deformation of Materials
MAAJ 5209 (AMM 5129)	Hot Working of Metals
MAAJ 5307 (AMM 5137)	Special Studies in Solid Mechanics and Materials
MAAJ 5452 (AMM 5144)	Superalloys and Ceramix-Metal Matrix Composites
MAAJ 5659 (AMM 5123)	Microstructure and Properties of Materials
MAAJ 5750 (AMM 5345)	Surfaces and Coatings
MAAJ 5751 (AMM 5369)	Metallic Phases and Transformations
With the approval of the Department, the following courses can be placed in one of the above categories:	
MAAJ 5011 (AMM 5138)	Advanced Topics in Advanced Materials and Manufacturing
MAAJ 5308 (MCG 5138)	Advanced Topics in Mechanical Engineering
MAAJ 5310	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5311 (MCG 5471)	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5312 (MCG 5472)	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5313 (MCG 5473)	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5314 (MCG 5474)	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5315 (MCG 5475)	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5316 (MCG 5476)	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5317 (MCG 5477)	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5318 (MCG 5478)	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5319 (MCG 5479)	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5402 (MCG 5370)	Special Topics in Mechanical and Aeronautical Engineering
MAAJ 5403 (MCG 5470)	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5852 (MCG 5483)	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5853 (MCG 5488)	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5854 (MCG 5384)	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5855 (MCG 5482)	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5857 (MCG 5487)	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5858 (MCG 5376)	Special Topics in Mechanical and Aerospace Engineering
MAAJ 5850 (MCG 5480)	Special Topics in Mechanical and Aerospace Engineering

Regulations

See the General Regulations section of this Calendar.

Regularly Scheduled Break

For immigration purposes in the programs listed below, the summer term (May to August) is considered a regularly scheduled break approved by the University. Students should resume full-time studies in September.

- M.Eng. Aerospace (coursework and research project pathways only)
- M.Eng. Materials (coursework and research project pathways only)
- M.Eng. Mechanical (coursework and research project pathways only)

Note: a Regularly Scheduled Break as described for immigration purposes does not supersede the requirement for continuous registration in Thesis, Research Essay, or Independent Research Project as described in Section 8.2 of the Graduate General Regulations.

Admission

The normal requirement for admission to the master's program is a bachelor's degree with at least high honours standing in mechanical or aerospace engineering or a related discipline.

Admission

The normal requirement for admission to the Ph.D. program is a master's degree in mechanical or aerospace engineering or a related discipline.

Students who are in the master's program may be admitted to the Ph.D. program if they show outstanding academic performance and demonstrate significant promise for advanced research, upon recommendation of the department. In addition, graduate courses offered by departments in other disciplines may be taken for credit with approval by the department in which the student is registered.

Mechanical and Aerospace Engineering (Joint) (MAAJ) Courses

MAAJ 5001 [0.5 credit] (AMM 5101)
Theory of Elasticity

MAAJ 5002 [0.5 credit] (AMM 5102)
Advanced Stress Analysis

MAAJ 5003 [0.5 credit] (AMM 5103)
Theory Perfectly Plastic Solid

MAAJ 5004 [0.5 credit] (MCG 5104)
Theory of Plates and Shells

MAAJ 5005 [0.5 credit] (MCG 5105)
Continuum Mechanics

MAAJ 5006 [0.5 credit] (AMM 5106)
Advanced Topics in Elasticity

MAAJ 5007 [0.5 credit] (MCG 5107)
Adv. Dynamics w/Applications

MAAJ 5008 [0.5 credit] (MCG 5108)
Finite Element Analysis

MAAJ 5009 [0.5 credit] (MCG 5109)
Advanced Topics in Finite Element Analysis

MAAJ 5010 [0.5 credit] (MCG 5310)
Performance and Economics of V/Stol Aircraft

MAAJ 5011 [0.5 credit] (AMM 5138)
Advanced Topics in Advanced Materials and Manufacturing

MAAJ 5012 [0.5 credit] (AMM 5364)
Computational Metallurgy

MAAJ 5013 [0.5 credit] (MCG 5125)
Advanced Dynamics

MAAJ 5014 [0.5 credit] (MCG 5314)
Ground Transportation Systems and Vehicles

MAAJ 5015 [0.5 credit] (MCG 5120)
Micro and Nano Systems

MAAJ 5021 [0.5 credit] (MCG 5321)
Methods of Energy Conversion

MAAJ 5022 [0.5 credit] (MCG 5322)
Nuclear Engineering

MAAJ 5025 [0.5 credit] (MCG 5325)
Wind Engineering

MAAJ 5026 [0.5 credit] (MCG 5326)
System Modelling, Dynamics and Control

MAAJ 5027 [0.5 credit] (MCG 5327)
Nonlinear System Analysis and Controls

MAAJ 5028 [0.5 credit] (MCG 5328)
3D Machine Vision: From Robots to the Space Station

MAAJ 5030 [0.5 credit] (MCG 5330)
Engineering Acoustics

MAAJ 5031 [0.5 credit] (MCG 5331)
Aero-Acoustics

MAAJ 5042 [0.5 credit] (MCG 5342)
Gas Turbines

MAAJ 5048 [0.5 credit] (MCG 5348)
Convective Heat and Mass Transfers

MAAJ 5050 [0.5 credit] (MCG 5300)
Fundamentals of Fluid Dynamics
Also listed as MECH 5000.

MAAJ 5051 [0.5 credit] (AMM 5130)
Deformation and Fracture of Engineering Materials

MAAJ 5052 [0.5 credit] (AMM 5122)
Failure Analysis of High-Temperature Protective Coatings for Aerospace Applications

MAAJ 5053 [0.5 credit] (AMM 5124)
Fatigue and Damage Tolerance in Aircraft

MAAJ 5054 [0.5 credit] (MCG 5147)
Finite-Volume Methods for Compressible Flows

MAAJ 5055 [0.5 credit] (MCG 5148)
High-Performance Parallel Scientific Computing

MAAJ 5056 [0.5 credit] (AMM 5125)
Materials Characterization Techniques

MAAJ 5057 [0.5 credit] (AMM 5121)
Materials Selection in Engineering Design

MAAJ 5058 [0.5 credit] (MCG 5149)
Non-Equilibrium Gas Dynamics

MAAJ 5059 [0.5 credit] (MCG 5309)
Environmental Fluid Mechanics
Includes: Experiential Learning Activity
Also listed as MECH 5009.

MAAJ 5100 [0.5 credit] (MCG 5110)
Micromechanics of Solids

MAAJ 5101 [0.5 credit] (MCG 5111)
Gas Dynamics

MAAJ 5102 [0.5 credit] (AMM 5317)
Experimental Stress Analysis

MAAJ 5103 [0.5 credit] (AMM 5374)
Integrated Manufacturing - CIMS

MAAJ 5105 [0.5 credit] (MCG 5115)
Non-Linear Optimization

MAAJ 5107 [0.5 credit] (AMM 5117)
Intro to Composite Materials
Includes: Experiential Learning Activity

MAAJ 5108 [0.5 credit] (AMM 5118)
Introduction to Plasticity

MAAJ 5109 [0.5 credit] (AMM 5119)
Fracture Mechanics

MAAJ 5122 [0.5 credit] (MCG 5352)
Optimal Control Systems

MAAJ 5123 [0.5 credit] (MCG 5353)
Robotics

MAAJ 5151 [0.5 credit] (MCG 5311)
Dynamics and Aerodynamics of Flight
Includes: Experiential Learning Activity
Also listed as MECH 5101.

MAAJ 5152 [0.5 credit] (MCG 5301)
Theory of Viscous Flows

MAAJ 5153 [0.5 credit] (MCG 5303)
Incompressible Non-Viscous Flows

MAAJ 5154 [0.5 credit] (MCG 5304)
Compressible Non-Viscous Flows

MAAJ 5155 [0.5 credit] (MCG 5315)
Orbital Mechanics and Space Control
Includes: Experiential Learning Activity
Also listed as MECH 5105.

MAAJ 5156 [0.5 credit] (AMM 5381)
Lightweight Structures

MAAJ 5157 [0.5 credit] (MCG 5121)
Space Mission Analysis and Design

MAAJ 5158 [0.5 credit] (MCG 5308)
Experimental Methods in Fluid Mechanics

MAAJ 5159 [0.5 credit] (MCG 5122)
Smart Structures

MAAJ 5206 [0.5 credit] (AMM 5126)
Deformation of Materials

MAAJ 5209 [0.5 credit] (AMM 5129)
Hot Working of Metals

MAAJ 5251 [0.5 credit] (MCG 5354)
Guidance, Navigation and Control

MAAJ 5252 [0.5 credit] (MCG 5356)
Neuro and Fuzzy Control

MAAJ 5253 [0.5 credit] (MCG 5366)
Finite Element Analysis II

MAAJ 5254 [0.5 credit] (MCG 5483)
Fundamentals of Combustion
Also listed as MECH 5204.

MAAJ 5255 [0.5 credit] (MCG 5324)
Building Performance Simulation
Includes: Experiential Learning Activity
Also listed as MECH 5205.

MAAJ 5301 [0.5 credit] (MCG 5131)
Heat Transfer by Conduction

MAAJ 5302 [0.5 credit] (MCG 5132)
Heat Transfer by Convection

MAAJ 5303 [0.5 credit] (MCG 5133)
Heat Transfer by Radiation

MAAJ 5304 [0.5 credit] (MCG 5134)
Heat Transfer w/Phase Change

MAAJ 5305 [0.5 credit] (MCG 5343)
Advanced Thermodynamics

MAAJ 5306 [0.5 credit] (MCG 5136)
Special Studies in Fluid Mech and Heat Transfer

MAAJ 5307 [0.5 credit] (AMM 5137)
Special Studies in Solid Mechanics and Materials

MAAJ 5308 [0.5 credit] (MCG 5138)
Advanced Topics in Mechanical Engineering

MAAJ 5309 [0.5 credit] (MCG 5375)
CAD/CAM

MAAJ 5311 [0.5 credit] (MCG 5471)
Special Topics in Mechanical and Aerospace Engineering

MAAJ 5312 [0.5 credit] (MCG 5472)
Special Topics in Mechanical and Aerospace Engineering

MAAJ 5313 [0.5 credit] (MCG 5473)
Special Topics in Mechanical and Aerospace Engineering

MAAJ 5314 [0.5 credit] (MCG 5474)
Special Topics in Mechanical and Aerospace Engineering

MAAJ 5315 [0.5 credit] (MCG 5475)
Special Topics in Mechanical and Aerospace Engineering

MAAJ 5316 [0.5 credit] (MCG 5476)
Special Topics in Mechanical and Aerospace Engineering

MAAJ 5317 [0.5 credit] (MCG 5477)
Special Topics in Mechanical and Aerospace Engineering

MAAJ 5318 [0.5 credit] (MCG 5478)
Special Topics in Mechanical and Aerospace Engineering

MAAJ 5319 [0.5 credit] (MCG 5479)
Special Topics in Mechanical and Aerospace Engineering

MAAJ 5340 [0.5 credit] (MCG 5344)
Gas Turbine Combustion

MAAJ 5352 [0.5 credit] (MCG 5332)
Instrumentation Techniques
Also listed as MECH 5302.

MAAJ 5354 [0.5 credit] (MCG 5334)
Computational Fluid Dynamics of Compressible Flow
Also listed as MECH 5304.

MAAJ 5356 [0.5 credit] (MCG 5306)
Theory of Subsonic Flows

MAAJ 5357 [0.5 credit] (MCG 5307)
Theory of Supersonic Flows

MAAJ 5401 [0.5 credit] (MCG 5141)
Statistical Thermodynamics

MAAJ 5402 [0.5 credit] (MCG 5370)
Special Topics in Mechanical and Aeronautical Engineering

MAAJ 5403 [0.5 credit] (MCG 5470)
Special Topics in Mechanical and Aerospace Engineering

MAAJ 5408 [0.5 credit] (MCG 5551)
Theorie d'Ecoulement Visqueux

MAAJ 5409 [0.5 credit] (MCG 5552)
Theorie de Turbulence

MAAJ 5451 [0.5 credit] (MCG 5341)
Turbomachinery
Includes: Experiential Learning Activity
Also listed as MECH 5401.

MAAJ 5452 [0.5 credit] (AMM 5144)
Superalloys and Ceramix-Metal Matrix Composites

MAAJ 5457 [0.5 credit] (MCG 5347)
Conductive and Radiative Heat Transfer
Also listed as MECH 5407.

MAAJ 5459 [0.5 credit] (MCG 5349)
Two-Phase Flow and Heat Transfer

MAAJ 5500 [0.5 credit] (MCG 5557)
Méthodes numeriques en mécanique

MAAJ 5501 [0.5 credit] (MCG 5151)
Laminar Flow Theory

MAAJ 5502 [0.5 credit] (MCG 5152)
Theory of Turbulance

MAAJ 5505 [0.5 credit] (MCG 5155)
Inviscid Flow Theory

MAAJ 5506 [0.5 credit] (MCG 5156)
Measurement of Fluid Mech

MAAJ 5507 [0.5 credit] (MCG 5157)
Num Comp:Fluid Dyn and Heat Tran

MAAJ 5509 [0.5 credit] (AMM 5159)
Advanced Production Planning and Control

MAAJ 5550 [0.5 credit] (MCG 5350)
Advanced Vibration Analysis
Includes: Experiential Learning Activity
Also listed as MECH 5500.

MAAJ 5555 [0.5 credit] (MCG 5355)
Stability Theory & Application
Also listed as MECH 5505.

MAAJ 5557 [0.5 credit] (MCG 5124)
Advanced Kinematics
Includes: Experiential Learning Activity
Also listed as MECH 5507.

MAAJ 5607 [0.5 credit] (MCG 5167)
Nuclear Reactor Engineering

MAAJ 5608 [0.5 credit] (AMM 5168)
Industrial Organization

MAAJ 5609 [0.5 credit] (MCG 5169)
Advanced Topics in Reliability Engineer

MAAJ 5652 [0.5 credit] (AMM 5362)
Failure Prevention

MAAJ 5655 [0.5 credit] (MCG 5365)
Finite Element Analysis I
Also listed as MECH 5605.

MAAJ 5656 [0.5 credit] (MCG 5367)
The Boundary Element Method
Includes: Experiential Learning Activity
Also listed as MECH 5607.

MAAJ 5657 [0.5 credit] (MCG 5361)
Creative Problem Solving and Design
Also listed as MECH 5601.

MAAJ 5659 [0.5 credit] (AMM 5123)
Microstructure and Properties of Materials
Also listed as MECH 5609.

MAAJ 5700 [0.5 credit] (MCG 5170)
Computer-Aided Design
Includes: Experiential Learning Activity

MAAJ 5701 [0.5 credit] (MCG 5171)
Applied Reliability Theory

MAAJ 5703 [0.5 credit] (MCG 5173)
Systems Engineer and Integration

MAAJ 5707 [0.5 credit] (MCG 5177)
Robot Mechanics

MAAJ 5709 [0.5 credit] (AMM 5179)
Manufacturing System Analysis

MAAJ 5750 [0.5 credit] (AMM 5345)
Surfaces and Coatings
Also listed as MECH 5700.

MAAJ 5751 [0.5 credit] (AMM 5369)
Metallic Phases and Transformations
Precludes additional credit for MECH 5701.

MAAJ 5802 [0.5 credit] (AMM 5182)
Theory of Elastic Instability

MAAJ 5804 [0.5 credit] (MCG 5184)
Mechatronics

MAAJ 5805 [0.5 credit] (MCG 5185)
Multivariable Digital Control

MAAJ 5806 [0.5 credit] (MCG 5186)
Non-Linear Disc Dyn and Control

MAAJ 5850 [0.5 credit] (MCG 5480)
Special Topics in Mechanical and Aerospace Engineering
Also listed as MECH 5800.

MAAJ 5851 [0.5 credit] (MCG 5380)
Safety and Risk Assessment of Nuclear Power

MAAJ 5852 [0.5 credit] (MCG 5483)
Special Topics in Mechanical and Aerospace Engineering
Also listed as MECH 5802.

MAAJ 5853 [0.5 credit] (MCG 5488)
Special Topics in Mechanical and Aerospace Engineering
Also listed as MECH 5803.

MAAJ 5854 [0.5 credit] (MCG 5384)
Special Topics in Mechanical and Aerospace Engineering
Also listed as MECH 5804.

MAAJ 5855 [0.5 credit] (MCG 5482)
Special Topics in Mechanical and Aerospace Engineering
Also listed as MECH 5805.

MAAJ 5857 [0.5 credit] (MCG 5487)
Special Topics in Mechanical and Aerospace Engineering
Also listed as MECH 5807.

MAAJ 5858 [0.5 credit] (MCG 5376)
Special Topics in Mechanical and Aerospace Engineering
Also listed as MECH 5808.

MAAJ 5901 [0.5 credit] (MCG 5191)
Combustion in Premixed Systems

MAAJ 5902 [0.5 credit] (MCG 5192)
Combustion in Diffusion System

Mechanical Engineering (MECH) Courses

MECH 5000 [0.5 credit] (MCG 5300)
Fundamentals of Fluid Dynamics
Equations of fluid motion: Navier-Stokes and Euler's equations. 2D and 3D irrotational flows: potential and stream functions; superposition; numerical modelling; Boundary- and free-shear layers: laminar, transitioning and turbulent states. RANS turbulence models. Self-similarity, momentum-integral and numerical modelling of thin shear layers.
Also listed as MAAJ 5050.

MECH 5001 [0.5 credit] (MCG 5301)
Theory of Viscous Flows
Navier-Stokes and boundary layer equations; mean flow equations for turbulent kinetic energy; integral formulations. Stability, transition, turbulence, Reynolds stresses; separation. Calculation methods, closure schemes. Compressibility, heat transfer, and three-dimensional effects.
Includes: Experiential Learning Activity

MECH 5003 [0.5 credit] (MCG 5303)
Incompressible Non-Viscous Flow
The fundamental equations and theorems for non-viscous fluid flow; solution of two-dimensional and axisymmetric potential flows; low-speed airfoil and cascade theory; wing lifting-line theory; panel methods.

MECH 5004 [0.5 credit] (MCG 5304)
Compressible Non-Viscous Flow
Steady isentropic, frictional, and diabatic flow; shock waves; irrotational compressible flow, small perturbation theory and similarity rules; second-order theory and unsteady, one-dimensional flow.

MECH 5005 [0.5 credit] (MCG 5305)
Uninhabited Aircraft Systems Design
UAS design, operations, and mission analysis; operational challenges; theory of flight and vehicle performance; regulations and safety; human factors and system integration; system-level reliability and life cycle assessment; payload and sensor analysis.
Includes: Experiential Learning Activity

MECH 5006 [0.5 credit]
Solar Energy
This course will take an in-depth look at solar radiation fundamentals, solar collector design and performance, heat transfer characteristics of solar collectors, energy storage, passive and active thermal systems, photovoltaics and applications of solar energy for collection and utilization.

MECH 5008 [0.5 credit] (MCG 5308)
Experimental Methods in Fluid Mechanics
Fundamentals of techniques of simulation of fluid dynamic phenomena. Theoretical basis, principles of design, performance and instrumentation of ground test facilities. Applications to aerodynamic testing.
Includes: Experiential Learning Activity

MECH 5009 [0.5 credit] (MCG 5309)
Environmental Fluid Mechanics Relating to Energy Utilization
Characteristics of energy sources and emissions into the environment. The atmosphere; stratification and stability, equations of motion, simple winds, mean flow, turbulence structure and dispersion near the ground. Flow and dispersion in groundwater, rivers, lakes and oceans. Physical and analytical modeling of environmental flows.
Includes: Experiential Learning Activity
Also listed as MAAJ 5059.

MECH 5101 [0.5 credit] (MCG 5311)
Dynamics and Aerodynamics of Flight
Aircraft nonlinear equations of motion and their linearization; effect of stability and control derivatives on the open-loop dynamics response; autopilot design and aircraft stability and control augmentation; pilot-in-the-loop; aeroelastic effects on stability and control.
Includes: Experiential Learning Activity
Also listed as MAAJ 5151.

MECH 5103 [0.5 credit] (MCG 5328)
3D Machine Vision: From Robots to the Space Station

Through lectures and project work, this course introduces fundamental 3D machine vision methods (triangulation and time-of-flight), presents cutting-edge neural network approaches, and explores major engineering applications (e.g. robotics, autonomous vehicles, space navigation) where perception of the 3D environment is essential.

MECH 5105 [0.5 credit] (MCG 5315)
Orbital Mechanics and Space Control
Orbital dynamics and perturbations due to the Earth's figure, the sun, and the moon with emphasis on mission planning and analysis. Rigid body dynamics applied to transfer orbit and on-orbit momentum management and control of spacecraft. Effects of flexible structures on a spacecraft control system.
Includes: Experiential Learning Activity
Also listed as MAAJ 5155.

MECH 5106 [0.5 credit] (MCG 5121)
Space Mission Analysis and Design
Review of solar system and space exploration. Space mission design and geometry. Analysis of orbit design, transfers, interplanetary trajectories. Effect of environment on spacecraft design. Space propulsion and launch vehicle design. Launch sequence, windows, cost. Reusable launch systems.

MECH 5107 [0.5 credit] (AMM 5317)
Experimental Stress Analysis
Introduction to theory of elasticity. Photo-elasticity: types of polariscopes, two- and three-dimensional stress fields, frozen patterns. Photoelastic coatings. Strain gauges; gauge factors, sensitivity, calibration, and temperature compensation. Moire fringes, brittle lacquers, mechanical strain gauges.

MECH 5108 [0.5 credit] (MCG 5329)
Space Robotics
This course covers the full spectrum of manipulator robotics applied to in-orbit servicing, repair of spacecraft and removal of orbital debris as the first step towards developing a space infrastructure. It covers space manipulator missions, kinematics, dynamics, trajectory generation, control systems, and some special topics.

MECH 5201 [0.5 credit] (MCG 5321)
Methods of Energy Conversion
Technical, economic and environmental aspects of present and proposed large-scale systems of energy conversion.

MECH 5202 [0.5 credit] (MCG 5122)
Smart Structures
An introduction to the fundamentals of smart materials and structures: mechanisms and classification of the smart materials; their fundamental characteristics and operating principals; sensors and actuators design; design framework of smart structures; control experimentation of smart structures; application case studies.

MECH 5203 [0.5 credit] (MCG 5322)
Nuclear Engineering
Reactor design and safety requirement overview; reactor physics, chemistry and engineering, CANDU reactor design and operation; CANDU reactor fuel channels, thermalhydraulics and fuel; reactor safety design and analysis; IAEA and Canadian safety analysis requirements; reactor accidents; nuclear energy policy.

MECH 5204 [0.5 credit] (MCG 5483)
Fundamentals of Combustion
Emphasis on gas phase reacting flows. Background of combustion thermodynamics, diffusion mass transfer, and chemical kinetics. Detonations and deflagrations. Chemical and dynamic structure of flames. Gaseous flame propagation under laminar and turbulent conditions. Flame stabilization and extinction. Introduction to burning rate theory.
Also listed as MAAJ 5254.

MECH 5205 [0.5 credit] (MCG 5324)
Building Performance Simulation
During this course students will develop an understanding of the methodologies and theory employed historically and contemporarily in the Building Performance Simulation (BPS) field, develop capabilities for extending the functionality of BPS tools, and establish skills in applying BPS tools in research, analysis, and design.
Includes: Experiential Learning Activity
Also listed as MAAJ 5255.

MECH 5206 [0.5 credit] (MCG 5325)
Wind Engineering
Theoretical and practical areas pertinent to the operation of wind turbines. World energy needs, wind farms versus traditional power plants, global wind characteristics, efficient turbine design, electrical components, modes of turbine operation and control, mechanical design, economic and environmental concerns.

MECH 5300 [0.5 credit] (MCG 5330)
Engineering Acoustics
Review of acoustic waves in compressible fluids; acoustic pressure, intensity and impedance; physical interpretation and measurement; transmission through media; layers, in-homogeneous media, solids; acoustic systems; rooms, ducts, resonators, mufflers, properties of transducers; microphones, loudspeakers, computational acoustics.

MECH 5301 [0.5 credit] (MCG 5331)
Aeroacoustics
The convected wave equation; theory of subsonic and supersonic jet noise; propeller and helicopter noise; fan and compressor noise; boundary layer noise, interior noise; propagation in the atmosphere; sonic boom; impact on environment.
Includes: Experiential Learning Activity

MECH 5302 [0.5 credit] (MCG 5332)
Instrumentation Techniques
An introduction for the non-specialists to the concepts of digital and analog electronics with emphasis on data acquisition, processing and analysis. Topics covered include operational amplifiers, signal processing, digital logic systems, computer interfacing, noise in electronic systems. Hands-on sessions illustrate theory and practice.

Also listed as MAAJ 5352.

MECH 5304 [0.5 credit] (MCG 5334)
Computational Fluid Dynamics of Compressible Flows
Solution techniques for parabolic, elliptic and hyperbolic equations developed for problems of interest to fluid dynamics with appropriate stability considerations. A staged approach to solution of full Euler and Navier-Stokes equations is used. Grid generation techniques appropriate for compressible flows are introduced.
Also listed as MAAJ 5354.

MECH 5400 [0.5 credit] (MCG 5344)
Gas Turbine Combustion
Combustion fundamentals and gas turbine combustor design. Combustion fundamentals include fuel evaporation, chemistry of combustion, chemical kinetics and emissions formation and introduction to computational combustion modelling. Combustor design addresses the interrelationship between operational requirements and combustion fundamentals.
Precludes additional credit for MECH 5800 (MCG 5480) when MECH 5800 was offered with this topic.

MECH 5401 [0.5 credit] (MCG 5341)
Turbomachinery
Types of machines. Similarity: performance parameters; characteristics; cavitation. Velocity triangles. Euler equation: impulse and reaction. Radial pumps and compressors: analysis, design and operation. Axial pumps and compressors: cascade and blade-element methods; staging; off-design performance; stall and surge. Axial turbines. Current design practice.
Includes: Experiential Learning Activity
Also listed as MAAJ 5451.

MECH 5402 [0.5 credit] (MCG 5342)
Gas Turbines
Interrelationship among thermodynamic, aerodynamic, and mechanical design. Ideal and real cycle calculations. Cycle optimization; turbo-shaft, turbojet, turbofan. Component performance. Off-design performance; matching of compressor, turbine, nozzle. Twin-spool matching.

MECH 5403 [0.5 credit] (MCG 5343)
Advanced Thermodynamics
The course covers three major topics: review of fundamentals from a consistent viewpoint, properties and equations of state, and applications and special topics. The third topic includes an introduction to statistical thermodynamics.

MECH 5407 [0.5 credit] (MCG 5347)
Conductive and Radiative Heat Transfer
Analytical, numerical and analog solutions to steady-state and transient conduction heat transfer in multi-dimensional systems. Radiative heat exchange between black, grey, non-grey diffusive and specular surfaces, including effects of athermanous media.
Also listed as MAAJ 5457.

MECH 5408 [0.5 credit] (MCG 5348)
Convective Heat and Mass Transfer
Analogies between heat, mass and momentum transfer. Forced and free convection relations for laminar and turbulent flows analytically developed where possible and otherwise deduced from experimental results, for simple shapes and in heat exchangers. Mass transfer theory and applications.

MECH 5500 [0.5 credit] (MCG 5350)
Advanced Vibration Analysis
General theory of continuous and discrete multi-degree-of-freedom vibrating systems. Emphasis on numerical techniques of solving complex vibrating systems, with selected applications from aerospace, civil, and mechanical engineering.
Includes: Experiential Learning Activity
Also listed as MAAJ 5550.

MECH 5501 [0.5 credit] (MCG 5125)
Advanced Dynamics
Developing and applying the governing equations of motion for discrete and continuous mechanical systems. Includes Newton-Euler and Lagrangian formulations; classical and finite element approaches for continuous systems; and linear stability, frequency response, and propagation solution methods.
Includes: Experiential Learning Activity

MECH 5502 [0.5 credit] (MCG 5352)
Optimal Control Systems
Review of transfer function and state-space system descriptions. Elements of the optimal control problem. Variational calculus. Optimal state feedback control. Riccati equations. Optimal observers and Kalman-Bucy Filters. Extension to discrete time systems including an introduction to dynamic programming. Practical applications are emphasized throughout the course.

MECH 5503 [0.5 credit] (MCG 5353)
Robotics
The history of and introduction to robotics methodology. Robots and manipulators; homogeneous transformation, kinematic equations, solving kinematic equations, differential relationships, motion trajectories, dynamics. Control; feedback control, compliance, servomotors, actuators, external and internal sensors, grippers and vision systems. Microprocessors and their application to robot control. Programming.

MECH 5504 [0.5 credit] (MCG 5354)
Guidance, Navigation and Control
Guidance system classification, flight control systems, targeting, target tracking, sensing. Modern multivariable control analysis; design requirements, sensitivity, robustness, perturbations, performance analysis. Modern filtering and estimation techniques. Terrestrial navigation; tactical air navigation (TACAN), star trackers Guidance mission and performance. Aircraft, missile and spacecraft guidance and control.

MECH 5505 [0.5 credit] (MCG 5355)
Stability Theory and Applications
Fundamental concepts and characteristics of modern stability definitions. Sensitivity and variational equations; linear variational equations; phase space analysis; Lyapunov's direct method. Autonomous and nonautonomous systems; stability in first approximation; the effect of force type on stability; frequency method.
Also listed as MAAJ 5555.

MECH 5506 [0.5 credit] (MCG 5356)
Neuro and Fuzzy Control
Knowledge-based controllers. Fuzzy control: mathematics, relations, operations, approximate reasoning. Fuzzy knowledge base control and structure. Fuzzification, inference engine, defuzzification. Nonlinear, adaptive fuzzy control systems. Stability, Neuro-control: processing, learning. Adaptation of artificial neural systems: associative memories, algorithms, applications, and network implementation. Neurofuzzy systems: industrial applications.
Precludes additional credit for EACJ 5709 (ELG 5196).

MECH 5507 [0.5 credit] (MCG 5124)
Advanced Kinematics
Algebraic-geometry applications: kinematic calibration of serial and in-parallel robots; kinematic synthesis of planar, spherical, spatial mechanisms. Various DH-parametrisations, Jacobian formulations. Topics in: projective geometry; Cayley-Klein geometries; Plücker line coordinates; Gröbner bases; Grassmannians; kinematic mapping; Burmester theory. Emphasis on practical applications.
Includes: Experiential Learning Activity
Also listed as MAAJ 5557.

MECH 5508 [0.5 credit] (MCG 5326)
System Modelling, Dynamics and Control
The course provides an understanding of system modelling and the connection between energy domains. Within the temporal and/or frequency domains, system identification techniques and control aspects are explored for discrete and continuous systems along with lumped and distributed parameter models.

MECH 5509 [0.5 credit] (MCG 5327)
Nonlinear Systems Analysis & Controls
Introduction to nonlinear systems, stability of periodic solutions and limit cycles. Second-order nonlinear systems. Mathematical foundations for stability analysis, Lyapunov and LaSalle’s methods. Autonomous and non-autonomous systems. Input-Output stability formalisms. Basics of nonlinear control techniques based on Lyapunov methods.

MECH 5601 [0.5 credit] (MCG 5361)
Creative Problem Solving and Design
Problem-solving processes and how they can be applied in engineering design. Emphasis on learning methodologies rather than accumulating information. Techniques can be successfully applied in any engineering specialty.
Also listed as MAAJ 5657.

MECH 5602 [0.5 credit] (AMM 5362)
Failure Prevention (Fracture Mechanics and Fatigue)
Design of engineering structures to ensure against failure due to fatigue or brittle fracture. Nature of fatigue and brittle fracture; selection of suitable material, geometry, and inspection procedures for the load and environmental conditions.
Also listed as MAAJ 5652.

MECH 5603 [0.5 credit] (AMM 5381)
Lightweight Structures
Structural behaviour. Fundamentals of basic elasticity. Energy methods of structural analysis. Bending, shear, and torsion of open and closed multicell structures. Bending of plates. Structural idealization and its effects on open and closed sections. Structural stability.

MECH 5604 [0.5 credit] (AMM 5364)
Computational Metallurgy
Development of microstructure in alloys in solidification processes and post-solidification processing. Nucleation and growth of solid phase. Formation of a dendrite structure, macro and micro segregations. Pore formation in castings. Thermodynamic and kinetics of phase transformations and structure evolution in solid alloys.

MECH 5605 [0.5 credit] (MCG 5365)
Finite Element Analysis I
An introduction to the finite element methodology, with emphasis on applications to heat transfer, fluid flow and stress analysis. The basic concepts of Galerkin's method, interpolation, numerical integration, and isoparametric elements are taught using simple examples.
Also listed as MAAJ 5655.

MECH 5606 [0.5 credit] (MCG 5366)
Finite Element Analysis II
Time marching heat flow problems with linear and nonlinear analysis. Static plasticity. Time-dependent deformation problems; viscoplasticity, viscoelasticity, and dynamic analysis. Isoparametric elements and numerical integration are used throughout.

MECH 5607 [0.5 credit] (MCG 5367)
The Boundary Element Method (BEM)
Integral equations. The BIE for potential theory and for elastostatics in two-dimensions. Boundary elements and numerical integration schemes. Practical applications.
Includes: Experiential Learning Activity
Also listed as MAAJ 5656.

MECH 5609 [0.5 credit] (AMM 5123)
Microstructure and Properties of Materials
Essential microstructural features of metals and alloys: crystal structure, dislocations, grain boundaries. The importance of these features in controlling mechanical properties is emphasized. Analytical techniques observing microstructure in metals and other materials: TEM, SEM, electron diffraction, spectrometry.
Also listed as MAAJ 5659.

MECH 5700 [0.5 credit] (AMM 5345)
Surfaces and Coatings
Surface characteristics of solid materials and surface degradation/failure mechanisms including wear, fretting, oxidation, corrosion, and erosion are introduced. Coating methods including PVD, CVD, laser, thermal spray and electrochemical deposition are discussed in the context of failure prevention measures.
Also listed as MAAJ 5750.

MECH 5701 [0.5 credit] (AMM 5369)
Metallic Phases and Transformations
Thermodynamics of crystals, phase diagrams, principles of alloy phases, thermal analysis. Transformation rate and mechanisms. Short and long range diffusional transformations, diffusionless transformations. Phase transformations in engineering systems.
Also listed as MAAJ 5751.

MECH 5704 [0.5 credit] (AMM 5374)
Integrated Manufacturing Systems (CIMS)
Topics essential to CIMS including computer graphics, geometric modeling, numerically controlled machining, and flexible manufacturing. The fundamental data structures and procedures for computerization of engineering design, analysis and production.
Also offered at the undergraduate level, with different requirements, as MECH 4704, for which additional credit is precluded.

MECH 5705 [0.5 credit] (MCG 5375)
CAD/CAM
Computer aided design and manufacturing methodology through hands-on experience and state-of-the-art software. Topics include mathematical representation, solid modeling, drafting, mechanical assembly, mechanism design and CNC machining. CAD data exchange standards, rapid prototyping, concurrent engineering and design for X are also discussed.

MECH 5800 [0.5 credit] (MCG 5480)
Special Topics in Mechanical and Aerospace Engineering
Topic will vary from year to year.
Also listed as MAAJ 5850.

MECH 5801 [0.5 credit] (MCG 5489)
Special Topics in Mechanical and Aerospace Engineering
Topic will vary from year to year.

MECH 5802 [0.5 credit] (MCG 5483)
Special Topics in Mechanical and Aerospace Engineering
Topic will vary from year to year.
Also listed as MAAJ 5852.

MECH 5803 [0.5 credit] (MCG 5488)
Special Topics in Mechanical and Aerospace Engineering
Topic will vary from year to year.
Also listed as MAAJ 5853.

MECH 5804 [0.5 credit] (MCG 5384)
Special Topics in Mechanical and Aerospace Engineering
Topic will vary from year to year.
Also listed as MAAJ 5854.

MECH 5805 [0.5 credit] (MCG 5482)
Special Topics in Mechanical and Aerospace Engineering
Topic will vary from year to year.
Also listed as MAAJ 5855.

MECH 5806 [0.5 credit] (MCG 5486)
Special Topics in Mechanical and Aerospace Engineering
Topic will vary from year to year.

MECH 5807 [0.5 credit] (MCG 5487)
Special Topics in Mechanical and Aerospace Engineering
Topic will vary from year to year.
Also listed as MAAJ 5857.

MECH 5808 [0.5 credit] (MCG 5376)
Special Topics in Mechanical and Aerospace Engineering
Topic will vary from year to year.
Also listed as MAAJ 5858.

MECH 5809 [0.5 credit] (MCG 5382)
Special Topics in Mechanical and Aerospace Engineering
Topic will vary from year to year.

MECH 5906 [0.5 credit]
Directed Studies

MECH 5908 [1.5 credit] (MCG 5398)
Independent Engineering Study
Students pursuing a master's degree by course work carry out an independent study, analysis, and solution of an engineering problem or design project. The results are given in the form of a written report and presented at a departmental seminar.
Includes: Experiential Learning Activity

MECH 5909 [2.5 credits]
M.A.Sc. Thesis
Includes: Experiential Learning Activity

MECH 6909 [0.0 credit]
Ph.D. Thesis
Includes: Experiential Learning Activity