

Interdisciplinary Engineering & Applied Science (IDEAS)

Refer to:

- The [Duke Undergraduate Bulletin](#) section on the [IDEAS program](#) and
- Criterion #5 of the [General Criteria for Baccalaureate Level Degrees](#).

Non-ABET-accredited majors that are interdisciplinary in scope and include engineering and applied science are available. These majors are proposed by the student, approved by a faculty committee, and result in a bachelor of science in engineering degree. Programs with a broad foundation in the engineering sciences also may be developed under this program by those who intend to enter non-engineering professions. Although not individually accredited, these programs satisfy the national general engineering accreditation criteria. Any student, in consultation with their advisor or another faculty member, may propose a unique combination of courses designed to meet particular career objectives. A proposal must be submitted to the associate dean of Pratt School of Engineering and the Engineering Faculty Council for approval; it may be submitted as early as the second semester of the freshman year and must be submitted before the beginning of the senior year. The proposal must include a letter stating the students' reasons for pursuing the suggested program of study.

From 1985 to 2018 sixteen IDEAS curricula were approved.

Six of them were curricula in Biochemical Engineering.

Curricula included from 9 to 16 engineering courses, 12 on average.

ABET general requirements	IDEAS Template
a. One year of Math and Science	9 courses in math and science
b. One and a half year of Eng'g Science and Eng'g Design	13 courses in engineering
c. General Education consistent with the institution	5 SS / H
d. capstone design experience	2 semesters design-oriented independent study

"one year" means 1/4 of the total credits for graduation ... for Duke Engineering that's $(34/4) = 8.5$ courses

IDEAS curriculum minimum requirements

1. 34 courses that include:
 - a. writing 101
 - b. 9 courses in math and the natural sciences
 - c. 13 courses in engineering:
EGR 101, EGR 103/CS 201,
+ 4 eng'g track core + 3 eng'g track electives + 2 eng'g sci electives
+ capstone design, 2 independent study or equivalent (refer to Criterion #5(d) of the [General Criteria for Baccalaureate Level Degrees](#)).
 - i. 5 or more eng'g track core and eng'g track electives at or above 300 level
 - ii. 3 or more eng'g track core and eng'g track electives at or above 400 level
 - d. 1 open track elective (not necessarily an engineering course)
 - i. track course prerequisites may satisfy eng'g sci elective or nat'l sci req's
 - e. 5 Social Science & Humanities
 - i. Cover 3 of 4 distribution areas (FL, CZ, SS, AL)
 - ii. 2 courses in the same department, one of which at 200 level or higher
 - iii. 2 Soc. Sci. & Humanities course requirements may be satisfied by AP credits
 - f. 5 or more free electives
 - i. AP credit may not be applied toward free elective courses
2. Only students with AP credit in Computer Science may substitute CS 201 for EGR 103. For these students CS 201 counts as one of the twelve engineering courses.
3. At least (1) Physics course must be taken post matriculation
4. A student's independent study advisor need not be the student's academic advisor.

Example course sequence for IDEAS curricula

FIRST YEAR

MATH 111L. Calculus I	MATH 112L. Calculus II
CHEM 101DL. Chemistry	PHYS 151L. Mechanics
EGR 103L. or CS 201 Computer Programming	EGR 101 Engineering Design + Communication
Open elective 1	WRITING 101

SECOND YEAR

MATH 218D-2. Linear Algebra + Vector Spaces	MATH 219. Multivariable Calculus
PHYS 152L. Electricity & Magnetism	Natural Science elective
Track core 1	Track core 2
SSH 1	SSH 2

THIRD YEAR

MATH 353. Ordinary + Partial Differential Eq'ns	Open elective 3
Engineering Science elective 1	Engineering Science elective 2
Engineering Track elective 1	Engineering Track elective 2
SSH 3	Open Track elective
Open elective 2	Open elective 4

FOURTH YEAR

Track core 3	Track core 4
Engineering Track elective 3	Open elective 5
Capstone Design, Independent Study or equivalent	Capstone Design, Independent Study or equivalent
SSH 4	SSH 5

A partial list of potential 'Engineering Science Elective' courses.

The engineering science electives should be selected in consultation with the academic advisor.

course	pre-req's
BME 221L. Biomaterials	BME 244L
BME 244L. Quantitative Physiology w/ Biostatistics	EGR 103, Math 218D-2/219, Bio 201/203
BME 260L, Modeling Cell and Molecular Systems	Bio 201, Math 219, BME 244
BME 271, Signals and Systems	ECE 110, Math 218D-2
CEE 301L or ME 366L . Fluid Mechanics	Math 353 (co), EGR 224 (co)
CEE 421, Matrix Structural Analysis	EGR 201
CEE 461, Chemical Principles in Env. Engineering (*)	Chem 101
CEE 462, Biological Principles in Env. Engineering	none
CEE 520, Continuum Mechanics	EGR 201, Math 219, 218D-2, 353?
CEE 530, Introduction Finite Elements	Math 353, 453
ECE 110L, Fundamentals of Elec & Comp Engineering (*)	EGR 103, Math 112 (co)
ECE 230, Micro Elec Devices and Circuits	EGR 103, Phys 152, ECE 110
ECE 250D. Computer Architecture	CS 201
ECE 270L, Intro to Electromagnetic Fields	EGR 103, Phys 152, Math 218D-2, ECE 110L
ECE 280L, Intro to Signals and Systems	ECE 110L
ECE 341L, Solar Cells (*)	Phys 152
EGR 201L. Mechanics of Solids (*)	Math 112, Phys 151
EGR 224L, Elec Fundamentals of Mechatronics	EGR 103, EGR 201, Math 219, Phy 152
EGR 244L, Dynamics	Math 219, EGR 201
ME 221L, Structure and Properties of Solids	Chem 101, EGR 201
ME 331L, Thermodynamics	Chem 101, EGR 201
ME 438, Constructal Theory (*)	none

(*) pre-req's for these engineering science electives are met by the regular engineering requirements

Duke courses that meet the Natural Science requirement for IDEAS curricula

- BIOLOGY 20 AP/IB/IPC credit
- BIOLOGY 201DL Gateway to Biology: Molecular Biology
- BIOLOGY 202DL Genetics and Evolution
- BIOLOGY 215/215L Introduction to Mathematical Modeling in Biology
- BIOLOGY 275A Biology for Engineers: Informing Engineering Decisions (@ NSOE Marine Lab)
- BIOLOGY 311 Systems Biology: An Introduction for the Quantitative Sciences
- CHEMISTRY 201DL Organic Chemistry I
- CHEMISTRY 202L Organic Chemistry II
- CHEMISTRY 210DL Modern Application of Chemical Principles
- EOS 101 The Dynamic Earth
- EOS 102 The Dynamic Ocean
- EOS 201L The Solid Earth: Minerals, Rocks, and Structural Geology
- EOS 202 Ocean and Atmospheric Dynamics
- EOS 370A Introduction to Physical Oceanography (@ NSOE Marine Lab)
- PHYSICS 264 Optics and Modern Physics
- PHYSICS 305 Introduction to Astrophysics
- PHYSICS 361 Intermediate Mechanics
- PHYSICS 513 Nonlinear Dynamics

Additional courses of potential interest

course	pre-req's
Bio 201DL, Molecular Biology	Chem 101,110
Bio 215, Mathematical Biology	Math 219
Bio 223D, Cell and Molecular Neurobiology	none
Bio 383A, Environmental and Human Health	none
Bio 416L. Experimental Microbiology	Bio 201
Chem 201DL, Organic Chemistry I	Chem 101, 110, 21
Chem 202L. Organic Chemistry II	Chem 201
Chem 310. Physical Chemistry I	
Chem 311. Physical Chemistry II	Chem 310
Econ 101D, Economic Principles	none
Econ 201D, Intermediate Microeconomics I	Econ 101, Math 112
Econ 256, Practical Financial Markets	none
Econ 325S, Economic Analysis of Energy Issues	Econ 201
Econ 368, Behavioral Finance	None
Econ 372, Intermediate Finance	Econ 101, Stat 130, Math 219
Econ 377A, Financial Markets and Financial Eng'g	consent
Econ 471, Financial Markets and Investments	Econ 372, Stat 130
Energy 524, Water Quality Health	Math 112, Chem 101
Environ 231, Energy and Environment	consent
Environ 365D. The Modern Regulatory State	none
Environ 501, Environmental Toxicology	Chem 202, Bio 383/223/215
Environ 540, Chem Fate of Organic Compounds	Chem 101, 202
ENVIRON 464 - Math of Dyn Sys of Environ Phenom	Math 121, Phys 151
EOS 101, Dynamic Earth	none
EOS 102, Dynamic Oceans	none
EOS 201, Earth Materials	EOS 101
EOS 202, Atmosphere and Ocean Dynamics	Math 112, Phys 151
EOS 370, Physical Oceanography	Math 122, Phys 152
Phys 264L, Optics and Modern Physics	Phys 152, Math 219
PHY 271L, Electronics	Phys 152, Math 219
Phys 363, Thermal Physics	Phys 264
Phys 414, Intro Biophysics	Bio 201, Phys 363/Chem311
Stat 210, Regression Analysis	Stat 230
Stat 230, Probability	Math 112
Stat 250D, Statistics	Math 219, Stat 230
Stat 323D, Statistical Computing	Stat 210, Stat 250 (pre/co)
Stat 360, Bayesian and Modern Statistics	Stat 210, Stat 230, Stat 250D, Math 218D-2 (co)

Curricula

Risk, Data, and Financial Engineering

Track Core		Pre-reqs
CEE 251L Uncertainty, Design, and Optimization	S	EGR 201 or ECE 110 (pending)
CEE 351 Engineering Systems Optimization	F	CEE 251, Math 219-2 (co)
CEE 690 Risk and Resilience Engineering	F/S	see below
CEE 690 Data Science and Machine Learning	F/S	see below
Track Electives		Pre-reqs
CEE 690 Calculus of Sustainability	S	Math 218D-2
CEE 628 Uncertainty Quantification	S	Math 218D-2, Math 353
ECE 555 Probability for Elec Eng'g		Math 218D-2, CEE 251L, EGR 305
ECE 687D Theory and Algorithms for ML		Math 218D-2, CEE 251L, CEE 351
Econ 204D Econometrics and Data Science	F,S	(Econ 101, 101D or 201D) and (Econ 104D or Stat 111)
Econ 378 Financial Risk Management	?	Econ 205D, 210D,
Energy 590 Economics of Modern Power Systems	F	
<u>FINTECH 533, 535, 536, 540, 545, 564</u>		533 may not satisfy both Track Elec & Capstone reqs
Math 581 Mathematical Finance	F	Math 212, 222, 230, or consent
Math 582/Econ 674 Financial Derivatives		Math 212, 230, or consent
Math 590, Insurance of Life, Death, Math	S	
Stat 240L Probability for Statistical Inference, Modeling, and Data Analysis.		Math 219
Stat 323D Statistical Computing	S	Stat 210 and (Stat 240L) or 230)
Other appropriate course at > 300 level		Approval of Ac. Advisor and Ac. Dean

Example course sequence for the Risk, Data and Financial Eng'g curriculum

FIRST YEAR

MATH 111L. Calculus I	MATH 112L. Calculus II
CHEM 101DL. Chemistry	PHYS 151L. Mechanics
EGR 103L or CS 201 Computer Programming	EGR 101. Engineering Design + Communication
Open elective 1	WRITING 101

SECOND YEAR

MATH 218D-2. Linear Algebra + Vector Spaces	MATH 219. Multivariable Calculus
PHYS 152L. Electricity & Magnetism	Engineering Science Elective 2
EGR 201L. Solids or ECE 110L. Fund'l ECE	CEE 251L. Uncertainty, Design, Optimization
SSH 1	SSH 2

THIRD YEAR

MATH 353. Ordinary + Partial Differential Eq'ns	Math or Natural Science elective
CEE 351. Engineering Economics and Optim	CEE 690 Risk and Resilience Engineering
RDFE engineering elective 1	Capstone Design, Independent Study or Financial Engineering I
Open elective 2	SSH 3
Open elective 3	Open elective 4

FOURTH YEAR

CEE 690 Data Science + Machine Learning	RDFE engineering elective 3
RDFE engineering elective 2	RDFE open elective
Capstone Design, Independent Study or Financial Engineering II	Open elective 5
SSH 4	SSH 5

Computational Simulation and Machine Learning

Track Core		Pre-reqs
EGR 201 Solid Mechanics or BME 244 Quantitative Physiology	F&S F&S	Math 122 Phys 151 EGR 103L, BIO 201 (co) , Math 219, 218D-2, or 353
CEE 690 Data Sci. and Machine Learning	F	EGR 103L, Math 218D-2, Math 219
CEE 530 Intro Finite Elements	F	Math 353, Math 453
ME 555 Sci Computing, Simulation, ML	F	consent
Track Electives		Pre-reqs
CEE 301L Fluid Mechanics	F/S	EGR 201L, EGR 244L (co)
CEE 690 Uncertainty Quantification		Math 218D-2, Math 353
BME 307 Transport Phen in Bio Syst	S	BME 244L, BME 260L, Math 353
ME 336L Fluid Mechanics	F&S	EGR 201L, EGR 224L, ME 331L, Math 353 (co)
CEE 421L Matrix Structural Analysis	F	Math 218D-2/EGR 201L
CEE 425 Analytical and Comp. Solid Mech	?	EGR 201L, Math 219, Math 218D-2
CEE 541 Structural Dynamics	?	EGR 421L and Math 353
Other course at > 300 level		Approval of Ac. Advisor and Ac. Dean

Notes:

- students may select one of: CEE 301L, BME 307, or ME 366L.
- Students may be required to complete three engineering science electives to get to 12 engineering courses in total, depending on courses taken to satisfy Track Elective Pre-req's
- A student's independent study advisor need not be the student's academic advisor.
The academic advisor for students on this track will be Guglielmo Scovazzi
Faculty who could serve as independent study advisors include (but are not limited to): Wilkins Aquino, John Dolbow, Johann Guilleminot, Craig Henriquez, and Guglielmo Scovazzi (director)

Example course sequence for the Computational Simulation And Machine Learning curriculum

FIRST YEAR

MATH 111L. Calculus I	MATH 112L. Calculus II
CHEM 101DL. Chemistry	PHYS 151L. Mechanics
EGR 103L or CS 201 Computer Programming	EGR 101 Engineering Design + Communication
elective	WRITING 101

SECOND YEAR

MATH 218D-2. Linear Algebra + Vector Spaces	MATH 219. Multivariable Calculus
PHYS 152L. Electricity & Magnetism	Natural Science elective
EGR 201L. Solid Mechanics	CSML open elective
elective	Eng'g Sci elective 1

THIRD YEAR

MATH 353. Ordinary + Partial Differential Eq'ns	Math 453. Intro Partial Differential Equations
CEE 690 Data Sci. and Machine Learning	elective
Eng'g Sci elective 2	elective
CEE 421 Matrix Structural Analysis	CEE 301L Fluid Mechanics
elective	elective

FOURTH YEAR

CEE 530 Intro Finite Elements	elective
Capstone Design or Independent Study	Capstone Design or Independent Study
CEE 541 Structural Dynamics	elective
ME 555 Sci. Computing, Simulation ML	elective

Environmental Health and Sustainability (copacetic with pre-med req's)

Track Core (CEE 490 and 3 from remaining 5)		Pre reqs
CEE 490 Calculus of Sustainability	even S	none
CEE 461 Chemical Principles in Env. Eng'g	F	Chem 101DL
CEE 462 Biological Principles in Env Eng'g	S	none
CEE 563 Chem Fate of Organic Compounds	F	none
CEE 566 Environmental Microbiology	F	CEE 462 or instructor consent
CEE 690 Health and Environmental Data Science	S	EGR 103, Math 218D-2, EGR 238
Track Electives		Pre reqs
CEE 565 Environmental Analytical Chemistry	S	Chem 201DL or Chem 401 or consent
CEE 575 Air Pollution Engineering	F	none
CEE 661 Environmental Molecular Biotechnology	odd S	Bio 201L
CEE 666 Aquatic Geochemistry	S	CEE 461 or CEE 561
CEE 667 Chem Transformation of Environ Contam	S	CEE 563
Other course at > 300 level		Approval of Ac. Advisor and Ac. Dean
Electives to meet pre-med req's		Pre-reqs
Bio 201L Molecular Biology	F&S	Chem 101DL
Bio 202L Genetics and Evolution		none
Chem 201DL Organic Chemistry I	F	Chem 101DL
Chem 202L Organic Chemistry II	S	Chem 201DL
Chem 210DL Modern Appl Chemical Principles		Chem 101DL
Biochem 301 Intro Biochemistry		Chem 201DL, 202L
English SS/H		none
Psy 101 Intro Psych or Psy 106/107 Behavior		none
Soc 110D Sociological Inquiry		none
BME 244 Quantitative Physiology		EGR 103L, Math 219 (co), Bio 201 (co)

Example course sequence for the Environmental Health and Sustainability

FIRST YEAR

MATH 111L. Calculus I	MATH 112L. Calculus II
CHEM 101DL. Chemistry	PHYS 151L. Mechanics
EGR 103L or CS 201 Computer Programming	EGR 101 or EGR 121 or CEE 132
WRITING 101	elective

SECOND YEAR

MATH 218D-2. Linear Algebra + Vector Spaces	MATH 219. Multivariable Calculus
PHYS 152L. Electricity & Magnetism *	Chem 201DL. Organic Chemistry I
elective	CEE 575 Air Pollution Engineering
elective	elective

THIRD YEAR

MATH 353. Ordinary + Partial Differential Eq'ns *	elective
elective	CEE 462. Biological Principles in Env Eng'g
Eng'g Sci elective 1	Eng'g Sci elective 2
Bio 201L. Molecular Biology	CEE 565. Environmental Analytical Chemistry
elective	elective

FOURTH YEAR

CEE 461. Chemical Principles in Env. Eng'g	CEE 490 Calculus of Sustainability
Capstone Design or Independent Study	Capstone Design or Independent Study
CEE 566. Environmental Microbiology	CEE 666. Aquatic Geochemistry
elective	elective

- (*) Students developing an IDEAS curriculum in Environmental Chemistry and Microbiology may choose to replace Physics 152L and/or Math 353 with Bio 201L, Bio 202L, Chem II, Orgo I, or Orgo II.
- A student's independent study advisor need not be the student's academic advisor. The academic advisor for students on this track will be Claudia Gunsch. Faculty who could serve as independent study advisors include (but are not limited to): Michael Bergin, Marc Deshusses, Lee Ferguson, Claudia Gunsch (director), Heileen Hsu-Kim, and Mark Wiesner.