24 March 2020

Aerospace Stream Selection: Streams A, B, C, D

Carleton UNIVERSITY
Canada's Capital University

Canadian Aerospace
Important Facts and Figures

- **Key early milestones**
  - First powered flight in the Commonwealth – Baddeck, 23 Feb 1909, *AES Silver Dart*
  - Canada was third nation to have its own satellite built and launched – 1962, *Alouette*
- **Aerospace is a national industry with regional clusters**
  - 2/3rd of economic activity in Quebec (45%) and Ontario (25%)
  - Montreal region has third largest concentration of aircraft manufacturing activity in World [1st: Seattle (Boeing). 2nd: Toulouse (Airbus)]

Canadian Aerospace Important Facts and Figures

- **Canada is a Global leader in:**
  - Civil helicopters
  - Small gas turbines
  - Simulators
  - Regional aircraft, business jets
  - Avionics
  - Landing gear systems,
  - Small and microsatellites
  - Maintenance

Suppliers

4 x Canadian OEM's

- **Economic impact (Ref AIAC Aerospace Economic Impact, 2018)**
  - ~90k employees, $32B in revenue (~80% from exports)
  - Employment normalized to population – 2nd versus all other nations (France is 1st)
  - Revenue normalized to GDP - 2nd versus all other nations (U.S. is 1st)

Aerospace at Carleton

- First BEng program in Canada (1988) and largest by enrolment

  (457 in 2020 vs. 30 in 1992)

- Four streams

  A - Aerodynamics, Propulsion and Vehicle Performance

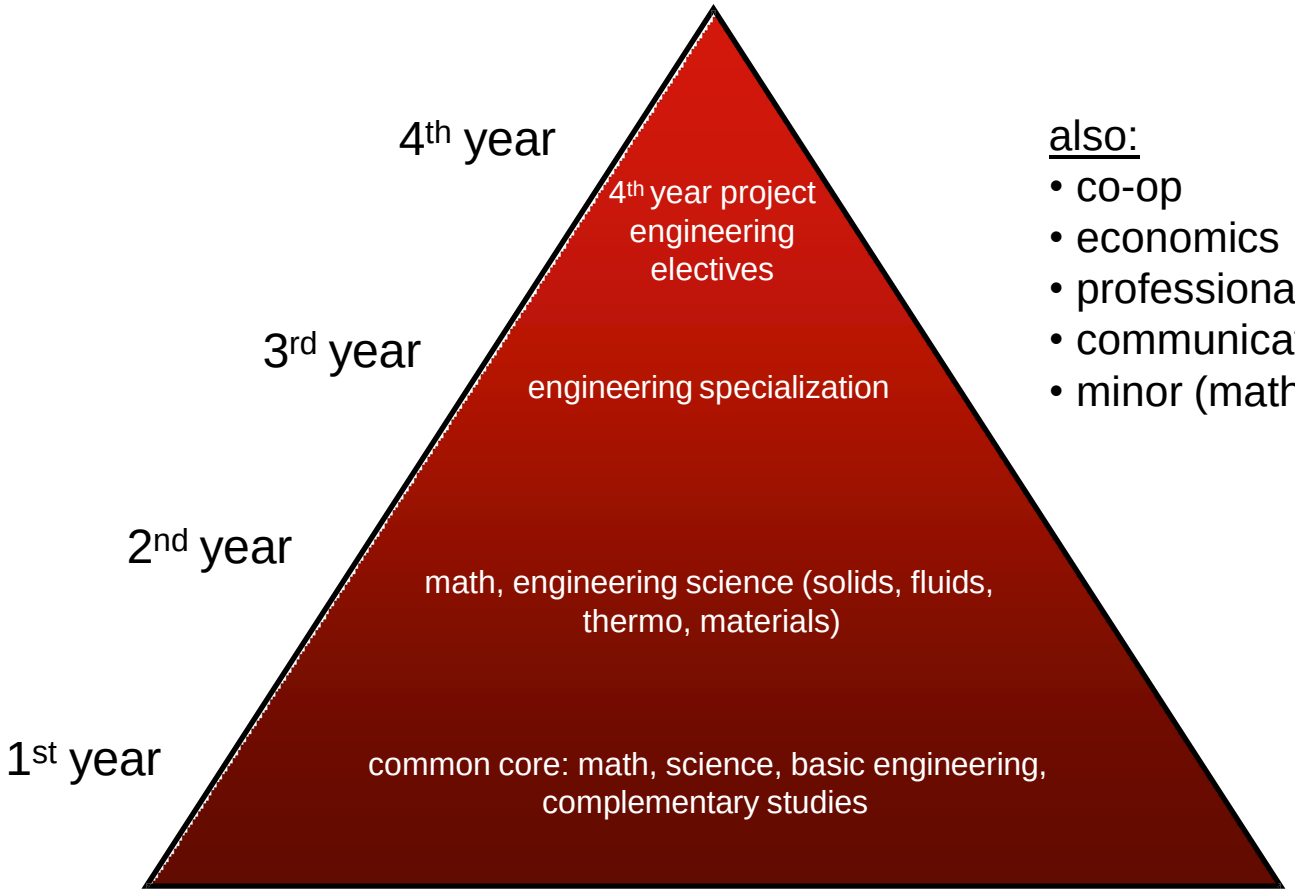
  B - Aerospace Structures, Systems and Vehicle Design

  C - Aerospace Electronics and Systems

  D - Space Systems Design

- Originally only Stream A and B
  - Stream C added in the early 1990's
  - Stream D added in 2007-08

Engineering Education

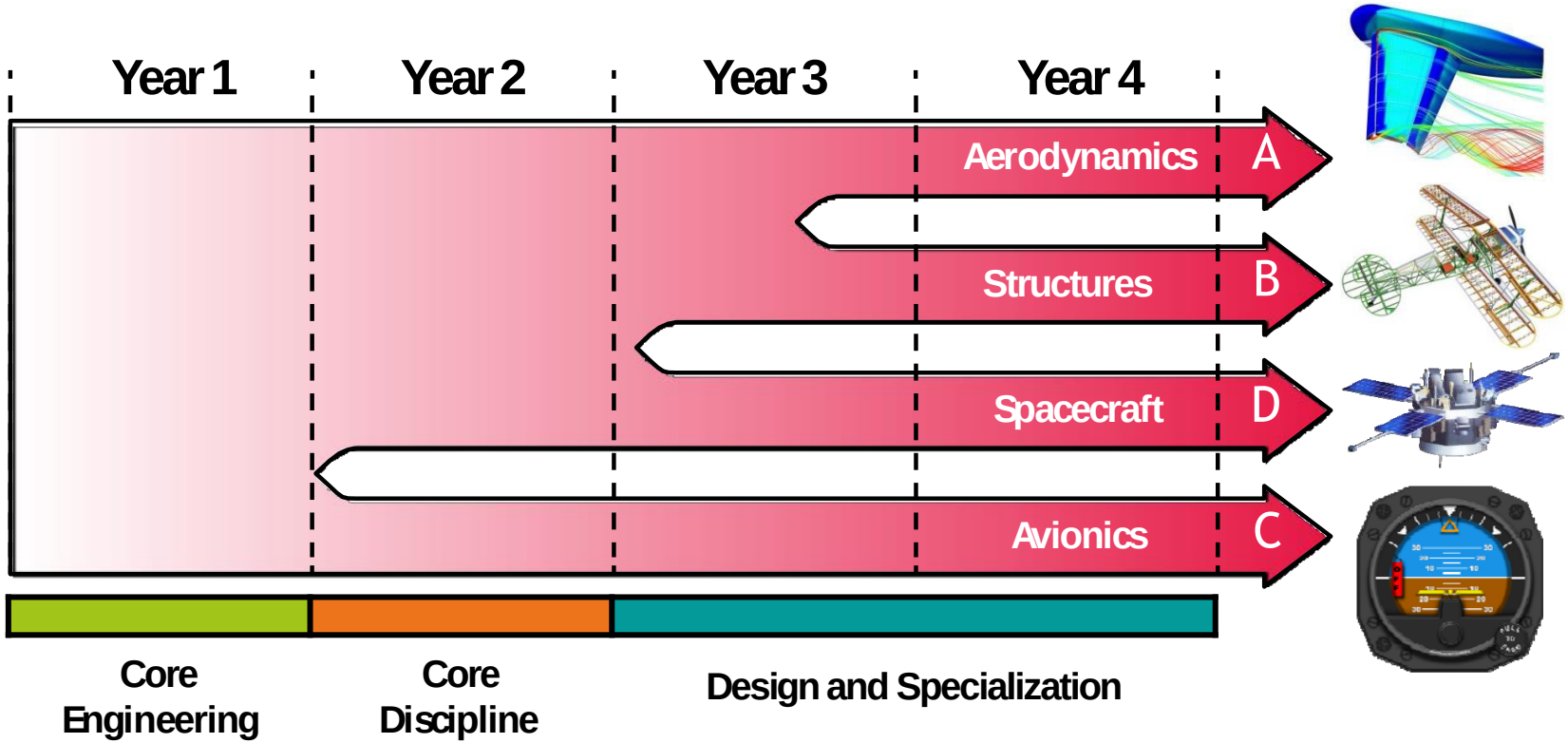


also:

- co-op
- economics
- professional practice
- communication skills
- minor (math, business, etc.)

Aerospace Streams

Overview of Bachelor Programs



Stream C is offered in cooperation with Electronic Engineering

Core Aerospace Courses

Most or all AERO students take

- AERO 2001 Engineering Graphical Design
- MAAE 2101 Engineering Dynamics
- MAAE 2202 Mechanics of Solids I
- MAAE 2300 Fluid Mechanics I
- MAAE 2400 Thermodynamics and Heat Transfer
- MAAE 2700 Engineering Materials
- MATH 1005 Differential Equations
- MATH 2004 Multivariable Calculus
- ECOR 2050 Design and Analysis of Engineering Experiments

- AERO 3002 Aero Design and Practice
- AERO 3700 Aerospace Materials
- AERO 4003 Systems Design
- MAAE 3004 Dynamics of Machinery
- MAAE 3300 Fluid Mechanics II
- MAAE 3500 Feedback Control Systems
- MATH 3705 Mathematical Methods I
- ECOR 3800 Engineering Economics

- MAAE 4907 (Capstone Design Project)
- many stream-specific courses that can be taken as electives (space permitting)

Jobs in Aerospace Engineering

Overview of Bachelor Programs

Aircraft Design

Rotorcraft Design

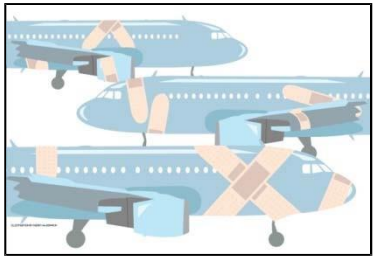
Satellite & Space Robotic Design

Simulators

Aerospace Systems

Gas Turbine Engines

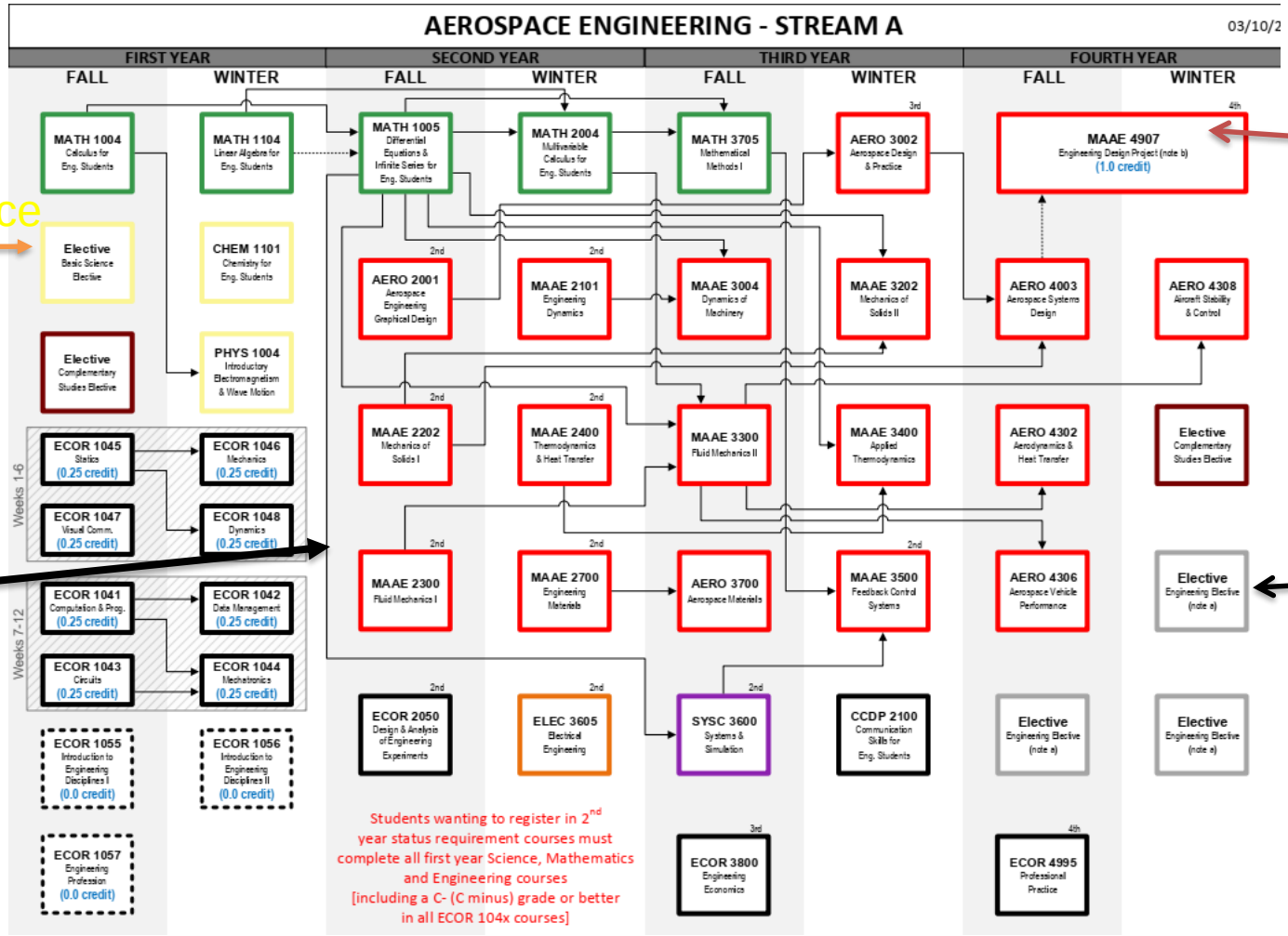
Maintenance, Repair, & Overhaul



How to read the Engineering "Tree"

Basic Science Elective

Beware of Pre-requisites!



Final Year Project

Engineering Electives

Stream A

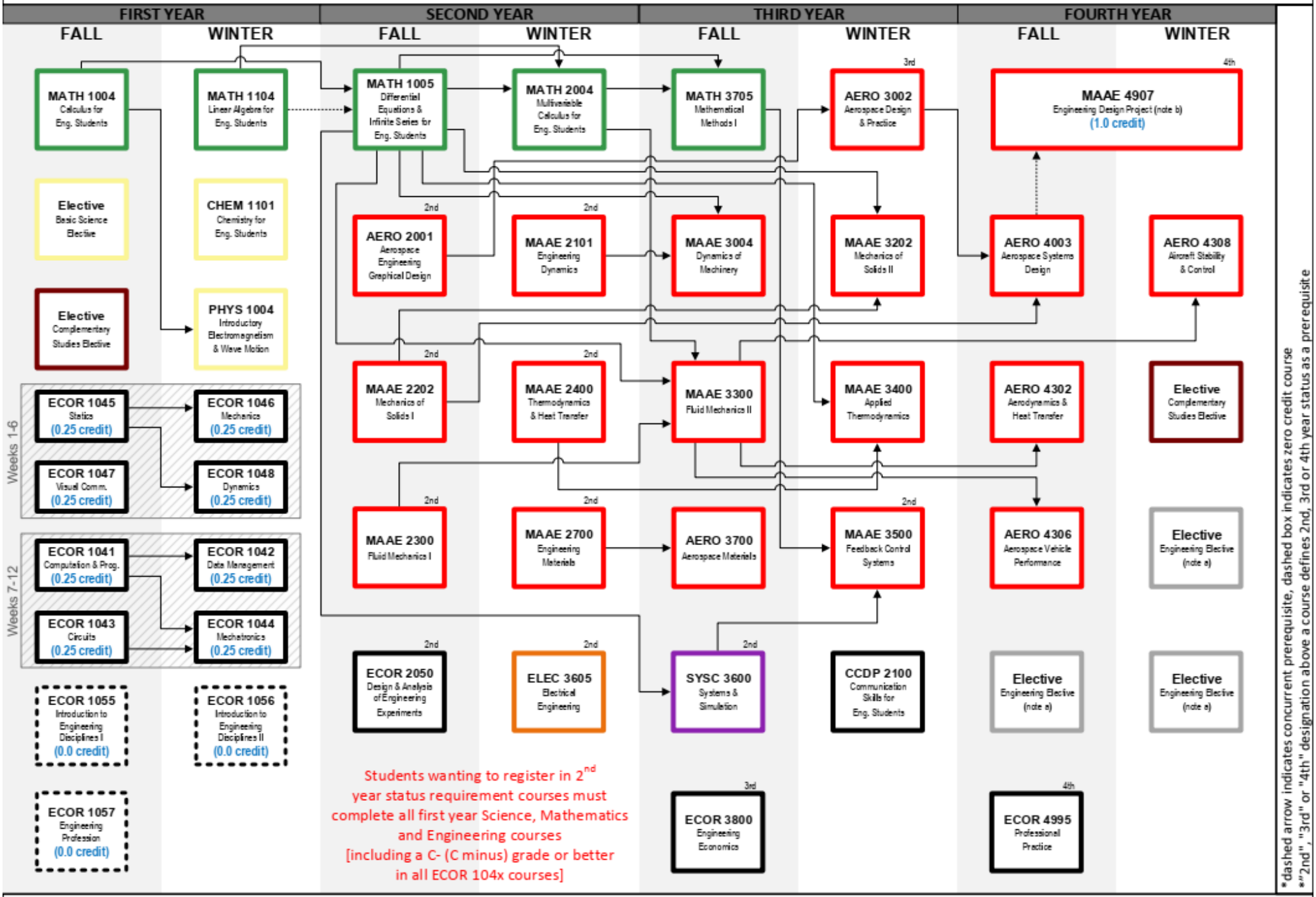
Aerodynamics, Propulsion & Vehicle Performance

- Sample stream-specific courses
  - Aerodynamics and Heat Transfer
  - Aerospace Vehicle Performance
  - Aircraft Stability and Control
- Typical electives
  - Computational Fluid Dynamics (CFD)
  - Rotorcraft Aerodynamics and Performance
  - Aerolasticity
  - Aeroacustics

- Example Careers
  - Aerodynamicist
  - Computational fluid dynamics engineer
  - Aircraft conceptual design
  - Aeroealstic analysis engineer
  - Aeroacustics engineer
  - Flight test engineer
  - Stability and handling prediction
  - Performance prediction engineer
  - Jet engine aerodynamic designer
  - Launch vehicle aerodynamicist
  - Other:
    - wind energy
    - ground vehicle aerodynamics
    - building aerodynamics, etc.

AEROSPACE ENGINEERING - STREAM A

03/10/2020



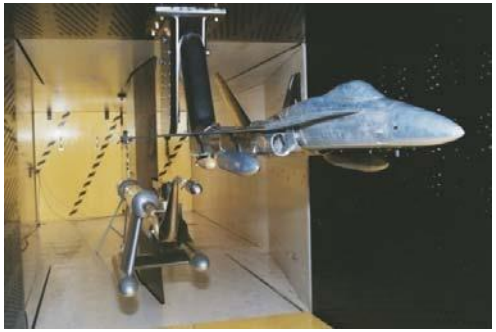
- Engineering Common Core
- Arts and Social Sciences
- Science (Physics, Chemistry, etc)
- Mech. & Aerospace Engineering
- Civil & Environmental Engineering
- Systems & Computer Engineering
- Electronics
- Mathematics & Statistics
- Electives

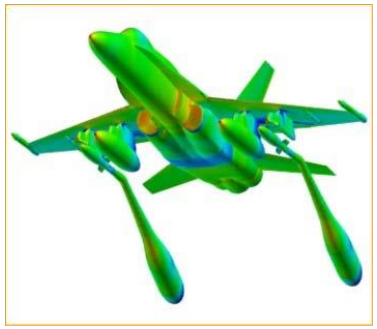
Notes:

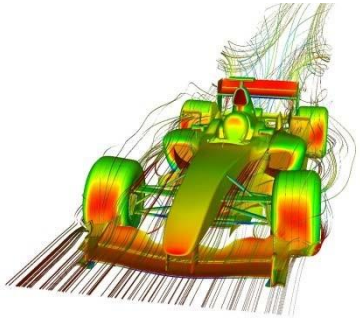
(a) 1.5 credits in Mechanical and Aerospace Engineering (MAAE, AERO or MECH) at the 4000-level or ELEC 4504 or ELEC 4602.

(b) Students must complete all first and second year courses, as well as 3.5 credits of third year courses (with the exception of Complementary Studies Elective) to enroll in MAAE 4907 (Eng. Design Project).

Key Industry and Research Opportunities







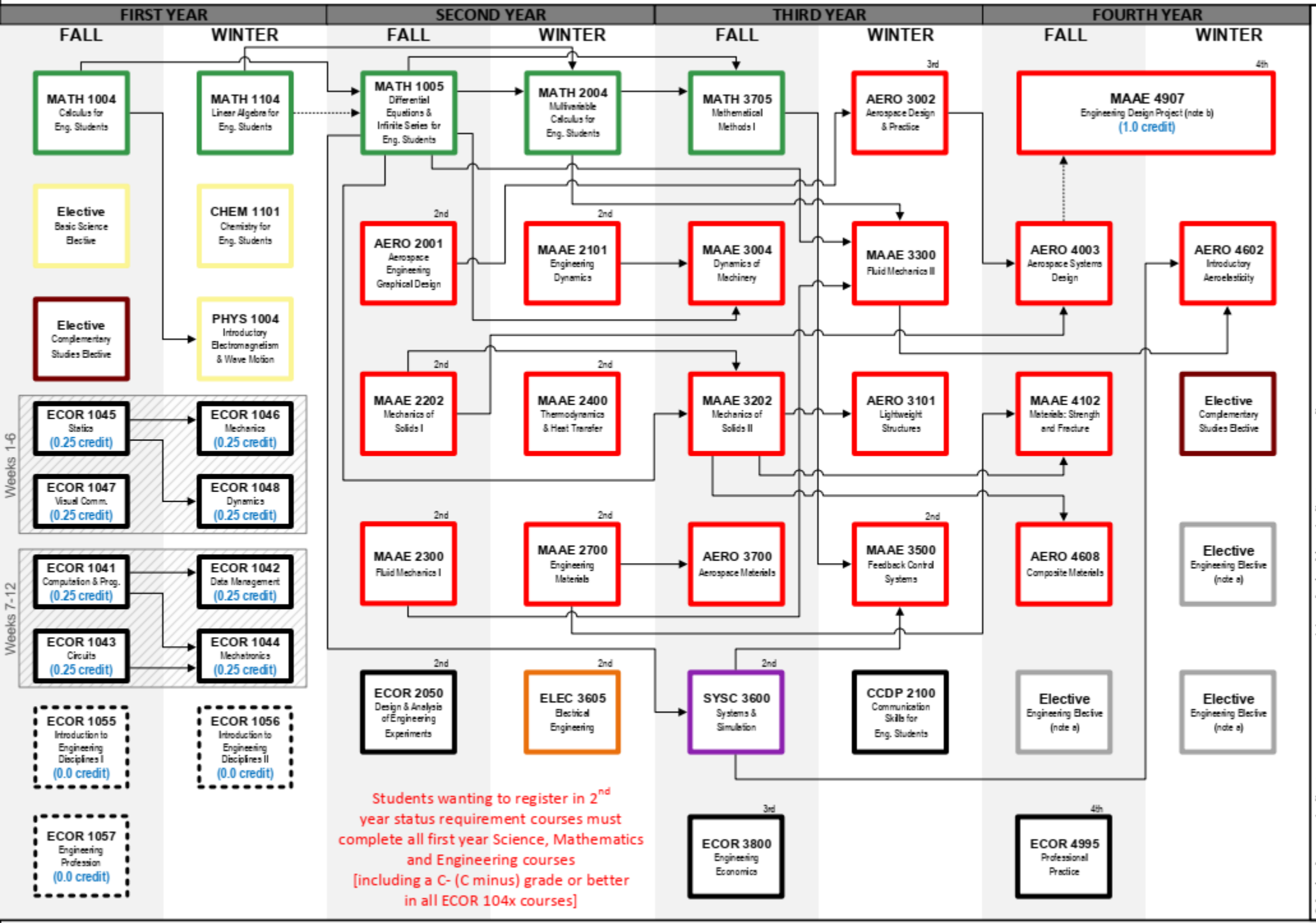
Stream B

Aerospace Structures, Systems and Vehicle Design

- Sample stream-specific courses
  - Aerospace Materials
  - Lightweight Structures
  - Composite Materials
  - Aeroelasticity
  - Strength and Fracture
- Typical electives
  - Finite Element Methods
  - Rotorcraft Aerodynamics and Performance
  - Rocket Design
- Example careers
  - Airframe structural engineer
  - Computational structural dynamicist
  - Conceptual design
  - Aeroelastics engineer
  - Aircraft mechanical systems
  - Landing gear
  - Engine structural design
  - Manufacturing engineer
  - Spacecraft structural design
  - Other:
    - Wind turbine structural design
    - transportation structures

AEROSPACE ENGINEERING - STREAM B

03/10/2020



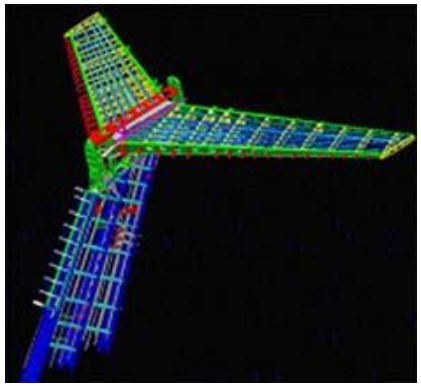
Engineering Common Core
Arts and Social Sciences
Science (Physics, Chemistry, etc)
Mech. & Aerospace Engineering
Civil & Environmental Engineering
Systems & Computer Engineering
Electronics
Mathematics & Statistics
Electives

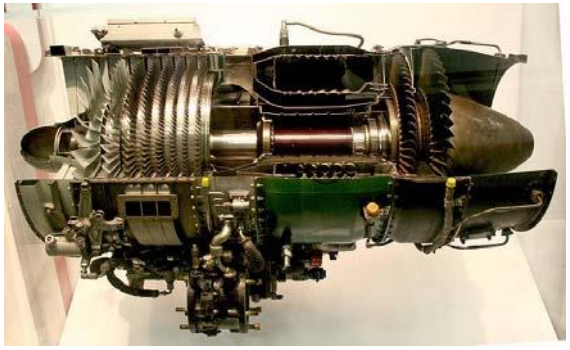
Notes:

(a) 1.5 credits in Mechanical and Aerospace Engineering (MAAE, AERO or MECH) at the 4000-level or ELEC 4504 or ELEC 4602.

(b) Students must complete all first and second year courses, as well as 3.5 credits of third year courses (with the exception of Complementary Studies Elective) to enroll in MAAE 4907 (Eng. Design Project).

Key Industry and Research Opportunities





Stream C

Aerospace Electronics and Systems

- **Sample stream-specific courses**
  - Communication Theory
  - Electromagnetic waves
  - Digital Electronics
  - Power Engineering

  Typical Electives:

  - Any from Electronics or MAE

- **Example careers**
  - Avionics engineer
  - Systems engineering
  - Fly-by-wire flight controls
  - Unmanned aerial systems
  - Airborne remote sensing
  - Engine controls
  - Spacecraft communications
  - Terrestrial telecommunications
  - Power generation

AEROSPACE ENGINEERING - STREAM C

03/10/2020

FIRST YEAR		SECOND YEAR		THIRD YEAR		FOURTH YEAR	
FALL	WINTER	FALL	WINTER	FALL	WINTER	FALL	WINTER
MATH 1004 Calculus for Eng. Students	MATH 1104 Linear Algebra for Eng. Students	MATH 1005 Differential Equations & Infinite Series for Eng. Students	MATH 2004 Multivariable Calculus for Eng. Students	MATH 3705 Mathematical Methods I	ELEC 3909 Electromagnetic Waves (3rd)	MAAE 4907 Engineering Design Project (note b) (1.0 credit) (4th)	
Elective Basic Science Elective	CHEM 1101 Chemistry for Eng. Students	ELEC 2501 Circuits & Signals (2nd)	ELEC 2507 Electronics I (2nd)	ELEC 3105 Basic EM & Power Engineering (2nd)	AERO 3002 Aerospace Design & Practice	AERO 4003 Aerospace Systems Design	ELEC 4504 Avionics Systems (4th)
Elective Complementary Studies Elective	PHYS 1004 Introductory Electromagnetism & Wave Motion	MAAE 2101 Engineering Dynamics (2nd)	ELEC 2607 Switching Circuits (2nd)	ELEC 3500 Digital Electronics	MAAE 2300 Fluid Mechanics I (2nd)	MAAE 2400 Thermodynamics & Heat Transfer (2nd)	SYSC 3501 Communication Theory
Weeks 1-6: ECOR 1045 Statics (0.25 credit)	ECOR 1046 Mechanics (0.25 credit)	MAAE 2202 Mechanics of Solids I (2nd)	AERO 2001 Aerospace Engineering Graphical Design (2nd)	ELEC 3509 Electronics II	MAAE 3500 Feedback Control Systems (2nd)	Elective Engineering Elective (note a)	Elective Complementary Studies Elective
Weeks 1-6: ECOR 1047 Visual Comm. (0.25 credit)	ECOR 1048 Dynamics (0.25 credit)	ECOR 2050 Design & Analysis of Engineering Experiments (2nd)	MAAE 2700 Engineering Materials (2nd)	SYSC 3600 Systems & Simulation (2nd)	CCDP 2100 Communication Skills for Eng. Students	Elective Engineering Elective (note a)	Elective Engineering Elective (note a)
Weeks 7-12: ECOR 1041 Computation & Prog. (0.25 credit)	ECOR 1042 Data Management (0.25 credit)	ECOR 3800 Engineering Economics (3rd)				ECOR 4995 Professional Practice (4th)	
Weeks 7-12: ECOR 1043 Circuits (0.25 credit)	ECOR 1044 Mechatronics (0.25 credit)						
ECOR 1055 Introduction to Engineering Disciplines I (0.0 credit)	ECOR 1056 Introduction to Engineering Disciplines II (0.0 credit)						
ECOR 1057 Engineering Profession (0.0 credit)							

Students wanting to register in 2nd year status requirement courses must complete all first year Science, Mathematics and Engineering courses [including a C- (C minus) grade or better in all ECOR 104x courses]

*dashed arrow indicates concurrent prerequisite, dashed box indicates zero credit course
*"2nd", "3rd", or "4th" designation above a course defines 2nd, 3rd or 4th year status as a prerequisite

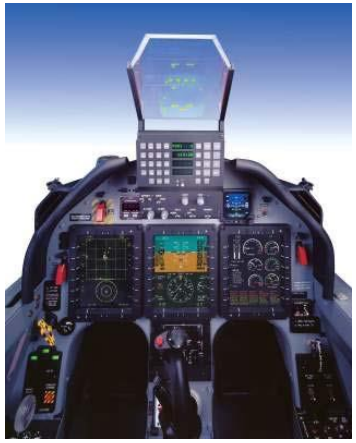
Engineering Common Core
Arts and Social Sciences
Science (Physics, Chemistry, etc)
Mech. & Aerospace Engineering
Civil & Environmental Engineering
Systems & Computer Engineering
Electronics
Mathematics & Statistics
Electives

Notes:

(a) 1.5 credits in Mechanical and Aerospace Engineering (MAAE, AERO or MECH) at the 4000-level or AERO 3240, AERO 3841, ELEC 4502, ELEC 4503, ELEC 4505, ELEC 4506, ELEC 4509, ELEC 4600, ELEC 4602, ELEC 4609, ELEC 4703, ELEC 4706, ELEC 4707, ELEC 4708, ELEC 4709, SYSC 4205, SYSC 4600 or SYSC 4607

(b) Students must complete all first and second year courses, as well as 3.5 credits of third year courses (with the exception of Complementary Studies Elective) to enroll in MAAE 4907 (Eng. Design Project).

Key Industry and Research Opportunities



Stream D

Space Systems Design

Sample stream-specific courses

- Orbital Mechanics
- Spacecraft Design I and II
- Spacecraft Attitude Dynamics and Control
- Transatmospheric and Spacecraft Propulsion

Typical Electives:

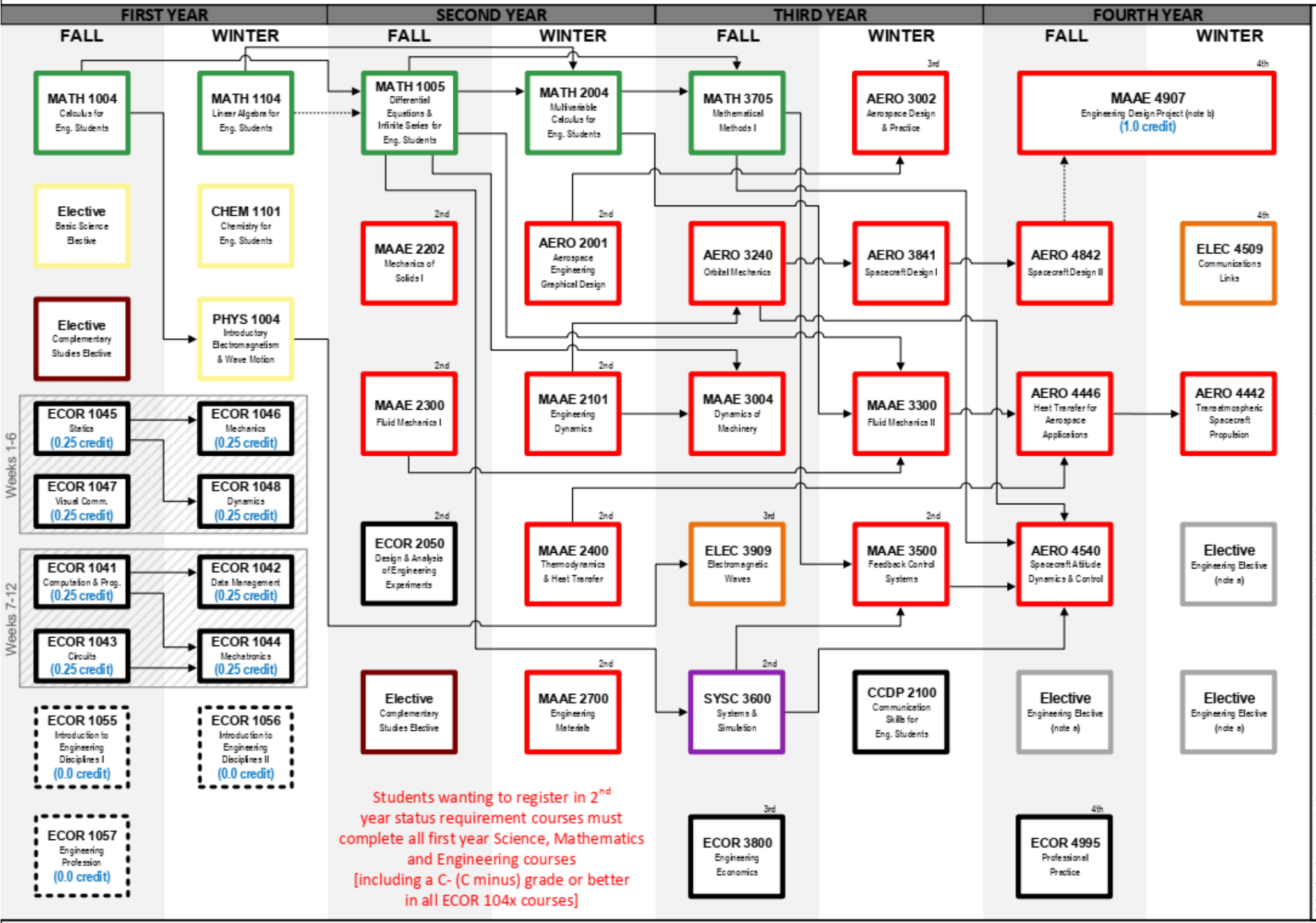
- Any from MAE

Example careers

- Satellite Operations – Telesat, Kepler, CSA/SED, Planet
- Systems Engineering – UTIAS/SFL (employees, not students), Telesat, Kepler, MDA, Comdev/Honeywell
- Satellite Design, build and test – MDA, Magellan
- Launch Vehicle Engineering and Management – SpaceX, Rocketlab
- Government research – CSA/DFL, NRC

AEROSPACE ENGINEERING - STREAM D

03/10/2020



Engineering Common Core
Arts and Social Sciences
Science (Physics, Chemistry, etc)
Mech. & Aerospace Engineering
Civil & Environmental Engineering
Systems & Computer Engineering
Electronics
Mathematics & Statistics
Electives

Notes:

(a) 1.5 credits in Mechanical and Aerospace Engineering (MAAE, AERO or MECH) at the 4000-level or AERO 3101, AERO 3700, ELEC 4503, ELEC 4600 or ELEC 4709.

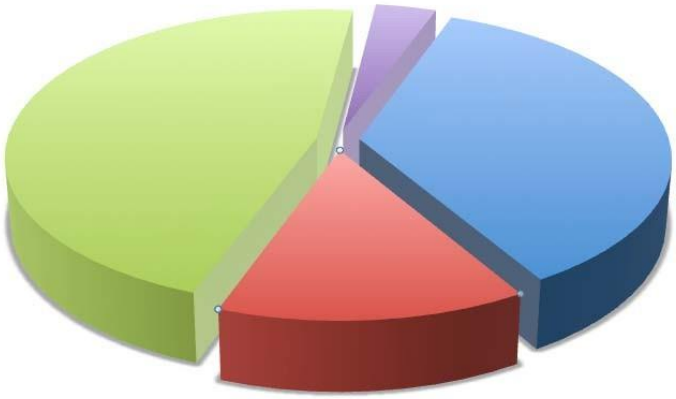
(b) Students must complete all first and second year courses, as well as 3.5 credits of third year courses (with the exception of Complementary Studies Elective) to enroll in MAAE 4907 (Eng. Design Project).

Key Industry and Research Opportunities

What is Our Makeup?

Department of Mechanical & Aerospace Engineering

- Single, integrated department (not two separate parts)
- Approximately 1300 undergraduate students
  - 2019 first year admissions (total 365)



- Mechanical
- Biomedical and Mechanical
- Aerospace
- SREE

- Entering minimum averages: 83% Aerospace, 76% Mechanical
- 41 full-time Professors + 22 Adjunct Professors + 5 Emeritus Professors

Engineering Co-op Program

Department of Mechanical & Aerospace Engineering

- Co-op option available for all programs
- 30% of students in co-op
- 4, 8, 12, and 16 month placement options
- Placement options after 2nd year
- 12 or 16 month placement after 3rd year most popular

Year	Fall	Winter	Summer
1	Study 1	Study 2	Optional Work
2	Study 3	Study 4	Optional Work
3	Study 5	Study 6	Work
4	Work	Work	Work
5	Study 7	Study 8	

Currently 12 Capstone Design Projects

- Fixed-Wing Unmanned Air Vehicle
- Satellite Design Project
- UAV - Blended-Wing
- FSAE Formula Car
- Carleton University Simulator Project
- Gas Turbine
- Building Integrated Thermal Energy Systems
- Crash Test Dummy
- Intelligent Telepresence and Assistive Devices
- Biomass Reactor
- Sustainable Energy Systems Portfolio
- Integrated Autonomous Car