UNIVERSITY OF NOTRE DAME

Department of Aerospace & Mechanical Engineering Undergraduate Handbook

2020-2021

Academic Year

(Revised on 4/25/2021)

AME Department
Contact Information

Title	Name	Contact Information
Department Chair	David Go	EMAIL: dgo@nd.edu PHONE: 574-631-8394 OFFICE: 365A Fitzpatrick Hall
Associate Department Chair	James Schmiedeler	EMAIL: jschmie1@nd.edu PHONE: 574-631-6403 OFFICE: 365B Fitzpatrick Hall
Director of Undergraduate Studies (DUS)	Bill Goodwine	EMAIL: jgoodwine@nd.edu PHONE: 574-631-3283 OFFICE: 376 Fitzpatrick Hall
Assistant Director of Undergraduate Studies (ADUS)	Jing Wang	EMAIL: jwang35@nd.edu PHONE: 574-631-7073 OFFICE: 361A Fitzpatrick Hall
Undergraduate Academic Program Administrator	Donna Fecher	EMAIL: dfecher@nd.edu PHONE: 574-631-5432 OFFICE: 365 Fitzpatrick Hall

Contents

1 Advising Information

1.1 The Undergraduate Academic Program Administrator

Mrs. Donna Fecher can help if you need:

- Directions on when and how to initiate eForms to:
- Add or drop a class
- AME course registration overrides
- Change majors, including adding a minor or concentration to existing major
- Clarification and confirmation of information on the AME Web Page
- GPS adjustments pertaining to AME major requirements

1.2 The Directors of Undergraduate Studies

Prof. Bill Goodwine or Prof. Jing Wang are the best resource for specifics about the AE or ME major:

- Planning for International Studies, except summer
- Dual degree programs
- Pre-professional students
- Course substitutions
- Advice on transfer credit for courses taken at another institution
- Graduate fellowship opportunities
- What, if anything, can be double-counted for various types of requirements
- CPT/OPT issues

1.3 The Assistant Dean for Advising and Academic Affairs

Assistant Dean Mike Ryan can help if you have:

- Issues related to academic probation or dismissal
- Course withdrawal after drop date
- Leaves of absence from University
- Course overload approval (19+ credit hours/semester)
- S/U grading approval

1.4 Faculty Advisors

They are the best resource for general, “big picture” discussions:

- Student and department expectations for the college experience
- Discernment: is AE or ME the right major?
- Choosing electives
- Choosing minors and concentrations
- Research opportunities in AME
- Career aspirations
- Graduate school aspirations

Students are expected to meet with their assigned Faculty Advisor at least one time each semester. You can find your advisor's name from Graduation Progress System (GPS).

1.5 AME Web Page

The Undergraduate webpage is the best resource for:

- Standard major planning: degree requirements for AE and ME programs
- Course prerequisites
- Courses satisfying minor and concentration requirements
- Information that may predict (somewhat) years in which certain electives may be offered

1.6 Other Resources

The Course Catalog on InsideND is the best resource for:

- Course descriptions
- Course attributes, which indicate what requirements a course satisfies, e.g., AME Technical Elective, writing requirement, etc.

University Health Services

The Career Center is the best resource for:

- Opportunities available at specific companies
- Scheduling interviews
- Resume preparation
- Mock interviews

University Student Affairs

Office of Community Standards

2 Course Plans

2.1 Aerospace Engineering Course Plan (Class of 2022 & 2023)

The following four-year course plan is for Sophomore (Class of 2023) and Junior (Class of 2022) students in Aerospace Engineering (AE). Students need to take Notre Dame Core Curriculum to fulfill the University Core Requirements.

AE students are required to take two AE Technical Specialization courses (6 credit) and one AE Professional Development course (3 credit) to fulfill the degree elective requirements.

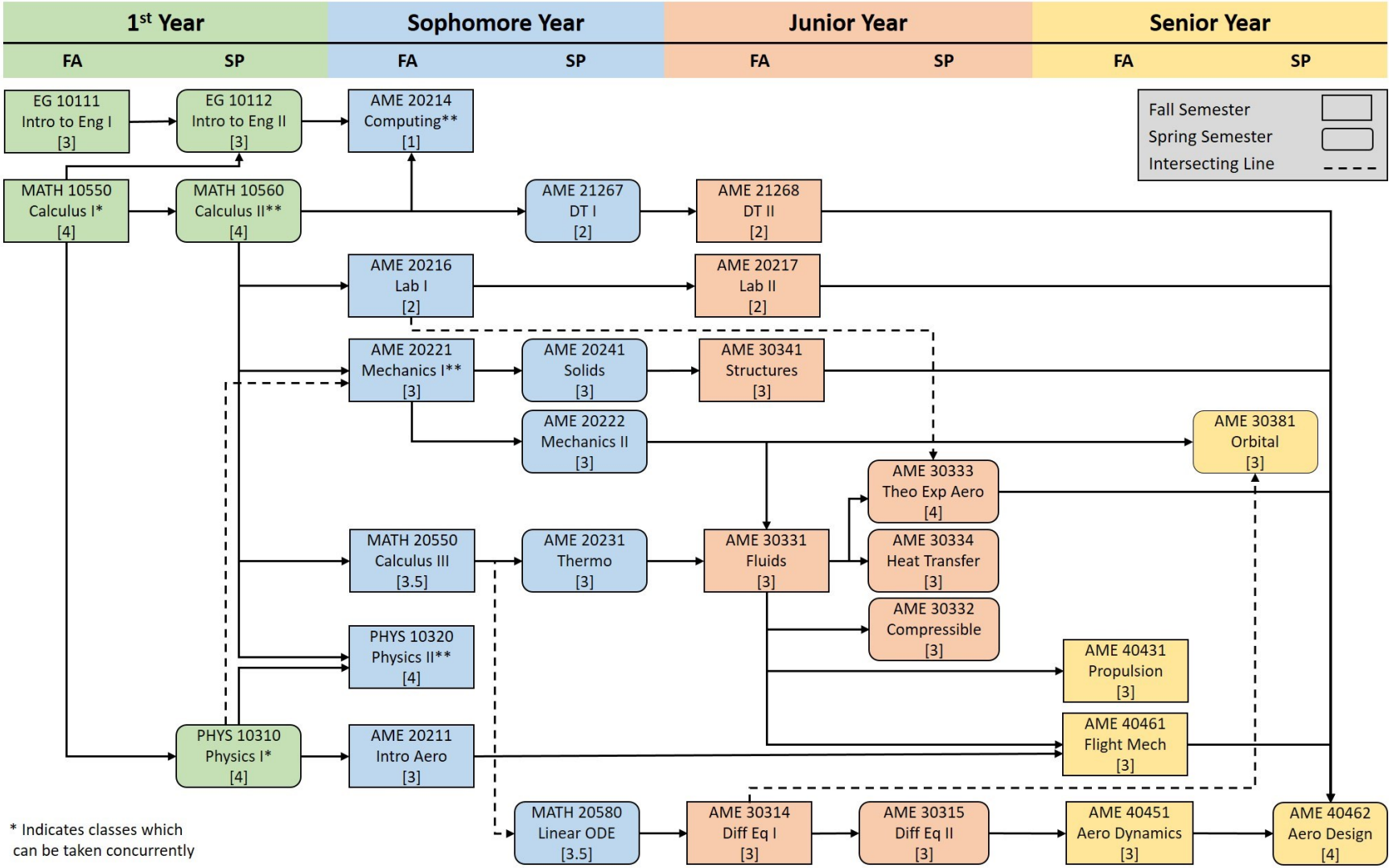
First Year					
Fall Semester			**Spring Semester**		
MATH 10550	Calculus I	4	MATH 10560	Calculus II	4
CHEM 10171	Intro to Chemical Principles	4	CHEM 10122	General Chemistry	3
EG 10111	Intro to Engineering Systems I	3	EG 10112	Intro to Engineering Systems II	3
	Core Curriculum Course	3	PHYS 10310	Engineering Physics I: Mechanics	4
USEM Or WR 13100	University Seminar Writing & Rhetoric	3	USEM Or WR 13100	University Seminar Writing & Rhetoric	3
FYS 10101	Moreau 1st Year Experience	1	FYS 10102	Moreau First Year Experience	1
	Total:	**18**		**Total:**	**18**

Sophomore Year					
Fall Semester			**Spring Semester**		
MATH 20550	Calculus III	3.5	MATH 20580	Intro to Linear Algebra and Differential Equations	3.5
PHYS 10320	Engineering Physics II: Electromagnetism	4	AME 20231	Thermodynamics	3
AME 20221	Mechanics I	3	AME 20222	Mechanics II	3
AME 20216 Or AME 21267	Lab I Design Tools I	2	AME 20216 Or AME 21267	Lab I Design Tools I	2
AME 20211	Intro to Aeronautics	3	AME 20241	Solid Mechanics	3
AME 20214	Intro to Engineering Computing	1		Core Curriculum Course	3
	Total:	**16.5**		**Total:**	**17.5**

Junior Year					
Fall Semester			**Spring Semester**		
AME 21267	Design Tools II	2	AME 30332	Compressible Aerodynamics	3
AME 20217	Lab II	2	AME 30333	Theoretical and Experimental Aerodynamics	4
AME 30314	Differential Equations, Vibrations and Controls I	3	AME 30315	Differential Equations, Vibrations and Controls II	3
AME 30331	Fluid Mechanics	3	AME 30334	Heat Transfer	3
AME 30341	Aerospace Structures	3		Core Curriculum Course	3
	Core Curriculum Course	3			
	Total:	**16**		**Total:**	**16**

Senior Year					
Fall Semester			**Spring Semester**		
AME 40431	Gas Turbines and Propulsion	3	AME 30381	Orbital and Space Dynamics	3
AME 40451	Aerospace Dynamics	3	AME 40462	Aerospace Design	4
AME 40461	Flight Mechanics and Introduction to Design	3		AE Technical Specialization	3
	AE Technical Specialization	3		AE Professional Development	3
	Core Curriculum Course	3		Core Curriculum Course	3
	Total:	**15**		**Total:**	**16**

2.2 Aerospace Engineering Curriculum Prerequisite Map (Class of 2022 & 2023)



2.3 Aerospace Engineering Course Plan (Class of 2024)

The following four-year course plan is for 1st year students (Class of 2024) students in Aerospace Engineering (AE). Students need to take Notre Dame Core Curriculum to fulfill the University Core Requirements.

AE students are required to take two AE Technical Specialization courses (6 credit) and one AE Professional Development course (3 credit) to fulfill the degree elective requirements.

First Year					
Fall Semester			**Spring Semester**		
MATH 10550	Calculus I	4	MATH 10560	Calculus II	4
CHEM 10171	Intro to Chemical Principles	4	CHEM 10122	General Chemistry	3
EG 10114	Engineering Discernment	1	EG 10116	Engineering Programming	3
EG 10115	Engineering Projects*[1]	2	PHYS 10310	Engineering Physics I: Mechanics	4
USEM Or WR 13100	University Seminar Writing & Rhetoric	3	USEM Or WR 13100	University Seminar Writing & Rhetoric	3
FYS 10101	Moreau First Year Experience	1	FYS 10102	Moreau First Year Experience	1
	Core Curriculum Course	3			
	Total:	**18**		**Total:**	**18**

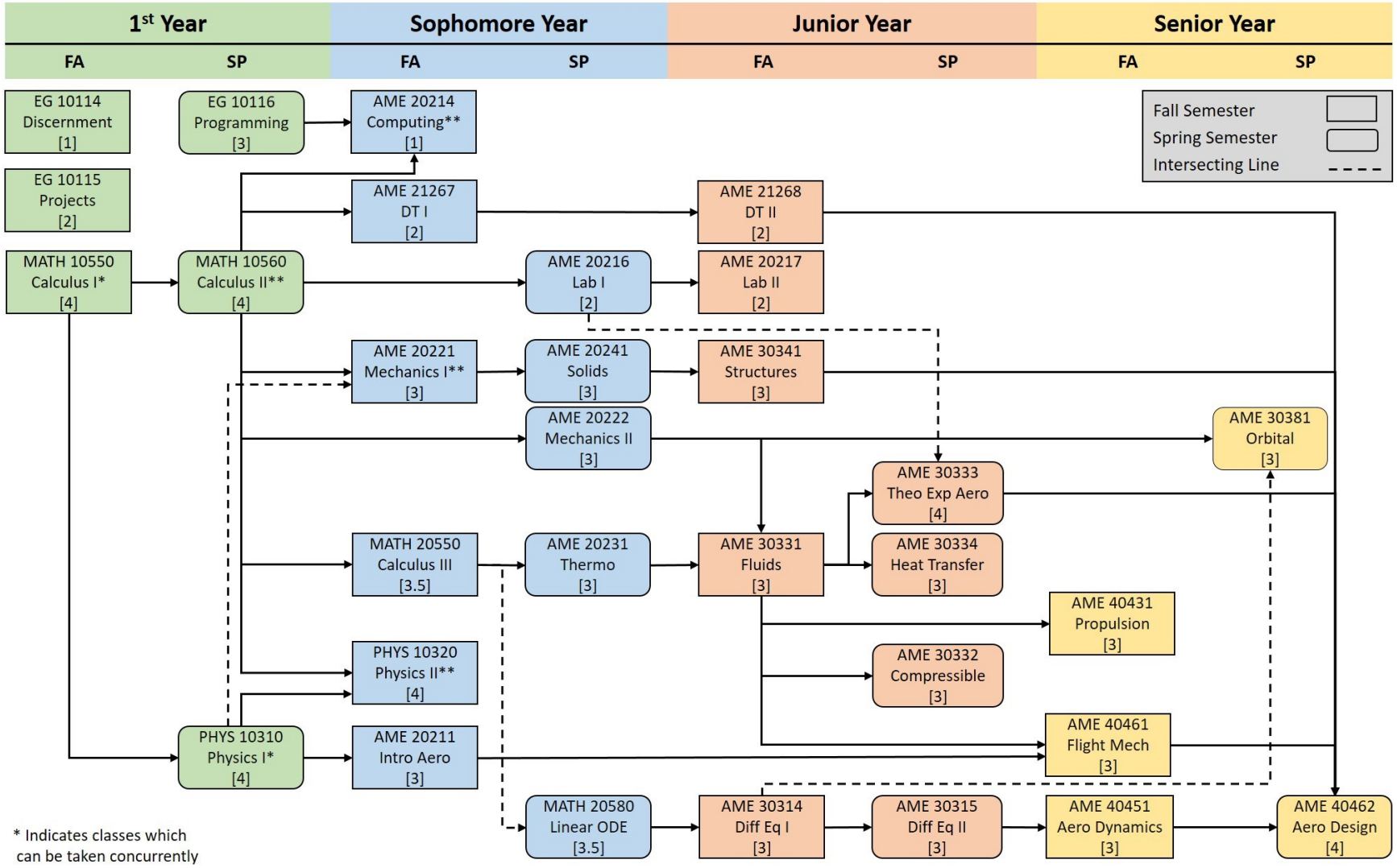
Sophomore Year					
Fall Semester			**Spring Semester**		
MATH 20550	Calculus III	3.5	MATH 20580	Intro to Linear Algebra and Differential Equations	3.5
PHYS 10320	Engineering Physics II: Electromagnetism	4	AME 20231	Thermodynamics	3
AME 20221	Mechanics I	3	AME 20222	Mechanics II	3
AME 20216 Or AME 21267	Lab I Design Tools I	2	AME 20216 Or AME 21267	Lab I Design Tools I	2
AME 20211	Intro to Aeronautics	3	AME 20241	Solid Mechanics	3
AME 20214	Intro to Engineering Computing	1		Core Curriculum Course	3
	Total:	**16.5**		**Total:**	**17.5**

*[1] *Any department projects course could substitute for this course.*

Junior Year					
Fall Semester			**Spring Semester**		
AME 30314	Differential Equations, Vibrations and Controls I	3	AME 30315	Differential Equations, Vibrations and Controls II	3
AME 20217	Lab II	2	AME 30332	Compressible Aerodynamics	3
AME 21268	Design Tools II	2	AME 30333	Theoretical and Experimental Aerodynamics	4
AME 30331	Fluid Mechanics	3	AME 30334	Heat Transfer	3
AME 30341	Aerospace Structures	3		Core Curriculum Course	3
	Core Curriculum Course	3			
	Total:	**16**		**Total:**	**16**

Senior Year					
Fall Semester			**Spring Semester**		
AME 40431	Gas Turbines and Propulsion	3	AME 30381	Orbital and Space Dynamics	3
AME 40451	Aerospace Dynamics	3	AME 40462	Aerospace Design	4
AME 40461	Flight Mechanics and Introduction to Design	3		AE Professional Development	3
	AE Technical Specialization	3		AE Technical Specialization	3
	Core Curriculum Course	3		Core Curriculum Course	3
	Total:	**15**		**Total:**	**16**

2.4 Aerospace Engineering Curriculum Prerequisite Map (Class of 2024)



2.5 Aerospace Engineering Course Plan (Class of 2025+)

The following four-year course plan is for prospective students (Class of 2025+) students in Aerospace Engineering (AE). Students need to take Notre Dame Core Curriculum to fulfill the University Core Requirements.

AE students are required to take two AE Technical Specialization courses (6 credit) and one AE Professional Development course (3 credit) to fulfill the degree elective requirements.

AE students are required to take AME 20210 Intro to Design Thinking in Engineering before taking AME 21267 Design Tools I (DT I).

First Year					
Fall Semester			**Spring Semester**		
MATH 10550	Calculus I	4	MATH 10560	Calculus II	4
CHEM 10171	Intro to Chemical Principles	4		AE Professional Development Or Core Curriculum Course	3
EG 10114	Engineering Discernment	1	EG 10116	Engineering Programming	3
EG 10115	Engineering Projects*[2]	2	PHYS 10310	Engineering Physics I: Mechanics	4
USEM Or WR 13100	University Seminar Writing & Rhetoric	3	USEM Or WR 13100	University Seminar Writing & Rhetoric	3
FYS 10101	Moreau First Year Experience	1	FYS 10102	Moreau First Year Experience	1
	Core Curriculum Course	3			
	Total:	**18**		**Total:**	**18**

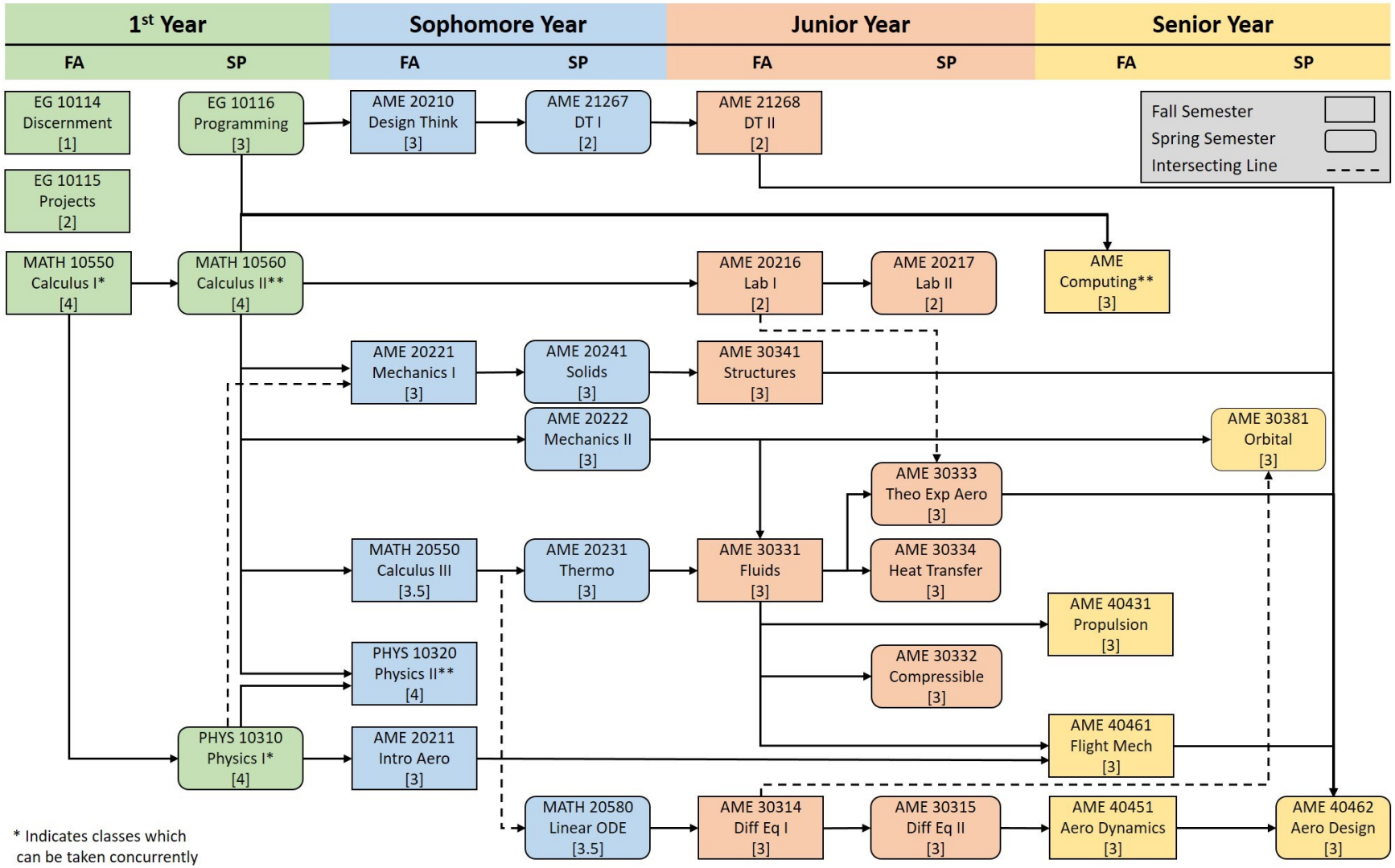
Sophomore Year					
Fall Semester			**Spring Semester**		
MATH 20550	Calculus III	3.5	MATH 20580	Intro to Linear Algebra and Differential Equations	3.5
PHYS 10320	Engineering Physics II: Electromagnetism	4	AME 20231	Thermodynamics	3
AME 20221	Mechanics I	3	AME 20222	Mechanics II	3
AME 20210	Introduction to Design Thinking in Engineering I	3	AME 20216 Or AME 21267	Lab I Design Tools I	2
AME 20211	Intro to Aeronautics	3	AME 20241	Solid Mechanics	3
				Core Curriculum Course	3
	Total:	**16.5**		**Total:**	**17.5**

*[2] *Any department projects course could substitute for this course.*

Junior Year					
Fall Semester			**Spring Semester**		
AME 30314	Differential Equations, Vibrations and Controls I	3	AME 30315	Differential Equations, Vibrations and Controls II	3
AME 20216 Or AME 21267	Lab I Design Tools I	2	AME 20217 Or AME 21268	Lab II Design Tools II	2
AME 20217 Or AME 21268	Lab II Design Tools II	2	AME 30332	Compressible Aerodynamics	3
AME 30331	Fluid Mechanics	3	AME 30333	Theoretical and Experimental Aerodynamics	3
AME 30341	Aerospace Structures	3	AME 30334	Heat Transfer	3
	Core Curriculum Course	3		Core Curriculum Course	3
	Total:	**16**		**Total:**	**17**

Senior Year					
Fall Semester			**Spring Semester**		
AME 40431	Gas Turbines and Propulsion	3	AME 30381	Orbital and Space Dynamics	3
AME 40451	Aerospace Dynamics	3	AME 40462	Aerospace Design	3
AME 40461	Flight Mechanics and Introduction to Design	3		AE Professional Development Or Core Curriculum Course	3
	AE Technical Specialization	3		AE Technical Specialization	3
	AME Computing Course	3		Core Curriculum Course	3
	Total:	**15**		**Total:**	**15**

2.6 Aerospace Engineering Curriculum Prerequisite Map (Class of 2025+)



2.7 Mechanical Engineering Course Plan (Class of 2022 & 2023)

The following four-year course plan is for Sophomore (Class of 2023) and Junior (Class of 2022) students in Mechanical Engineering (ME). Students need to take Notre Dame Core Curriculum to fulfill the University Core Requirements.

ME students are required to take four AEM Technical Elective courses (12 credit) and two General Technical Elective courses (6 credit) to fulfill the degree elective requirements.

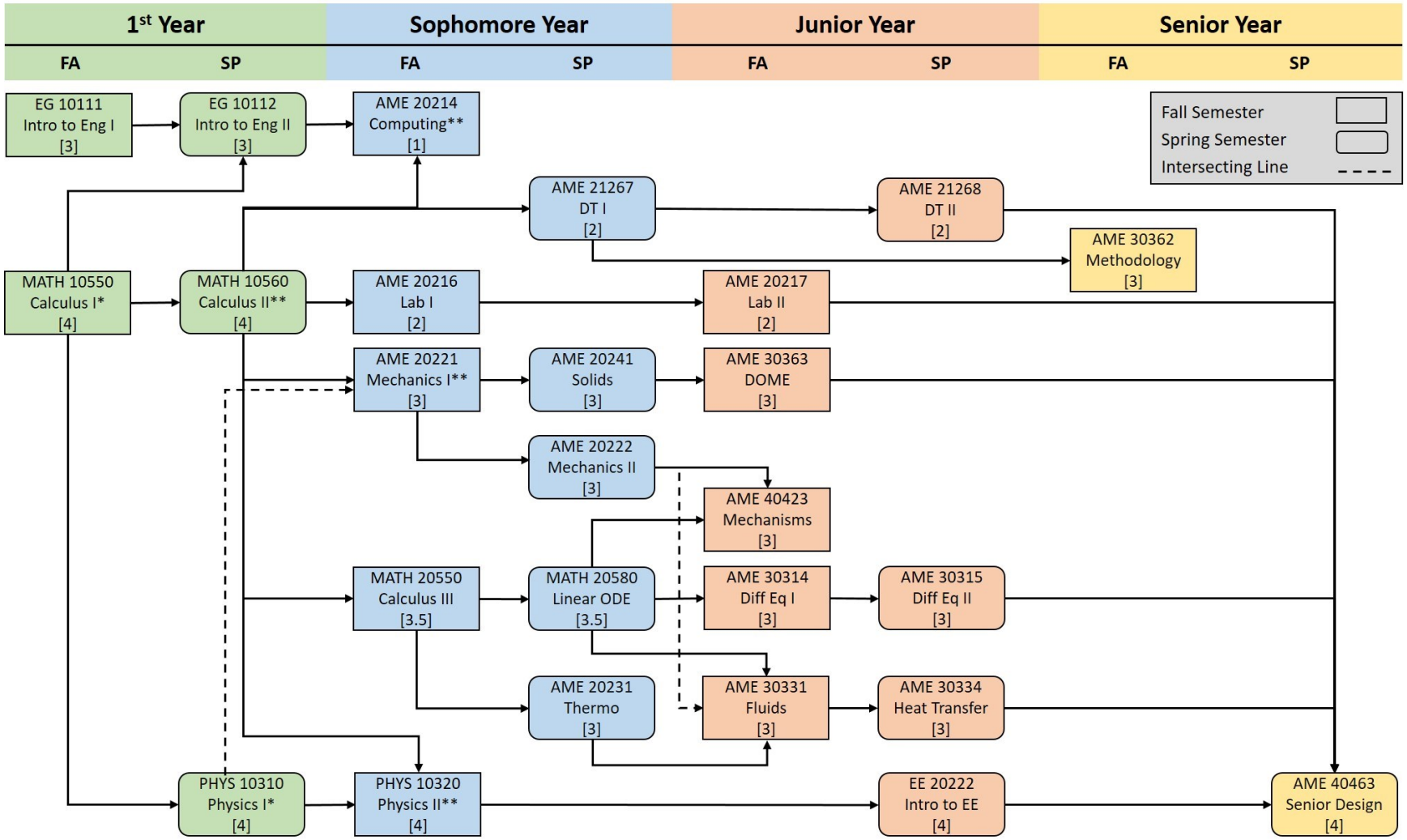
First Year					
Fall Semester			**Spring Semester**		
MATH 10550	Calculus I	4	MATH 10560	Calculus II	4
CHEM 10171	Intro to Chemical Principles	4	CHEM 10122	General Chemistry	3
EG 10111	Intro to Engineering Systems I	3	EG 10112	Intro to Engineering Systems II	3
	Core Curriculum Course	3	PHYS 10310	Engineering Physics I: Mechanics	4
USEM Or WR 13100	University Seminar Writing & Rhetoric	3	USEM Or WR 13100	University Seminar Writing & Rhetoric	3
FYS 10101	Moreau 1st Year Experience	1	FYS 10102	Moreau First Year Experience	1
	Total:	**18**		**Total:**	**18**

Sophomore Year					
Fall Semester			**Spring Semester**		
MATH 20550	Calculus III	3.5	MATH 20580	Intro to Linear Algebra and Differential Equations	3.5
PHYS 10320	Engineering Physics II: Electromagnetism	4	AME 20231	Thermodynamics	3
AME 20221	Mechanics I	3	AME 20222	Mechanics II	3
AME 20216 Or AME 21267	Lab I Design Tools I	2	AME 20216 Or AME 21267	Lab I Design Tools I	2
CBE 30361	Science of Engineering Materials	3	AME 20241	Solid Mechanics	3
AME 20214	Intro to Engineering Computing	1		Core Curriculum Course	3
	Total:	**16.5**		**Total:**	**17.5**

Junior Year					
Fall Semester			**Spring Semester**		
AME 30314	Differential Equations, Vibrations and Controls I	3	AME 30315	Differential Equations, Vibrations and Controls II	3
AME 20217 Or AME 21268	Lab II Design Tools II	2	AME 20217 Or AME 21268	Lab II Design Tools II	2
AME 30331	Fluid Mechanics	3	AME 30334	Heat Transfer	3
AME 30363	Design of Machine Elements	3	EE 20222	Intro to Electrical Engineering	4
AME 40423	Mechanisms and Machines	3		Core Curriculum Course	3
	Core Curriculum Course	3			
	Total:	**17**		**Total:**	**15**

Senior Year					
Fall Semester			**Spring Semester**		
AME 30362	Design Methodology	3	AME 40463	Senior Design Project	4
	AME Technical Elective	3		AME Technical Elective	3
	AME Technical Elective	3		AME Technical Elective	3
	General Technical Elective	3		General Technical Elective	3
	Core Curriculum Course	3		Core Curriculum Course	3
	Total:	**15**		**Total:**	**16**

2.8 Mechanical Engineering Curriculum Prerequisite Map (Class of 2022 & 2023)



* Indicates classes which can be taken concurrently

2.9 Mechanical Engineering Course Plan (Class of 2024)

The following four-year course plan is for 1st year students (Class of 2024) in Mechanical Engineering (ME). Students need to take Notre Dame Core Curriculum to fulfill the University Core Requirements of degree.

ME students need to take four AME Technical Elective courses (12 credit) and two General Technical Elective courses (6 credit) to fulfill the degree elective requirements.

ME students are required to take AME 20210 Intro to Design Thinking in Engineering before taking Design Tools class. Design Tools I (DT I).

First Year					
Fall Semester			**Spring Semester**		
MATH 10550	Calculus I	4	MATH 10560	Calculus II	4
CHEM 10171	Intro to Chemical Principles	4	CHEM 10122	General Chemistry	3
EG 10114	Engineering Discernment	1	EG 10116	Engineering Programming	3
EG 10115	Engineering Projects*[3]	2	PHYS 10310	Engineering Physics I: Mechanics	4
USEM Or WR 13100	University Seminar Writing & Rhetoric	3	USEM Or WR 13100	University Seminar Writing & Rhetoric	3
FYS 10101	Moreau First Year Experience	1	FYS 10102	Moreau First Year Experience	1
	Core Curriculum Course	3			
	Total:	**18**		**Total:**	**18**

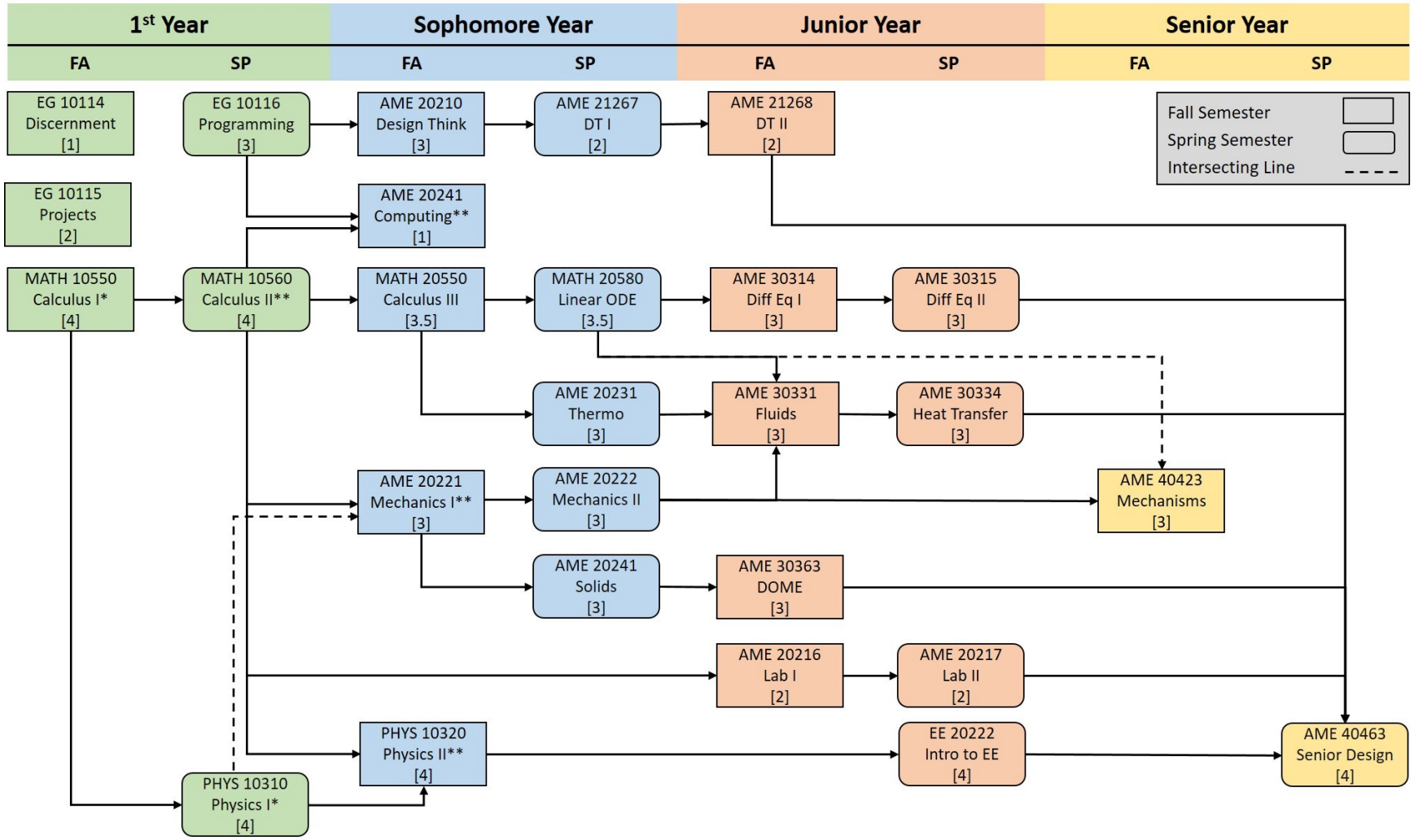
Sophomore Year					
Fall Semester			**Spring Semester**		
MATH 20550	Calculus III	3.5	MATH 20580	Intro to Linear Algebra and Differential Equations	3.5
PHYS 10320	Engineering Physics II: Electromagnetism	4	AME 20231	Thermodynamics	3
AME 20221	Mechanics I	3	AME 20222	Mechanics II	3
AME 20214	Intro to Engineering Computing	1	AME 20241	Solid Mechanics	3
AME 20210	Intro to Design Thinking in Engineering	3	AME 20216 Or AME 21267	Lab I Design Tools I	2
CBE 30361	Science of Engineering Materials	3		Core Curriculum Course	3
	Total:	**17.5**		**Total:**	**17.5**

*[3] *Any department projects course could substitute for this course*

Junior Year					
Fall Semester			**Spring Semester**		
AME 30314	Differential Equations, Vibrations and Controls I	3	AME 30315	Differential Equations, Vibrations and Controls II	3
AME 30331	Fluid Mechanics	3	AME 30334	Heat Transfer	3
AME 20216 Or AME 21267	Lab I Design Tools I	2	AME 20217 Or AME 21268	Lab II Design Tools II	2
AME 20217 Or AME 21268	Lab II Design Tools II	2	EE 20222	Intro to Electrical Engineering	4
AME 30363	Design of Machine Elements	3		Core Curriculum Course	3
	Core Curriculum Course	3			
	Total:	**16**		**Total:**	**15**

Senior Year					
Fall Semester			**Spring Semester**		
AME 40423	Mechanisms and Machines	3	AME 40463	Senior Design Project	4
	AME Technical Elective	3		AME Technical Elective	3
	AME Technical Elective	3		AME Technical Elective	3
	General Technical Elective	3		General Technical Elective	3
	Core Curriculum Course	3		Core Curriculum Course	3
	Total:	**15**		**Total:**	**16**

2.10 Mechanical Engineering Curriculum Prerequisite Map (Class of 2024)



* Indicates classes which can be taken concurrently

2.11 Mechanical Engineering Course Plan (Class of 2025+)

The following four-year course plan is for prospective students (Class of 2025+) in Mechanical Engineering (ME). Students need to take Notre Dame Core Curriculum to fulfill the University Core Requirements of degree.

ME students need to take four AME Technical Elective courses (12 credit) and two General Technical Elective courses (6 credit) to fulfill the degree elective requirements.

ME students are required to take AME 20210 Intro to Design Thinking in Engineering before taking Design Tools class. Design Tools I (DT I). DT I is the prerequisites for DT II, Lab I is the prerequisites for Lab II.

First Year					
Fall Semester			**Spring Semester**		
MATH 10550	Calculus I	4	MATH 10560	Calculus II	4
EG 10114	Engineering Discernment	1	EG 10116	Engineering Programming	3
EG 10115	Engineering Projects*[4]	2	PHYS 10310	Engineering Physics I: Mechanics	4
USEM Or WR 13100	University Seminar Writing & Rhetoric	3	USEM Or WR 13100	University Seminar Writing & Rhetoric	3
CHEM 10171	Intro to Chemical Principles	4		ME General Technical Elective Or Core Curriculum Course	3
FYS 10101	Moreau First Year Experience	1	FYS 10102	Moreau First Year Experience	1
	Core Curriculum Course	3			
	Total:	**18**		**Total:**	**18**

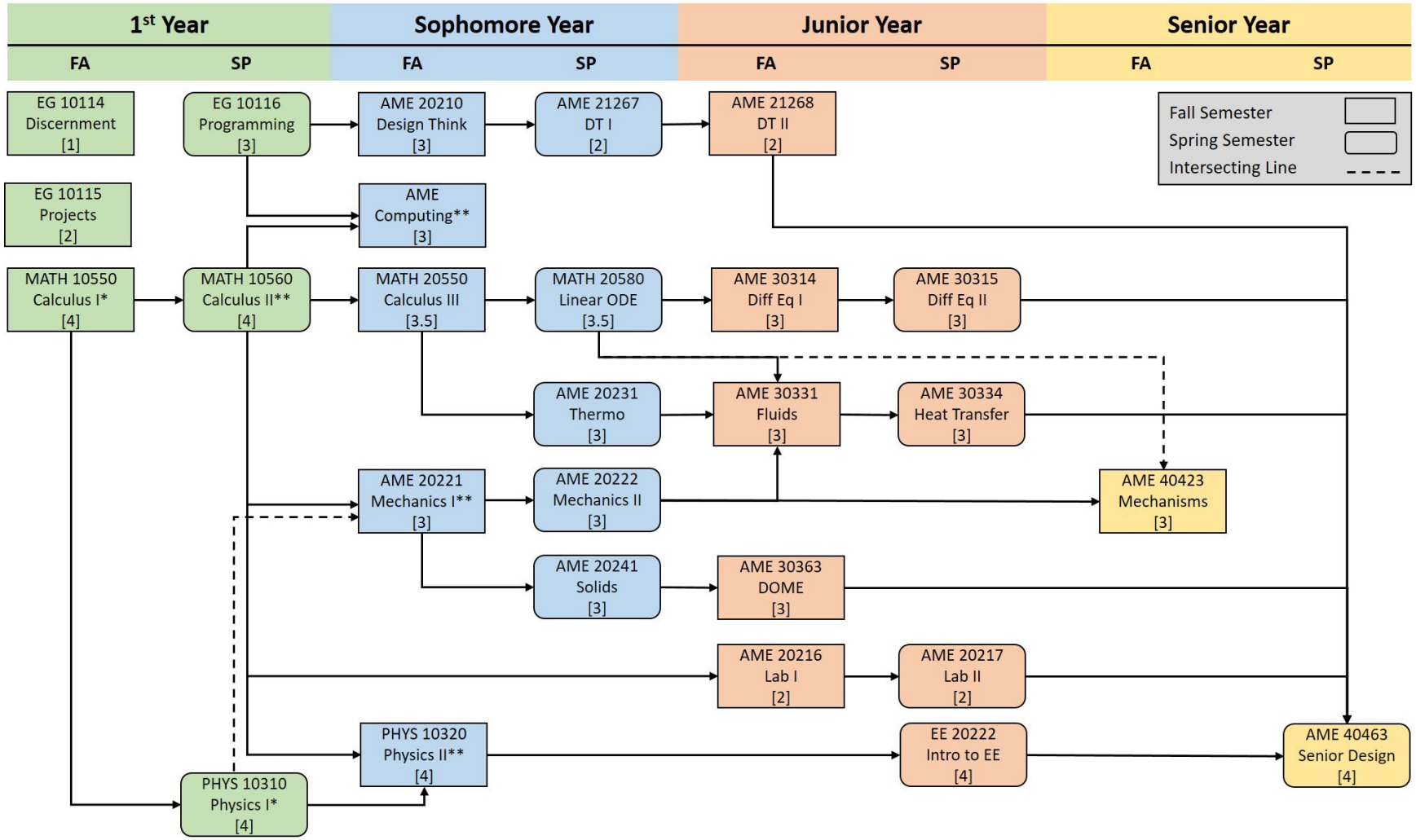
Sophomore Year					
Fall Semester			**Spring Semester**		
MATH 20550	Calculus III	3.5	MATH 20580	Intro to Linear Algebra and Differential Equations	3.5
PHYS 10320	Engineering Physics II: Electromagnetism	4	AME 20231	Thermodynamics	3
AME 20221	Mechanics I	3	AME 20222	Mechanics II	3
AME 20210	Intro to Design Thinking in Engineering	3	AME 20241	Solid Mechanics	3
	AME Computing Course Or Science of Engineering Materials		AME 20216 Or AME 21267	Lab I Design Tools I	2
		3		Core Curriculum Course	3
	Total:	**16.5**		**Total:**	**17.5**

*[4] *Any department projects course could substitute for this course*

Junior Year					
Fall Semester			**Spring Semester**		
AME 30314	Differential Equations, Vibrations and Controls I	3	AME 30315	Differential Equations, Vibrations and Controls II	3
AME 30331	Fluid Mechanics	3	AME 30334	Heat Transfer	3
AME 20216 Or AME 21267	Lab I Design Tools I	2	AME 20217 Or AME 21268	Lab II Design Tools II	2
AME 20217 Or AME 21268	Lab II Design Tools II	2	EE 20222	Intro to Electrical Engineering	4
AME 30363	Design of Machine Elements	3		Core Curriculum Course	3
	Core Curriculum Course	3			
	Total:	**16**		**Total:**	**15**

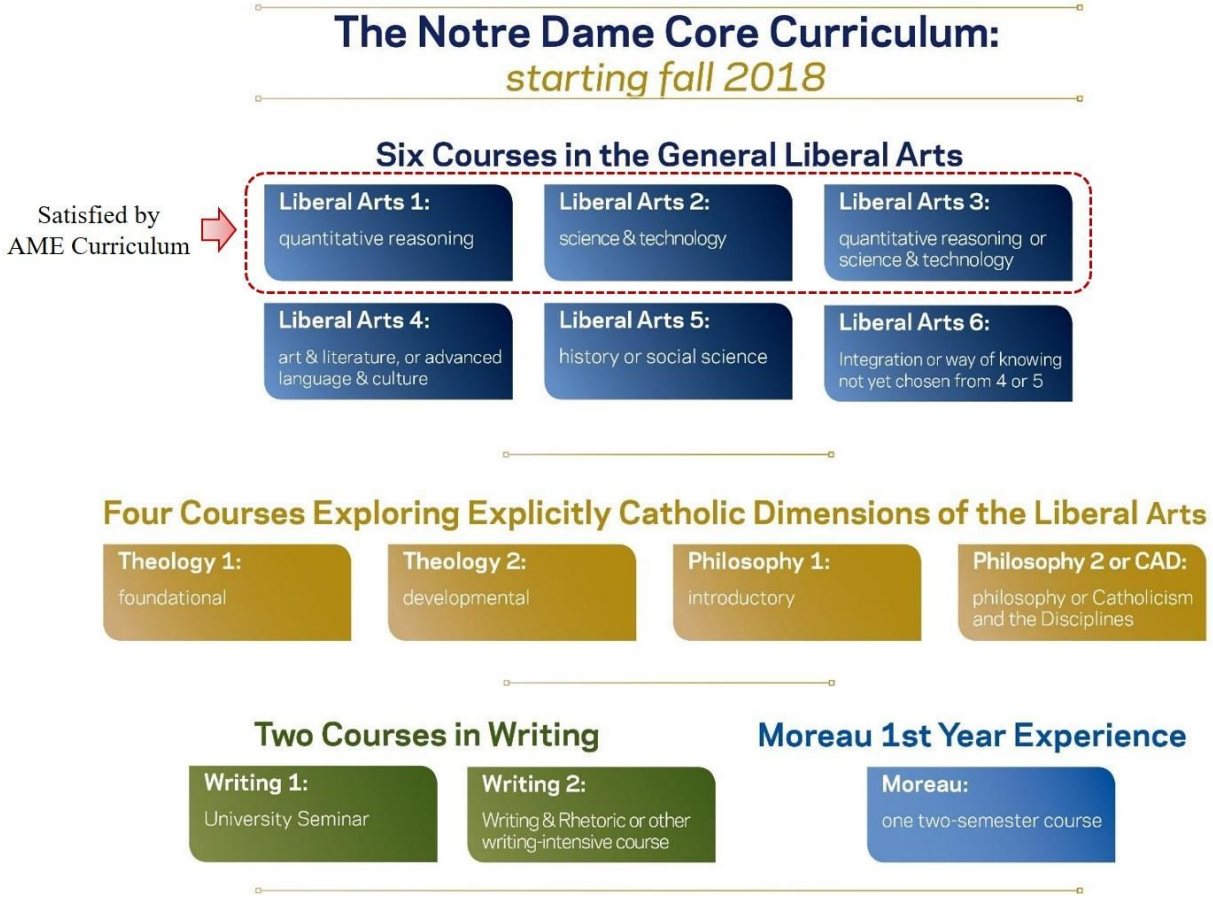
Senior Year					
Fall Semester			**Spring Semester**		
AME 40423	Mechanisms and Machines	3	AME 40463	Senior Design Project	4
	AME Computing Course Or Science of Engineering Materials	3		General Technical Elective	3
	AME Technical Elective	3		AME Technical Elective	3
	AME Technical Elective	3		AME Technical Elective	3
	General Technical Elective Or Core Curriculum Course	3		Core Curriculum Course	3
	Total:	**15**		**Total:**	**16**

2.12 Mechanical Engineering Curriculum Prerequisite Map (Class of 2025+)



* Indicates classes which can be taken concurrently

2.13 The Notre Dame Core Curriculum (Class of 2022 or Later)



Six Courses in the General Liberal Arts

- Liberal Arts 1: Quantitative Reasoning
- Liberal Arts 2: Science & Technology
- Liberal Arts 3: Quantitative Reasoning or Science & Technology
- Liberal Arts 4: Art & Literature, or Advanced Language & Culture
- Liberal Arts 5: History or Social Science
- Liberal Arts 6: Integration or Way of Knowing not yet chosen from 4 or 5

Four Courses Exploring Explicitly Catholic Dimensions of the Liberal Arts

- Theology 1: Foundational
- Theology 2: Developmental
- Philosophy 1: Introductory
- Philosophy 2 or CAD: Philosophy elective or Catholicism and the Disciplines

Two Courses in Writing

- Writing 1: University Seminar*[5]
- Writing 2: Writing & Rhetoric or Other Writing-Intensive Course*[6]

Moreau First Year Experience

- Moreau: One two-semester course

---

*[5] *A University Seminar (USEM) course may be double-counted to fulfill both the USEM requirement and one of the other liberal arts requirements.*

*[6] *Students who have AP credit to test out of Writing and Rhetoric may have opportunities to double-count by choosing an approved writing-intensive course that also fulfills a university, college, or major requirement.*

3 AME Electives

There are four different types of undergraduate AME electives, two for each program. Aerospace Engineering has the "Technical Specialization" elective and the "Professional Development" elective. Mechanical Engineering has "AME Technical Electives" and "General Technical Electives." The definition for each is different and students must take care to ensure that they satisfy the different elective requirements in their program.

3.1 Aerospace Engineering Technical Specialization Courses

- AME 30362 Design Methodology
- AME 30363 Design of Machine Elements
- AME 40423 Mechanisms and Machines
- AME 40510 Introduction to Numerical Methods
- AME 40532 Computational Fluid Dynamic
- AME 40541/60541 Finite Element Methods
- AME 40548/60548 Biofabrication
- AME 40571/60571 Structural Aspects of Biomaterials
- AME 40572/60572 Introduction to Biomechanics
- AME 40623/60623 Analytical Dynamics
- AME 40634/60634 Intermediate Heat Transfer
- AME 40643/60643 Additive Manufacturing
- AME 40652/60652 Intermediate Controls
- AME 40671/60671 Orthopaedic Biomechanics
- AME 48491 Undergraduate Research
- CE 30200 Structural Mechanics I
- CE 30210 Structural Mechanics II
- CE 40450 Hydraulics
- CBE 30355 Transport Phenomena I
- CBE 30361 Science of Engineering Materials
- CSE 20232 C/C++ Programming
- EE 20222 Introduction to Electrical Engineering and Embedded Systems
- EE 40455 Control Systems
- EG 34440 Probability and Statistics
- EG 40421 Integrated Engineering and Business Fundamentals
- ACMS 30440 Probability and Statistics
- ACMS 34445 Probability and Statistics for Data Science
- MATH 30540 Mathematical Statistics
- All AME 50000 level and 60000 level courses

3.2 Aerospace Engineering Professional Development Courses

Most, but not all, 30000-level or higher courses offered by the Colleges of Engineering or Science that are not otherwise required by the Aerospace Engineering curriculum may satisfy the Professional Development requirement.

Specifically, any course with a prefix AME, ACMS, CBE, CE, ENVG, CSE, EE, EG, ESTS, BIOS, CHEM, MATH, PHYS or SC that is 30000-level or higher (including the courses listed above as Technical Specialization courses) may be used to satisfy the Professional Development requirement with the following exceptions and additions:

- EE 20222 Intro to Electrical Engineering may be used to satisfy a Professional Development requirement.
- MATH 30650: Differential Equations, PHYS 30210: Physics I and PHYS 30220: Physics II may NOT be used to satisfy a Professional Development requirement.
- Three credits from a completed ROTC program on campus may be used to satisfy a Professional Development course requirement.
- ARCH 53413: Sustainability & Energy Modeling of Traditional Architecture

Limitations on Non-classroom courses: Only a total of 6 credits of non-classroom courses, such as AME 48491 Undergraduate Research and AME Special Studies, may be counted toward degree requirements.

3.3 Mechanical Engineering Technical Electives

Any course that is 30000-level or higher with an AME prefix that is not otherwise required by the Mechanical Engineering curriculum may be used to satisfy an AME Technical Elective requirement in the Mechanical Engineering program.

AME 20211: Introduction to Aeronautics may be used to satisfy an AME Technical Elective requirement in the Mechanical Engineering program if it is taken during the sophomore year of studies.

3.4 Mechanical Engineering General Technical Electives

Most, but not all, 30000-level or higher courses offered by the Colleges of Engineering or Science that are not otherwise required by the Mechanical Engineering curriculum may satisfy the General Technical Elective requirement.

Specifically, any course with a prefix AME, ACMS, CBE, CE, ENVG, CSE, EE, EG, BIOS, CHEM, MATH, PHYS or SC that is 30000-level or higher may be used to satisfy the General Technical Elective requirement with the following exceptions and additions:

MATH 30650: Differential Equations, PHYS 30210: Physics I and PHYS 30220: Physics II may not be used to satisfy the General Technical Elective requirement.

- ARCH 53413 Sustainability & Energy Modeling of Traditional Architecture
- BIOS 20201 General Biology A
- BIOS 20202 General Biology B
- CBE 20258 Numerical and Statistical Analysis
- CHEM 20273 Organic Reactions and Applications
- CSE 20232 C/C++ Programming
- DESN 40201 ID: Collaborative Productive Development
- MATH 20810 Honors Algebra I
- MATH 20820 Honors Algebra II
- PHYS 20330 Elements of Modern Physics

A student can apply up to 3 credit hours of a 40000-level military science class (AS, MSL, NSCI), taken while an active midshipman or cadet in good standing within a University ROTC program, toward satisfying the general technical elective requirements.

Additionally, for students graduating in May 2019 or later, at most one 20000 level course at 3 credits or fewer, not within the above list, taught within the College of Engineering may be used to satisfy a General Technical Elective requirement in the Mechanical Engineering program if it is taken during the first year or the sophomore year of studies.

Limitations on Non-classroom courses

Only a total of 6 credits of non-classroom courses, such as Undergraduate Research, Independent Undergraduate Design Projects and AME Special Studies, may be counted toward degree requirements. Students taking research from a non-AME faculty member should sign up for the research course from that department. The credit would count as a general technical elective.

3.5 Medical School

Engineering is the fifth most common major for Notre Dame Students applying to medical school. The Center for Health Sciences Advising can provide you with advice on choosing courses as an engineering student planning to attend medical school.

Most medical schools require applicants to have taken the MCAT (Medical College Admission Test), and to have completed:

- One year of Biology (Recommend BIOS 10171/11173: Biological Sciences I and lab, BIOS 10172/11174: Biological Sciences II and lab)
- Two years of Chemistry (10171, 10172, 20273, 20274 with labs)
- One year of Physics
- One year of English
- Biochemistry

Many schools recommend courses in:

- Psychology
- Social sciences (Economics, Political Science, Sociology, etc.)

Note that some medical schools (e.g. Harvard) require the biology courses to be taken in college (not satisfied by AP credits). If you have AP credit, you must take higher level biology courses with lab components. There are similar restrictions on AP chemistry and physics. Other schools accept credits awarded through AP testing (at Notre Dame this usually requires a score of 5). If you are interested in a specific medical school you should verify their policy on AP credits early in the program.

Hence, in addition to the AME degree requirements, students must take additional courses. In addition to the courses, the Notre Dame preprofessional programs generally require a 1 credit lab component with each course. Students with an interest in preparing for medical school should consult with personnel in the Center for Health Sciences Advising for curricular planning advice, as they have prepared course plans for engineering students interested in medical school.

In the ME program Introductory Biology I and II may be used to satisfy the General Technical Elective requirements. A student may petition that CHEM 20273 be used to satisfy an AME Technical Elective requirement. Note that the College of Engineering allows CHEM 10172, a prerequisite for CHEM 20273, to substitute for the College of Engineering requirement, CHEM 10122. If that substitution is not made, CHEM 10172 may only be taken as an overload. The lab components of the courses must be taken as overloads. It is recommended that a student interested in medical school take the laboratory component of General Chemistry II (CHEM 21274) as well.

3.6 ROTC

Aerospace Engineering Students who complete a ROTC program may use 3 credits of a senior year ROTC course to satisfy the Professional Development elective requirement.

Mechanical Engineering Students who complete a ROTC program may use 3 credits of a senior year ROTC course to satisfy a General Technical Elective requirement.

Both Aerospace and Mechanical Engineering Students in ROTC under the old core curriculum (seniors) may use 3

credits of a senior year ROTC course to satisfy the History or Social Science University Requirement.
For sophomores and juniors, ROTC courses currently DO NOT satisfy any Core Curriculum requirements.

4 Study Abroad

Students who study abroad in the academic year generally do it during the fifth or sixth semester; a few go for the entire junior year. Below are the requirements to participate in the programs. Any student who is not behind in the program is eligible to participate. However, in certain cases students must register for the correct courses during their sophomore year to attend the program, and if they do not do so, then they are not eligible to attend.

4.1 Fall Programs in Rome (for AE and ME students)

ME Students

- Students must have completed AME 21267 DT I and AME 20216 Lab I by the spring semester of sophomore year, so they can take AME 21268 DT II and AME 20217 Lab II in the spring semester of junior year.
- Students must take AME 30363 DOME and AME 40423 Mechanisms & Machines in the fall semester of senior year. Consequently, they must take AME 40463 Senior Design in the spring semester of senior year.
- Students must take Fluid Mechanics and the elective offered by AME in Rome in the semester they are in Rome.
- Students must take AME 30314 Differential Equations, Vibrations and Control I in Rome unless they take it during sophomore year.
- AL 24107 All Roads Lead to Rome
- A 2nd Theology offered in Rome

AE Students

- Students must have completed AME 21267 DT I and AME 20216 Lab I by the spring semester of sophomore year, so they can take 21268 DT II and AME 20217 Lab II in the spring semester of junior year.
- Students must take AME 30341 Aerospace Structures in the fall semester of senior year.
- Students must take Fluid Mechanics and the elective offered by AME in Rome in the semester they are in Rome.
- Students must take AME 30314 Differential Equations, Vibrations and Control I in Rome unless they took it during sophomore year.

4.2 Fall Programs in Other Locations (for AE and ME students)

ME Students

- Students must have completed DT I and Lab I by spring semester of sophomore year, so they can take DT II and Lab II in the spring semester of junior year.
- Students must take DOME and Mechanisms & Machines in the fall semester of senior year, or find equivalent courses for one or both of these at their international location. If they take DOME or Mechanisms & Machines in the fall of senior year, they must take Senior Design the spring semester of senior year.
- Students must take an approved Fluid Mechanics course at their international location or over the summer before junior year.
- Unless students take AME 30314 in their sophomore year, students must take a differential equations course prior to the spring semester of junior year and enroll in the spring semester of junior year in a zero-credit course for vibrations. This differential equations course may be at ND in the spring of sophomore year if they are one semester ahead in the math sequence. If they are not ahead in math, they must take it either at the international location or over the summer.
- Students should aim for three or more technical courses at their international location.

AE Students

- Students must have completed DT I and Lab I by spring semester of sophomore year, so they can take DT II and Lab II in the spring semester of junior year.
- Students must take Aerospace Structures in the fall semester of senior year, or find and equivalent course at the international studies location.
- Students must take an approved Fluid Mechanics course at their international location or over the summer before junior year.
- Unless students take AME 30314 in their sophomore year, they must take a differential equations course prior to the spring semester of their junior year and enroll in the spring semester of junior year in a zero-credit course for vibrations.

4.3 Spring Programs in London (Only for ME students)

- Students must have completed AME 21267 DT I and AME 20216 Lab I, so they can take AME 21268 DT II and AME 20217 Lab II in the fall semester of junior year.
- Students must take all three courses offered by AME in London
- AME 30334 Heat Transfer
- AME 30315 Differential Equations, Vibrations and Control II. If students take AME 30314 in the fall semester of sophomore year, they MUST delay AME 30315 until they go to London.
- Whatever AME technical elective course is offered in London.
- Students must take EE 20222 Intro to Electrical Engineering in the spring semester of sophomore year

4.4 Spring Program in Other Locations (Only for ME students)

- Students must have completed DT I and Lab I by the spring semester of sophomore year, so they can complete DT II and Lab II in the fall semester of junior year.
- Students should take a course equivalent to AME 30334 Heat Transfer if it is offered in their international location. If there is not one offered, they may delay Heat Transfer to the spring semester of senior year, in which case they may not take Senior Design until the spring semester of senior year. You are going to need a waiver from AME department to do so.
- Student must either
    - Have completed AME 30315 in their sophomore year OR
    - Complete a controls course in their international location.
        - The controls course must either cover Laplace Transforms or the student must take a zero-credit course covering that material PRIOR to going abroad.
        - The student must take a zero-credit course upon their return covering solutions to systems of first order differential equations and multi-degree of freedom vibrations.
- Students must take EE 20222 during the spring semester of their sophomore year.

Zero-Credit Courses

Sometimes it may not be possible to find a course at a given university abroad exactly equivalent to one offered on campus. In this case, and at the discretion of the Director of Undergraduate Studies, students may be required upon return to take zero-credit self-study courses to compensate for the topics not covered abroad.

4.5 Academic Year Program Locations

If a student needs to take AME courses abroad, these locations may work for them:

- Rome (Italy) AME
- London (UK) AME
- Dublin UCD, Trinity
- Hong Kong (China) HKUST
- Oxford (UK) by invitation
- Perth (Australia) UWA
- Singapore NUS

If a student does not need to take a course in their major during their semester abroad, they are welcome to study on any program that interests them.

For additional information on a specific program, please speak with your adviser or the AME Department Director of Undergraduate Studies and visit the Notre Dame International Study Abroad website:

https://international.nd.edu/education-abroad/study-abroad/.

4.6 Summer Programs

The **College of Engineering** offers programs in:

- Alcoy (Spain),
- London (England),
- Shenzhen (China),
- Kitakyushu (Japan),
- Rome (Italy).

Other options are available each summer through Notre Dame International Study Abroad.

5 Minors

The College of Engineering offers six minors, open to all University students who have taken the appropriate pre-requisite courses for upper-level engineering and science courses. For students in the College of Engineering, at least one, and up to two course(s) required for the minor may double-count towards degree requirements and the minor. The department who manages the minor should be consulted for the rules. Students in other colleges should consult their own program department for similar restrictions.

- Bioengineering
- Computational Engineering
- Energy Engineering
- Energy Studies
- Engineering Corporate Practice
- Environmental Earth Sciences
- Resiliency and Sustainability of Engineering Systems

5.1 Bioengineering (MBIE)

This minor, offered by the Department of Aerospace and Mechanical Engineering and the Department of Chemical and Biomolecular Engineering, comprises a six-course sequence that teaches students how to use the tools of engineering analysis with the fundamentals of the engineering and life sciences, to enliven the understanding of living organisms, medical treatments and biochemical pathways and to provide quantitative predictions and insight towards the design of medical and biological devices and processes.

Introduction requirement:
Students select one of five foundational courses that are suitable for students with interests in differing areas of bioengineering. Some of these courses are at the senior elective level, and may build on previous courses. Others at the sophomore level, and provide an introduction to a field. The Foundations course can be taken at any point in the undergraduate curriculum.

Concentration area requirements:
Students complete the minor requirements with any course in the college that has the BIOE attribute. Students are advised to pursue course sequences that are thematic, either from a single department or in a topic area that spans departments. However, there are no restrictions on specific course groupings.

Biological Sciences Requirements:
Students should complete the standard two semester introductory sequence in biology. These two courses are prerequisites for every biological science class offered at Notre Dame. They provide a solid grounding for students in biological sciences, covering the essential concepts of evolution, basic physiology, gene transcription and translation, proteins and signaling molecules, and progressing to ecosystems. The courses cover multi-organism systems, which is relevant for students interested in environmental engineering and epidemiology.

Non-engineering Majors:
The college council also approved awarding the minor to students in the college of science, and the demand from students in chemistry and biochemistry has been particularly strong. Students outside the college of engineering are expected to complete a minimum of two semesters of physics and three semesters of mathematics, including at least Calculus I and II. They must also meet the prerequisites for any engineering courses they plan to take as part of the minor, which generally includes a course in differential equations.
AP Credits and Double Counted Credits:

Credit for BIOS 10171 and BIOS 10172 could be satisfied for students who receive a 5 on the AP biology exam, consistent with Notre Dame Policy: https://firstyear.nd.edu/academics/advanced-placement-credit/ap-exam-credit/.

Double Counted Credits

As with other minors in the college of engineering, students can apply a maximum of six credits from their major requirements to fulfill minor requirements.

Course Requirements

Biological Sciences:

- BIOS 10171 Biology I: Big Questions (3 credits)
- BIOS 10172 Biology II: Molecules to Ecosystems (3 credits)

Engineering Courses:

1. One foundational course
   - AME 40571/60571 Structural Aspects of Biomaterials
   - AME 40572/60572 Introduction to Biomechanics
   - CBE 30357 Biotransport
   - CBE 30386 Introduction to Bioengineering
   - EE 40331 Biomedical Device Design
   - EE 40432 Systems Biology
2. Any three additional courses with the BIOE course designator

Study Abroad

Students wishing to study abroad may complete these requirements based on equivalent or similar course work offered in the London, Dublin, or Perth programs. Courses that have equivalent Notre Dame Course numbers assigned by the office of International Studies or the respective departments will be accepted automatically. Please contact Professor Glen Niebur (gniebur@nd.edu) in advance to discuss possible courses.

5.2 Computational Engineering (MCOM)

This minor, offered by the Department of Aerospace and Mechanical Engineering, recognizes the importance of computational tools in all disciplines of engineering and gives students exposure to the fundamentals of programming and numerical methods, experience and skills in computer usage, and knowledge of applications from a range different areas. The Computational Engineering Minor will provide the students with a solid grounding in the application of computational methods to various engineering problems such as fluid mechanics, structural analysis, elasticity, optimization, etc. With a fundamental understanding of the problems being solved and the numerical methods used to determine solutions, students are prepared to properly interpret the results, recognize the limitations of the methods employed, etc.

The Minor requires completion of five courses, more fully described below. One of the five courses may also satisfy a degree requirement in the student's major

One of the following courses must be taken to fulfill the requirements for the minor:

- AME 40532 Computational Fluid Dynamics
- AME 40541/60541 Finite Element Methods
- CE 60130 Finite Elements in Engineering

Any of the following courses may be taken in order to fulfill the requirements for the Computational Engineering Minor:

- ACMS 20210 Scientific Computing*[7]
- ACMS 20220 Scientific Computing Python*[7]
- ACMS 40212 Advanced Scientific Computing
- ACMS 40390 Numerical Analysis [or Math 40390]*[8]
- ACMS 40395 Numerical Linear Algebra
- ACMS 40630 Nonlinear Dynamical Systems
- ACMS 40730 Mathematical/Computational Modeling
- ACMS 40760 Introduction to Stochastic Modeling
- ACMS 50550 Functional Analysis
- ACMS 50051 Numerical PDE Techniques for Scientists and Engineers I [or PHYS 50051]
- ACMS 50052 Numerical PDE Techniques for Scientists and Engineers II
- ACMS 60395 Numerical Linear Algebra
- ACMS 60612 Advanced Scientific Computing
- ACMS 60690 Numerical Analysis I[8]
- ACMS 60790 Numerical Analysis II
- AME 20214 Introduction to Engineering Computing*[7]
- AME 40510 Introduction to Numerical Methods*[9]
- AME 40532 Computational Fluid Dynamics
- AME 40541/60541 Finite Element Methods
- AME 50559 Statistical Computing Methods for Scientists and Engineers
- AME 60614 Numerical Methods
- AME 60620 Multiscale Modeling
- AME 60649 Molecular Level Modeling for Engineering Applications
- CBE 20258 Computational Methods in Chemical Engineering*[9]
- CBE 40455 Process Operations
- CE 30125 Computational Methods [or CSE 30125]
- CE 40140 Applied/Computational Probability for Engineers; Uncertainty Quantification and Propagation
- CE 60130 Finite Elements in Engineering [or CSE 60130, or ACMS 60590]
- CE 60263 Finite Element Methods in Structural Mechanics
- CSE 20189 Basic UNIX for Engineers
- CSE 20232 C/C++ Programming
- CSE 40113 Design/Analysis of Algorithms
- CSE 40166 Computer Graphics
- CSE 40171 Introduction to Artificial Intelligence
- CSE 40431 Programming Languages
- CSE 40755 Parallel Computing

---

*[7] *Only one of these courses will be counted*

*[8] *Only one of these courses will be counted*

*[9] *Only one of these courses will be counted*

- MATH 30720 Discrete Fourier and Wavelet Transforms
- MATH 50510 Computer Programming/ Problem Solving
- PHYS 30421 Scientific Programming

5.3 Energy Engineering (MENE)

This minor, offered by the Department of Aerospace and Mechanical Engineering, recognizes that Energy is an important subject of current interest that involves many engineering and non-engineering disciplines, and enables students to develop a stronger background in and to prepare better for professional jobs or higher studies in the area. This minor differs from the Energy Studies minor as described below in that it focuses on the technical aspects of energy and requires courses concentrated in engineering and science.

Energy is clearly of pressing national and international concern, the fact of which is evidenced by recognition by Notre Dame in the creation of the Center for Sustainable Energy. The factual details of the nature of the technological energy needs facing society and the manner in which academia, and Notre Dame in particular, are addressing them were the focus of a recent article in the Signatures Magazine and include the following subjects:

- Blackouts, the stability of the power grid and other reliability issues in energy distribution;
- Energy efficiency and policy;
- The politics of power;
- Sources of energy and the related environmental concerns;
- Carbon dioxide capture and storage;
- Nuclear energy and the associated difficulties;
- Clean coal technology, and;
- Biofuels

The Energy Engineering Minor parallels the institutional commitment reflected in the creation of the Center for Sustainable Energy at the undergraduate level by providing undergraduates with the educational background necessary to confront this important technological issue of the current time.

The Minor requires completion of five courses, more fully described below. One of the five courses may also satisfy a degree requirement in the student's major

The following courses may be taken in order to fulfil the requirements for the Energy Engineering Minor:

- AME 20231 Thermodynamics
- AME 40401 Energy, Technology and Policy
- AME 40431 Gas Turbines and Propulsion
- AME 40472 Electrical and Hybrid Vehicles
- AME 40530 Wind Turbine Performance, Control and Design
- AME 47431 Special Studies: Designing Energy-Efficient Buildings
- AME 50531 Intermediate Thermodynamics
- AME 40532 Computational Fluid Dynamics
- AME 50535 Energy Systems
- AME 50539 Photovoltaic System Design for Engineers
- AME 53631 Molecular Thermodynamics
- AME 40634/60634 Intermediate Heat Transfer
- AME 60636 Fundamentals of Combustion
- AME 60638 Turbine Engine Components
- CBE 20256 Chemical Engineering Thermodynamics

- CBE 40425 Energy, Economics, and Environment
- CBE 40435 Electrochemical Energy and Storage
- CBE 40498 Energy and Climate
- EE 30372 Electric Machinery and Power Systems
- EE 47010 Alternative Energy Devices and Materials
- EE 40472 Electrical and Hybrid Vehicles
- EE 47015 Electric Vehicles and the Power Grid
- PHYS 30461 Thermal Physics

Only one of these courses will be counted

5.4 Energy Studies (MENS)

This minor, offered by the Center for Sustainable Energy at Notre Dame (cSEND) through the Department of Chemical and Biomolecular Engineering, differs from the minor in Energy Engineering described above in that it requires less technical content and more broadly examines the issue of energy from a variety of perspectives. Through this minor, students will learn to: quantify energy resources and use and recognize the fundamental laws of thermodynamics that govern energy conversion; develop a functional knowledge of the historical and economic frameworks that guide decision-making in the energy industry today; develop oral and written communication skills necessary to convey the critical information about energy to the non-expert; understand the environmental consequences such as pollution and climate change of today's energy technologies; understand the linkages between ethics and energy utilization; critically assess the strengths and weaknesses and the prospective impact of alternative energy technologies; and understand the influence of geopolitics, economics and public policy on our nation's and the world's energy future. The minor requires:

- ENER 20101
- ENER 20102
- Capstone project or CSC 33985
- Three courses (nine credit-hours) concentrated either in a technical or non-technical area of energy studies, approved in advance by the director of the Energy Studies Minor, selected from a list maintained by cSEND.

5.5 Engineering Corporate Practice (MECP)

The College of Engineering collaborates with the Mendoza College of Business and the College of Arts and Letters to offer this unique experience that prepares you for your future career while exploring topics at the intersection of engineering and business.

The Minor in Engineering Corporate Practice (MECP) is open to all engineering undergraduates.

Required coursework

- EG40421 Integrated Engineering and Business Fundamentals [or EG4442]
- EG40422 Advanced Integrated Engineering and Business Concepts
- Economics Course
- BAEG 20100 Accountancy I*[10] [or ACCT 20100]
- BAEG 20150 Corporate Financial Management [or FIN 20150]

Two of these courses may count toward your engineering degree requirements (one of the EG40000 courses, plus the ECON course to be counted as fulfilling the University social science requirement).

ECON courses may include (but not be limited to):

---

*[10] *Accounting and Finance cannot be taken simultaneously.*

- Principles of Microeconomics (ECON 10010, 10011, 20010, or 20011)
- Principles of Macroeconomics (ECON 10020 or 20020)
- Intermediate Micro Theory (ECON 30010)

For additional questions, please contact:

Professor Mike Kitz (Michael.P.Kitz.1@nd.edu)

Professor Todd Taylor (Ttaylo24@nd.edu).

5.6 Environmental Earth Sciences (MEES)

Students may double-count one class for their minor and major. Environmental engineering students wishing to minor in Environmental Earth Sciences may double-count either Planet Earth or Environmental Mineralogy, and will need to take additional EVES elective courses to account for course that is not double counted.

Course No.	Course Name	Credit
CE 20110	Planet Earth	4
CE 20520	Environmental Mineralogy	4
CE 45200 or CE 45300	Field Trip 1	1
	EVES Elective	4
	EVES Elective	3
	Total	16

EVES Elective courses include the following courses. If applicable, appropriate pre-requisites must be taken for entry into elective courses.

- CE 20300 Global Change, Water & Energy
- CE 20320 Envir. Aquatic Chemistry
- CE 30500 Surficial Processes
- CE 30530 Sedimentation & Stratigraphy
- CE 30540 Petrology of Earth Materials (4 credits)
- CE 30560 Dynamic Earth
- CE 40300 Geochemistry
- CE 40320 Envir. & Aquatic Chem
- CE 40360 Geomicrobiology
- CE 40381 Envir. Isotope Geochem
- CE 40382 Actinide Chemistry
- CE 45200 Spring Field Trip (1 credit)
- CE 45300 Fall Field Trip (1 credit)
- CE 60310 Organic Geochemistry

5.7 Resiliency and Sustainability of Engineering Systems (MRSE)

The Resiliency and Sustainability of Engineering Systems minor is open to students from all disciplines (i.e., not just limited to students in the College of Engineering) who can satisfy the pre-requisites for CE10700 (see below). The minor includes two required courses, three elective courses, and a capstone experience. The two required courses are:

- CE10700 Sustainable Development in a Changing World (Required)
  Spans a broad range of topics on the environmental consequences of engineering systems in sustainable development.

- CE30720 Resiliency of Engineering Systems (Required)
  Focuses on engineering for mitigation and resiliency, also emphasizing communication skills so that graduates are equipped to work with city planners, policymakers and the public.

The three elective courses will be selected in collaboration with the Director of the Minor. Options to fulfill this requirement span multiple departments and include pre-approved courses from departments such as Political Science, Psychology, Philosophy, Laws, Economics, and Sociology. Courses will be from at least two different departments. At least two of the elective courses will be at the advanced undergraduate level (i.e., junior or senior). In addition, at least one of the three elective courses will be outside the College of Engineering.

In addition to coursework, students will be required to complete a 1-credit capstone experience. The goal is for the student to obtain hands-on experience with resiliency and sustainability issues focusing on implementation in a real-world setting, such as a related research position or an internship with a governmental body, regulatory agency, environmental advocacy group, or other organization. Proposed by the student, each capstone experience will be approved by the Director of the Minor. Projects will vary among students, and it is expected that each experience will allow the student to pursue a topic of particular interest to him/her in much more depth than a single course might allow. Each experience will be accompanied by a Capstone Thesis Report that will be due no later than the spring semester of the senior year.

6 Concentrations

Though students are not required to choose or to complete a concentration, the Department offers several concentration which can be used for specializations. For it to qualify as a concentration, at least three courses indicated in the list below must be taken. Students should make sure that they have the necessary prerequisites that may not be part of the concentration. In the last semester before graduation, students should complete a change of major form available from the Administrative Assistant. If a concentration is properly completed, the concentration will be included on the student's final transcript.

The following are the courses included in each concentration. AEs cannot opt for the Aerospace concentration. Courses that are required in a program (marked below with* for AE and ** for ME) cannot be used as part of a concentration for that program.

6.1 Aerospace Concentration[11]

- AME 30332 Compressible Aerodynamics
- AME 30333 Theoretical and Experimental Aerodynamics
- AME 30341 Aerospace Structures
- AME 30381 Orbital and Space Dynamics
- AME 40431 Gas Turbines and Propulsion
- AME 40451 Aerospace Dynamics
- AME 40461 Flight Mechanics and Introduction to Design
- AME 50581 Space Systems and Analysis
- AME 60630 Microparticle Dynamics
- AME 60631 Experimental Methods in Fluids
- AME 60632 Physical Gas Dynamics
- AME 60638 Turbine Engine Components
- AME 60639 Advanced Aerodynamics

6.2 Bioengineering Concentration

All courses with the BIOE attributes in College of Engineering. Examples are listed below:

- AME 30386 Introduction to Bioengineering [or CBE 30386]
- AME 40548/60548 Biofabrication
- AME 40571/60571 Structural Aspects of Biomaterials [or CBE 40571]
- AME 40671/60671 Orthopaedic Biomechanics
- AME 40572/60572 Introduction to Biomechanics
- AME 60676 Biofluid and Bioheat Transfer
- AME 60672 Cell Mechanics
- AME 60673 Kinematics of Human Motion
- AME 60677 Biomimetic Tissue Engineering:
  Challenges & Applications for Microfabricated Cell Biomaterial Constructs

*[11] *Students in Aerospace Engineering cannot opt for the Aerospace concentration.*

- AME 60678 Biomedical Imaging Modalities
- AME 60679 Nanoparticles in Biomedicine
- AME 60770 Stem Cell Engineering
- CBE 30357 Biotransport
- CBE 40325 Immunoengineering
- CBE 40456 Polymer Engineering
- CBE 40479 Introduction to Cellular and Tissue Engineering
- CBE 40725 Principles of Molecular Engineering
- CBE 40481 Biomedical Engineering Transport Phenomena
- CBE 40483 Topics in Biomolecular Engineering
- CBE 40487 Drug Development and Pharmacology
- CBE 40888 Cellular and Physical Principals of Bioengineering
- CBE 41910 Biomolecular Engineering Lab
- EE 40331 Biomedical Device Engineering and Physics
- EE 40332 Introduction to Biophotnics and Biomedical Optics
- EE 40432 Introduction to Systems Biology
- PHYS 40432 Biological Physics

Any BIOS course 30,000-level or higher Examples are listed below:

- BIOS 30341 Cell Biology
- BIOS 31341 Cell Biology Laboratory
- BIOS 30344 Vertebrate (Human) Physiology
- BIOS 40340 Human Anatomy
- BIOS 40411 Biostatistics

6.3 Computational Engineering Concentration

- AME 40532 Computational Fluid Dynamics
- AME 40541/60541 Finite Element Methods
- AME 50559 Statistical Computing Methods for Scientists and Engineers
- AME 40510 Introduction to Numerical Methods
- AME 60614 Numerical Methods
- AME 60620 Multiscale Modeling
- AME60733 Solar Energy: Photovoltaic Systems
- CE 30125 Computational Methods [or CSE 30125]*
- CE 60130 Finite Elements in Engineering [or CSE 60130 or ACMS 60590]
- CSE 20232 C/C++ Programming
- CSE 40755 Parallel Computing
- MATH 20210 Computer Programming and Problem Solving
- MATH 30720 Discrete Fourier and Wavelet Transforms
- ACMS 40390 Numerical Analysis [or MATH 40390]

6.4 Control and Mechanical Systems Concentration

- AME 30381 Orbital and Space Dynamics*
- AME 40423 Mechanisms and Machines**
- AME 40451 Aerospace Dynamics*
- AME 40453 Automation and Controls
- AME 50521 Intermediate Dynamics
- AME 50551 Introduction to Robotics
- AME 50650 Applied Nonlinear Analysis and Control
- AME 40623/60623 Analytical Dynamics
- AME 40652/60652 Intermediate Controls
- AME 60651 Advanced Vehicle Dynamics
- AME 60654 Advanced Kinematics
- AME 60673 Kinematics of Human Motion
- EE 40455 Control Systems

6.5 Design and Manufacturing Concentration

- AME 30362 Design Methodology**
- AME 30363 Design of Machine Elements**
- AME 40643/60643 Additive Manufacturing
- AME 47431 Special Studies: Designing Energy-Efficient Buildings
- AME 50542 Engineering Analysis of Manufacturing Processes
- AME 40548/60548 Biofabrication
- AME 50551 Introduction to Robotics
- AME 50561 Reliability Engineering
- AME 60642 Manufacturing Systems
- AME 60654 Advanced Kinematics
- AME 60661 Optimum Design of Mechanical Elements
- AME 60662 Topology Optimization
- AME 60742 Metal Forming
- CE 35620 Community-Based Engineering Design Projects
- DESN 40201 Collaborative Product Development

6.6 Energy Concentration

- AME 40401 Energy, Technology and Policy
- AME 40431 Gas Turbines and Propulsion (ME only)
- AME 40472 Electrical and Hybrid Vehicles
- AME 40530 Wind Turbine Performance, Control and Design
- AME 47431 Special Studies: Designing Energy-Efficient Buildings
- AME 50531 Intermediate Thermodynamics
- AME 40532 Computational Fluid Dynamics

- AME 50535 Energy Systems
- AME 50539 Photovoltaic System Design for Engineers
- AME 53631 Molecular Thermodynamics
- AME 40634/60634 Intermediate Heat Transfer
- AME 60636 Fundamentals of Combustion
- AME 60638 Turbine Engine Components
- AME60733 Solar Energy: Photovoltaic Systems
- CBE 40425 Energy, Economics, and Environment
- CBE 40435 Electrochemical Energy and Storage
- CBE 40498 Energy and Climate
- CBE 40911 Fuel Cells Science and Technology
- EE 30372 Electric Machinery and Power Systems
- EE 40472 Electrical and Hybrid Vehicles
- EE 47010 Alternative Energy Devices and Materials
- EE 47015 Electric Vehicles and the Power Grid
- EG 34021 Electromechanical Energy Conversion
- EG 53413 Energy Performance of Buildings
- PHYS 30461 Thermal Physics

6.7 Materials Concentration

- AME 50542 Engineering Analysis of Manufacturing Processes
- AME 40571/60571 Structural Aspects of Biomaterials
- AME 60645 Advanced Mechanical Behavior of Materials
- AME 60646 Failure of Materials
- CBE 30361 Science of Engineering Materials**
- CBE 30362 Laboratory Techniques in Materials Science
- CBE 40461 Structure of Solids
- CBE 60556 Polymer Engineering
- CHEM 30324 Physical Chemistry for Engineers

6.8 Solid Mechanics Concentration

- AME 30341 Aerospace Structures*
- AME 40541/60541 Finite Element Methods
- AME 40572/60572 Introduction to Biomechanics
- AME 60624 Continuum Mechanics
- AME 60625 Advanced Structural Dynamics
- AME 60641 Advanced Mechanics of Solids
- AME 60645 Advanced Mechanical Behavior of Materials
- AME 60646 Failure of Materials
- AME 60741 Computational Nonlinear Solid Mechanics

- AME 60742 Metal Forming

6.9 Thermal and Fluid Sciences Concentration

- AME 30332 Compressible Aerodynamics*
- AME 30333 Theoretical and Experimental Aerodynamics*
- AME 40431 Gas Turbines and Propulsion*
- AME 50531 Intermediate Thermodynamics
- AME 40532 Computational Fluid Dynamics
- AME 60624 Continuum Mechanics
- AME 60631 Experimental Methods in Fluids
- AME 60632 Physical Gas Dynamics
- AME 60633 Introduction to Acoustics and Noise
- AME 40634/60634 Intermediate Heat Transfer
- AME 60635 Intermediate Fluid Mechanics
- AME 60636 Fundamentals of Combustion
- AME 60637 Ionization and Ion Transport
- AME 60638 Turbine Engine Components
- AME 60639 Advanced Aerodynamics
- AME 60676 Biofluid and Bioheat Transfer
- AME 60675 Cardiovascular Fluid Mechanics
- CE 60130 Finite Elements in Engineering

6.10 da Vinci Concentration

Introduction

AME has offered the "da Vinci Concentration (dVC)" for approximately seven years. While AME has called it a "concentration" it has mainly functioned as a means for Mechanical Engineering students to obtain additional flexibility in their program and has not been formally approved by the College Council. Therefore is not a formal concentration and does not appear on a student's transcript. AME wished to formalize this concentration.

Motivation

The concentration is inspired by Leonardo da Vinci, an exemplar of a Renaissance scholar, whose skill set included engineering. This concentration may appeal to those who seek distinction in their engineering education by allowing additional focus on the liberal arts. This can also be considered a means by which a student can be intentional, with foresight and planning, in structuring a sequence of three free electives in lieu of some technical electives.

Requirements

- The concentration is available only to ME students.
- Students must apply for the concentration during their sophomore year (or third year in the case of five year students).
- Students admitted into the dVC will be allowed to count as technical electives three courses (at three credits/course) from the University of Notre Dame's College of Arts and Letters. Two of those courses will qualify as a General Technical Elective, and one as an AME Technical Elective.
- Courses counted towards a dVC cannot be used to fulfill any other program options within the College of Engineering or University.

- Students can't obtain the dVC for an area where they are pursuing a minor.
- Completion of the dVC also requires students in their final term at Notre Dame to register in a zero credit course in AME. The requirement of this course will be for the student to give a thirty minute oral presentation to a committee. The committee is composed of two AME faculty members, and is organized by the dVC student. The committee assigns an S/U grade.
- It is essential that the three liberal arts courses have a coherent intellectual theme as well as depth. The intention of the program is to allow students to pursue topics that are likely not obviously related to their professional degree, but allow them to take advantage of the "universal" nature of knowledge nurtured at a "University." As such, themes that have no straightforward resonance with engineering, e.g. history, theology, literature, language, etc., are especially encouraged.

The application requires a short (one page) description of the theme of the concentration as well as identifying six courses, any three of which may be used to satisfy the concentration coursework requirements. It is important to have some upper level courses identified in the proposal.

Before the proposal is accepted, the Assistant Dean for Undergraduate Studies in the College of Arts & Letters reviews the proposed coursework to evaluate the feasibility of the proposed plan of study. Approval will depend on course availability and consistency of the proposed program with the goals of the dVC. If a student drops out of the program at any time, you will then be required to complete all of the ordinary technical elective requirements of the BSME. Final decisions for admission will be made within AME.

7 Undergrad Research/Thesis

7.1 Undergraduate Research

Most students benefit greatly from becoming involved in research projects and participating in the Department's research activities. AME students may do research for either course credit or as a paid research aide. Please note: students cannot receive credit and be paid for the same research position.

Finding a Research Advisor

To find suitable supervisors and research topics, students should talk to their instructors and academic advisors to find out about on-going research in the Department.

Students can explore the departmental website and the faculty websites for more detailed information on their research. Individual faculty members should be contacted directly to see if they have openings for undergraduate research aides.

Research as a Paid Position

The supervising faculty member will determine if the research can be done as a paid position. Once this decision is made, the student should come the Department office and complete the necessary employment paperwork with Mrs. Donna Fecher.

Research for Credit

AME 18491/28491/38491/48491 are the variable credit course, Undergraduate Research. AME students can use 6 credits of non-classroom courses to fulfill degree requirements in both the Aerospace and Mechanical degree programs.

The permission of the faculty supervising the research is required to register for AME 18491/28491/38491/48491. To register for the course a student should:

- Go to the AME Department office and pick up an Undergraduate Research quest form.
- Complete the form and have the supervising faculty member sign the form indicating he will work with this student.
- Return the form to the Department office.
- The office staff will then enter the approval code for the on-line registration system (should be done within 2 working days) and send the student a confirming email.
- The student then needs to go into InsideND and add the research class to his/her schedule (Note: student must enter the number of credit hours taking when registering).

Research Course Report Requirements

Each individual student should submit a written report of his or her research scholarship commensurate with the number of credit hours they are receiving for the course. Minimum length requirements are

- 1 credit: 5 pages, 12 point font, double spaced
- 2 credits: 10 pages, 12 point font, double spaced
- 3 credits: 15 pages, 12 point font, double spaced

These are minimum page requirements and longer reports are common. If your research resulted in a submitted scholarly publication, then that may be acceptable instead of a separate report. If you wish to go this route, then you must contact Prof. Bill Goodwine at least a week prior to the report due date to give me time to review it and decide.

While some of your work may involve fellow students, you need to submit an individual report, using your own words, describing the research and your findings. You can also describe and acknowledge the work of others, but your contribution should be the focus and clearly identified.

Undergraduate Research Conference

Unless opted out by their advisor, students receiving academic credit for undergraduate research must participate in the annual University Undergraduate Scholars Conference organized by the Center for **Undergraduate Scholarly Engagement**. Participation is required even if the research was completed in the fall semester or summer session preceding the conference.

7.2 Undergraduate Thesis

Eligibility

There are two undergraduate thesis programs in the Department.

Undergraduate Thesis Program: This requires written permission from the Director of Undergraduate Studies. Any undergraduate in the AE or ME program is eligible to write a thesis though it is recommended that only those having strong academic backgrounds should consider this program. Successful completion will be recognized by the words "Graduation with Senior Thesis" on the student's transcript and on the Commencement Exercises announcement.

Procedure for thesis in both programs

A thesis and the work leading up to it must be supervised by an AME faculty member who will be the thesis advisor. The work may have been done over several semesters or years including summers. The thesis advisor will make sure that the quality of the work done and that of the written thesis are acceptable at the level of an undergraduate degree.

The steps to be taken during the semester in which the thesis is submitted and defended are listed below. Each step must be completed before the next. The last dates for each action during this semester are also indicated in parenthesis. The necessary forms for approvals and signatures are available from the AME Department Office and should be submitted to the Administrative Assistant responsible for the undergraduate program.

1. Approval of a request to participate must be obtained from the Director of Undergraduate Studies (by the end of the 2nd week of the semester). This request must be in writing, and must include the endorsement of the thesis advisor.
2. The student must complete a "Change of Major" form that can be obtained in the department office. This form allows the student to formally add the thesis to their degree program so that it is recognized by the Registrar's Office at the University Level.
3. An examining committee should be chosen by the student (by mid-semester break). The examining committee consists of three members: the thesis advisor and two other AME faculty of the student's choice. The student will acquire signatures on the committee selection form from all members of the committee indicating that they agree to read the thesis and participate in the defense examination.
4. The completed thesis should be handed to the advisor (at least 5 weeks before last day of class). The advisor will read the thesis and suggest any changes needed. The student will make these changes, if any, and get the advisor's approval to proceed to the next step.
5. The advisor-approved thesis should be handed to each member of the examining committee (at least 3 weeks before last day of class). The student will provide them with complete, printed copies. The committee members can discuss the thesis with the student before the defense examination if they wish to.
6. The thesis should be defended before the committee in an oral examination (at least 2 weeks before last day of class). The student will schedule a time for an examination that is convenient for all participants, and inform the Departmental Administrative Assistant so that a location can be reserved. One of the faculty, who is not the thesis advisor, will serve as the Chair for this examination. The defense examination will consist of a 30 min (approximate) public presentation followed by questions from the public, and will conclude with a closed-door question-and-answer session with the committee. The defense examination will be at least 90 mins long at the end of which the committee members will vote. A majority vote is needed to approve the

thesis. Approval may be unconditional or conditional; the latter implies that suggested changes must be incorporated in the final version of the thesis. Rejection means that the thesis is not accepted by the Department.

7. The final version of the thesis should be submitted to the Department (by the last day of class). The thesis advisor must make sure that any changes required by the examining committee during the defense examination have been made. The student will send a pdf version of the thesis to the Departmental Administrative Assistant for AME records, and with this all requirements for a thesis will be satisfied.

Guidelines for Thesis

The thesis should be the product of the student's individual and original work. The written document should be produced entirely on a computer and compiled as a single pdf document. The format recommended by the Graduate School for M.S. and Ph.D. students may be followed if desired. A title page (including title of thesis, name of student, and name of advisor), abstract, table of contents, and list of references should be included. The length of the document should be commensurate with its contents, and long computer programs should not be part of the document.

8 Student Organizations and Activities

8.1 Professional Societies

8.1.1 The American Institute of Aeronautics and Astronautics (AIAA) Student Chapter

Faculty advisor: Dr. Thomas Juliano

Since 1963, members from a single professional society have achieved virtually every milestone in modern American flight. That society is the American Institute of Aeronautics and Astronautics. With more than 35,000 individual members and 100 corporate members, AIAA is the world's largest technical society dedicated to the global aerospace profession. Created in 1963 by the merger of the two great aerospace societies of the day, the American Rocket Society (founded in 1930 as the American Interplanetary Society), and the Institute of the Aerospace Sciences (established in 1933 as the Institute of the Aeronautical Sciences), AIAA carries forth a proud tradition of more than 80 years of aerospace leadership.

8.1.2 The American Society of Mechanical Engineers (ASME) Student Chapter

Faculty advisor: Dr. Edward Kinzel

Founded in 1880 as the American Society of Mechanical Engineers, today's ASME is a 120,000-member professional organization focused on technical, educational and research issues of the engineering and technology community. ASME conducts one of the world's largest technical publishing operations, holds numerous technical conferences worldwide, and offers hundreds of professional development courses each year. ASME sets internationally recognized industrial and manufacturing codes and standards that enhance public safety.

The work of the Society is performed by its member-elected Board of Governors and through its five Councils, 44 Boards and hundreds of Committees in 13 regions throughout the world. There are a combined 400 sections and student sections serving ASME's worldwide membership.

8.1.3 The Society of Automotive Engineers (SAE) Student Chapter

Faculty advisor: Dr. Michael M. Stanisic

The Society of Automotive Engineers has more than 84,000 members - engineers, business executives, educators, and students from more than 97 countries - who share information and exchange ideas for advancing the engineering of mobility systems. SAE is your one-stop resource for standards development, events, and technical information and expertise used in designing, building, maintaining, and operating self-propelled vehicles for use on land or sea, in air or space.

Our vision is the advancement of the mobility community to serve humanity. This includes: Capable practitioners worldwide in land, sea, air, space, government, industry, and education and a worldwide network of technically informed mobility practitioners.

8.1.4 Women in Engineering

Notre Dame Women in Engineering encourages women to pursue engineering as an exciting and fulfilling educational and career choice. We bring together women at all levels — undergraduate, graduate, faculty, and alumni — to create a community of support and opportunities for women to thrive.

The Society of Women Engineers (SWE) gives support, guidance and recognition to women engineers and engineering students. Today, SWE is a nationally recognized professional, educational, non-profit, service organization. Its student section membership includes graduate and undergraduate female and male engineers.

8.1.5 Minority Engineering Program

Director: Leo McWilliams

The Minority Engineering Program (MEP) works to establish an environment with programs that will help students of diverse backgrounds succeed and become integrated with the college.

8.2 Honor Societies

8.2.1 TAU BETA PI

Faculty advisor: Leo McWilliams

In 1960, the Indiana Gamma Chapter of Tau Beta Pi was installed at Notre Dame to foster a spirit of liberal culture in the engineering college and to recognize those who have conferred honor upon Notre Dame by distinguished scholarship and exemplary character as undergraduates in engineering or by their attainment as alumni in the field of engineering. Seniors in the top fifth of their class and juniors in the top eighth of their class are eligible for election under rigid standards of scholarship, character, leadership, and service.

8.2.2 PI TAU SIGMA

Faculty advisor: Dr. Swetlana Neretina

In 1963, the Sigma Beta Chapter of Pi Tau Sigma, the national honor society for mechanical engineers, was installed at Notre Dame. Juniors, seniors, and alumni are elected to membership on the basis of scholastic attainment, leadership, quality of character, and a demonstration of probable future success in engineering.

8.2.3 SIGMA GAMMA TAU

Faculty advisor: Dr. Meng Wang

In 1981, the Notre Dame Chapter of Sigma Gamma Tau, the national honor society for aerospace engineers was installed. This organization recognizes and honors those individuals in the field of aeronautics and astronautics who have distinguished themselves through scholarship, integrity, service, and outstanding achievement. Senior students who rank in the top third of their aerospace engineering class are eligible for admission.

8.3 Clubs

8.3.1 Robotic Football Club

Dr. Michael M. Stanisic

Designing and building robot 'players' that compete in an intercollegiate football conference.

8.3.2 Baja SAE

Dr. Michael M. Stanisic

The University of Notre Dame Baja Team is dedicated to competing at the highest level of the Baja SAE competition. The team members learn to apply their engineering education to a demanding project that requires strict time management, budgeting, team organization, precise design, and careful execution of the build. Through the process of taking a design from the concept stages to a tested and raced product, students learn what it takes to be successful in a competitive environment.

8.3.3 E-NABLE

Faculty advisor: Richard Strebinger

Enable ND is focused on using the skills we learn in class to be a "force for good in the world." With a focus on biodesign, Notre Dame Students are working to create prosthetic and assistive technologies for those in the area that need them.

8.3.4 Rocketry Team

The team designs and builds a complex vehicle each year with a projected apogee between 3,500 and 5,500 ft. alongside a mission-oriented payload.

The team competes in the NASA Student Launch against other college teams across the nation which culminates in a final launch in Huntsville, Alabama.

The team not only allows for college students to share in their passion for aerospace, but also encourages them to instill that same passion in the community through educational outreach efforts.