ENGINEERING & APPLIED SCIENCE (EAS)

EAS 0010 Pre-First Year Program in WRIT/MATH/BIOL
This course will provide a preview of Engineering Mathematics at Penn, cover classical physics as applied to the kinematics and dynamics of static and moving bodies, provide a four week orientation to the School of Engineering and Applied Science, and give student experience in designing, writing, and debugging basic programs in Java.
0-1 Course Unit

EAS 0091 Chemistry Advanced Placement/International Baccalaureate Credit (Engineering Students Only)
Fall or Spring
1 Course Unit

EAS 0097 Embed Controlled Gardening
A service course intended to integrate concepts of basic physics, biology and electronics and systems engineering for the benefit of Penn engineering students, teachers and students from two minority centered community public schools. The course will engage the participants in the design and implementation of indoors cultivating systems using photo-voltaic (PV) technology to energize LED emulating the needed solar radiation for plant growth, a liquid nutrient distribution system, sensors / actuators capable of selecting the harvestable plants and keeping track of overall system parameters.
Fall or Spring
1 Course Unit

EAS 2030 Engineering Ethics
In this course, students will study the social, political, environmental and economic context of engineering practice. Students will develop an analytical toolkit to identify and address ethical challenges and opportunities in the engineering profession, including studies of risk and safety, professional responsibility, and global perspectives. The course will begin with a foundation in the history of engineering practice and major Western ethical and philosophical theories. Students will then apply this material to both historical case studies, such as Bhopal, the NASA Shuttle Program, and Three Mile Island, as well as contemporary issues in big data, artificial intelligence, and diversity within the profession. Students will consider how engineers, as well as governments, the media, and other stakeholders, address such issues.
Fall or Spring
1 Course Unit

EAS 2040 Technical Innovation & Civil Discourse in a Dynamic World
The promises of today's emerging technologies include longer, healthier lives; safer, faster, and more efficient transportation; and immediate, far-reaching communication mechanisms. Recent advances in machine learning, autonomous systems, nanomaterials, and neurotechnologies offer the potential to dramatically change the way our global society lives, works and shares information. With such prolific power, these technologies also pose new challenges and risks such as reduced individual privacy, political repercussions, and inequitable access to the benefits of technology. Rapid technological innovation often outpaces and challenges established legal regulations, cultural norms, and societal frameworks of communications. A robust civil discourse anchored in technical expertise, cultural context, and inclusivity can foster the optimization of the benefits of emerging technologies. This course is aimed in preparing undergraduate students to engage in and lead such discourses. The students will consider a series of engineering innovations from technical, legal and social perspectives and will hone the analytical and communication skills necessary to identify and address opportunities for civil discourse. Undergraduates must have passed the WRIT requirement.
Fall or Spring
1 Course Unit

EAS 2200 SEAS Global Program - Argentina I
Penn Engineering’s global and local service learning courses aim to improve human lives through sustainable engineering in all corners of the world. These courses offer students the opportunity to use their engineering skills to build solar powered heaters for renewable energy, water and sanitation infrastructure, orthotic devices for children, information technology support and meet other critical needs in areas around the world. Students must apply in early Fall semester to take these courses in the following Spring and Fall terms. There is a program fee associated with each course, but financial aid is available to qualified students. Each program is awards 2 CU of credit. For more information please visit: https://servelearn.seas.upenn.edu/about/
Spring
1 Course Unit

EAS 2210 SEAS Global Program - Argentina II
Penn Engineering’s global and local service learning courses aim to improve human lives through sustainable engineering in all corners of the world. These courses offer students the opportunity to use their engineering skills to build solar powered heaters for renewable energy, water and sanitation infrastructure, orthotic devices for children, information technology support, and meet other critical needs in areas around the world. Students must apply in early Fall semester to take these courses in the following Spring and Fall terms. There is a program fee associated with each course, but financial aid is available to qualified students. Each program is awards 2 CU of credit. For more information please visit: https://servelearn.seas.upenn.edu/about/
Fall
1 Course Unit
EAS 2220 SEAS Global Program - China I
Penn Engineering's global and local service learning courses aim to improve human lives through sustainable engineering in all corners of the world. These courses offer students the opportunity to use their engineering skills to build solar powered heaters for renewable energy, water and sanitation infrastructure, orthotic devices for children, information technology support and meet other critical needs in areas around the world. Students must apply in early Fall semester to take these courses in the following Spring and Fall terms. There is a program fee associated with each course, but financial aid is available to qualified students. Each program is awards 2 CU of credit. For more information please visit: https://servelearn.seas.upenn.edu/about/
Fall
1 Course Unit

EAS 2230 SEAS Global Program - China II
Penn Engineering's global and local service learning courses aim to improve human lives through sustainable engineering in all corners of the world. These courses offer students the opportunity to use their engineering skills to build solar powered heaters for renewable energy, water and sanitation infrastructure, orthotic devices for children, information technology support and meet other critical needs in areas around the world. Students must apply in early Fall semester to take these courses in the following Spring and Fall terms. There is a program fee associated with each course, but financial aid is available to qualified students. Each program is awards 2 CU of credit. For more information please visit: https://servelearn.seas.upenn.edu/about/
Fall
1 Course Unit

EAS 2240 SEAS Global Program - Guatemala I
Penn Engineering's global and local service learning courses aim to improve human lives through sustainable engineering in all corners of the world. These courses offer students the opportunity to use their engineering skills to build solar powered heaters for renewable energy, water and sanitation infrastructure, orthotic devices for children, information technology support and meet other critical needs in areas around the world. Students must apply in early Fall semester to take these courses in the following Spring and Fall terms. There is a program fee associated with each course, but financial aid is available to qualified students. Each program is awards 2 CU of credit. For more information please visit: https://servelearn.seas.upenn.edu/about/
Spring
1 Course Unit

EAS 2250 SEAS Global Program - Guatemala II
Penn Engineering's global and local service learning courses aim to improve human lives through sustainable engineering in all corners of the world. These courses offer students the opportunity to use their engineering skills to build solar powered heaters for renewable energy, water and sanitation infrastructure, orthotic devices for children, information technology support and meet other critical needs in areas around the world. Students must apply in early Fall semester to take these courses in the following Spring and Fall terms. There is a program fee associated with each course, but financial aid is available to qualified students. Each program is awards 2 CU of credit. For more information please visit: https://servelearn.seas.upenn.edu/about/
Fall
1 Course Unit

EAS 2260 SEAS Global Program - Rwanda I
Penn Engineering's global and local service learning courses aim to improve human lives through sustainable engineering in all corners of the world. These courses offer students the opportunity to use their engineering skills to build solar powered heaters for renewable energy, water and sanitation infrastructure, orthotic devices for children, information technology support and meet other critical needs in areas around the world. Students must apply in early Fall semester to take these courses in the following Spring and Fall terms. There is a program fee associated with each course, but financial aid is available to qualified students. Each program is awards 2 CU of credit. For more information please visit: https://servelearn.seas.upenn.edu/about/
Spring
1 Course Unit

EAS 2270 SEAS Global Program - Rwanda II
Penn Engineering's global and local service learning courses aim to improve human lives through sustainable engineering in all corners of the world. These courses offer students the opportunity to use their engineering skills to build solar powered heaters for renewable energy, water and sanitation infrastructure, orthotic devices for children, information technology support and meet other critical needs in areas around the world. Students must apply in early Fall semester to take these courses in the following Spring and Fall terms. There is a program fee associated with each course, but financial aid is available to qualified students. Each program is awards 2 CU of credit. For more information please visit: https://servelearn.seas.upenn.edu/about/
Spring
1 Course Unit

EAS 2280 SEAS Global Program - Ghana I
Penn Engineering's global and local service learning courses aim to improve human lives through sustainable engineering in all corners of the world. These courses offer students the opportunity to use their engineering skills to build solar powered heaters for renewable energy, water and sanitation infrastructure, orthotic devices for children, information technology support and meet other critical needs in areas around the world. Students must apply in early Fall semester to take these courses in the following Spring and Fall terms. There is a program fee associated with each course, but financial aid is available to qualified students. Each program is awards 2 CU of credit. For more information please visit: https://servelearn.seas.upenn.edu/about/
Spring
1 Course Unit

EAS 2290 SEAS Global Program - Ghana II
Penn Engineering's global and local service learning courses aim to improve human lives through sustainable engineering in all corners of the world. These courses offer students the opportunity to use their engineering skills to build solar powered heaters for renewable energy, water and sanitation infrastructure, orthotic devices for children, information technology support and meet other critical needs in areas around the world. Students must apply in early Fall semester to take these courses in the following Spring and Fall terms. There is a program fee associated with each course, but financial aid is available to qualified students. Each program is awards 2 CU of credit. For more information please visit: https://servelearn.seas.upenn.edu/about/
Fall
1 Course Unit
EAS 2420 Energy Education in Philadelphia Schools
Students will learn about basic residential energy efficiency measures and practices from an established community based energy organization, the Energy Coordinating Agency of Philadelphia. Identify and understand fundamental core STEM energy concepts. Develop a short "energy efficiency" curriculum appropriate for middle or high school students. Teach three (3) sessions in a science class in the School District of Philadelphia.
Fall or Spring
1 Course Unit

EAS 2440 Curiosity: Ancient and Modern Thinking about Thinking
This course will examine two approaches to the still unanswered question of what happens when we humans come up with new knowledge. How should we describe the impulse, or set of impulses, that leads us to seek it? What is happening when we achieve it? And how do we describe the new state in which we find ourselves after we have it? We will study the work of contemporary physicists and cognitive scientists on these questions along side the approaches developed by the two most powerful thinkers from antiquity on the topic, Plato and Aristotle.
Not Offered Every Year
Also Offered As: CLST 3803, INTG 3440
1 Course Unit

EAS 2610 Emerging Technologies and the Future of the World
Technological change is always occurring, but the rate of change seems to be accelerating. Advances in robotics, artificial intelligence, cyber, biotechnology, and other arenas generate promise as well as peril for humanity. Will these emerging technologies unleash the innovative capacity of the world, generating new opportunities that help people live meaningful lives? Alternatively, are automation and other technologies chipping away at the labor market in a way that could create severe generational dislocation at best, and national and international turmoil at worst? These questions are important, and have consequences for how we live our lives, how nations interact, and the future of the world writ large. Emerging technologies could shape public policy at the local, national, and international level, and raise questions of fairness, ethics, and transparency. This course takes a unique approach, combining insights from engineering, political science, and law in an interdisciplinary way that will expose students both to the key technologies that could shape the future and ways to think about their potential politics, and society.
Fall or Spring
Also Offered As: INTG 2610, PSCI 2401
1 Course Unit

EAS 3010 Climate Policy and Technology
The course will exam Pacala and Socolow's hypothesis that "Humanity already possesses the fundamental scientific, technical and industrial know-how to solve the carbon and climate problem for the next half-century" Fifteen "climate stabilization wedges" i.e., strategies that each have the potential to reduce carbon emissions by 1 billion tons per year by 2054, will be examined in detail. Technology and economics will be reviewed. Socio-political barriers to mass-scale implementation will be discussed. Pacala and Socolow note "Every element in this portfolio has passed beyond the laboratory bench and demonstration project; many are already implemented somewhere at full industrial scale".
Fall or Spring
Mutually Exclusive: EAS 5050
1 Course Unit

EAS 3060 Electricity and Systems Markets
The course discusses the existing electricity system from technical, economic, and policy perspectives. Basic power system engineering will be reviewed early in the course. Generation, transmission, distribution, and end-use technologies and economics will be discussed. Additional topics will include system operation, industry organization, government regulation, the evolution of power markets, environmental policy, and emerging technologies.
Fall or Spring
Mutually Exclusive: EAS 5060
1 Course Unit

EAS 3200 Basic Chemical Process Safety
Process safety is an important but often overlooked aspect of a chemical engineer's education. When working in chemical engineering, it's simply not possible to learn by trial and error when the error can have catastrophic or dangerous implications. Students will learn the important technical fundamentals to allow them to contribute to a safer future. Chemical process safety is a scientific discipline as important as chemical production. What the students learn here could literally save their life. At the conclusion of the course, the expectation is that students should be able to identify hazards, safety risks and perform inherently safer design for chemical processes. By the end of the course, students will achieve Level I certification from SACHE (Safety and Chemical Engineering Education), a division of AIChE.
Not Offered Every Year
Prerequisite: CBE 1600
1 Course Unit

EAS 3220 Immunology for Bioengineers
Immunology is fast growing field that is critical to human health and therapeutic development and engineering. To better prepare bioengineers for a career in immunotherapy and biotech areas, it is essential for them to learn the fundamental knowledge of the immune system and the diseases associated as well as common and emerging technologies used in immunological research. This will not only enable the students to communicate more effectively in a multidisciplinary team, it will also empower them to take advantage of their training in engineering and mathematics to develop tools to analyze the immune system with great depth, solve important questions in immunology, and engineering new therapeutics. Therefore, the goal of this course is to provide the immunology foundation for engineering students and technical background of commonly used tools and emerging technologies in immunological research. The course is open to upper level undergraduate students who have taken courses in biochemistry and/or cell biology.
1 Course Unit
EAS 4010 Energy and Its Impacts: Technology, Environment, Economics, Sustainability
The objective is to introduce students to one of the most dominating and compelling areas of human existence and endeavor: energy, with its foundations in technology, association to economics, and impacts on ecology and society. This introduction is intended both for general education and awareness and for preparation for careers related to this field, with emphasis on explaining the technological foundation. The course spans from basic principles to applications. A review of energy consumption, use, and resources; environmental impacts, sustainability and design of sustainable energy systems; introductory aspects of energy economics and carbon trading; methods of energy analysis, forecasting; energy storage; electricity generation and distribution systems (steam and gas turbine based power plans, fuel cells), fossil fuel energy (gas, oil, coal) including nonconventional types (shale gas and oil, oil sands, coalbed and tight-sand gas), nuclear energy wastes: brief introduction to renewable energy use: brief introduction to solar, wind, hydroelectric, geothermal, biomass; energy for buildings, energy for transportation (cars, aircraft, and ships); prospects for future energy systems: fusion power, power generation in space. Students interested in specializing in one or two energy topics can do so by choosing them as their course project assignments. Prerequisite: Any University student interested in energy and its impacts, who is a Junior or Senior. Students taking the course EAS 5010 will be given assignments commensurate with graduate standing.
Fall
Mutually Exclusive: EAS 5010
1 Course Unit

The objective is to introduce students to the major aspects of renewable energy, with its foundations in technology, association to economics, and impacts on ecology and society. This introduction is intended both for general education and awareness and for preparation for careers related to this field. The course spans from basic principles to applications. A review of solar, wind, biomass, hydroelectric, geothermal energy, and prospects for future energy systems such as renewable power generation in space. Prerequisite: Junior standing
Not Offered Every Year
Mutually Exclusive: EAS 5020
1 Course Unit

EAS 4030 Energy Systems and Policy
This is a survey course that will examine the current U.S. energy industry, from production to consumption, and its impacts on local, regional, and the global environment. The course will seek to provide a fuller understanding of existing energy systems, ranging from technical overviews of each, a review of industry organization, and an exploration of the well-established policy framework each operates within. Near-term demands upon each energy supply system will be discussed, with particular focus on environmental constraints. Policy options facing each energy industry will be reviewed.
Fall or Spring
Mutually Exclusive: EAS 5030
1 Course Unit

EAS 4080 Building Leadership
This course will build students’ personal leadership skills by helping them to kick-start a venture that they are passionate about. Ideas could range from a non-profit to help provide tutoring skills to local under-represented youth, to designing a product that could be launched on a crowdfunding platform to create a movement to drive more minority representation in books/media. Students must bring their own idea for their project and as we work to build it out, they will develop the leadership skills needed to bring it to life (e.g., networking, harnessing an ecosystem, building out a project plan). Lectures will be a mix lessons on real-world skill building (e.g., for networking - where to start, who to contact) with activities that will be specifically applied to the student’s venture. In addition, guest lecturers will be brought in so that students can learn from their leadership journeys. Students will also be paired with mentors to act as a sounding board and there will be weekly in-class discussions on their projects so that students can push each other as well - similar to how CEO roundtables work. At the end of this course, the goal will be to build enough momentum that students can take their project and continue to build it outside of class. Students will also be pushed to “think big” so that their ideas from just a passion project to something that will have an impact. Prerequisite: Idea for the Passion Project that you want to build and Permission of the instructor.
Summer Term
1 Course Unit

EAS 4990 Senior Capstone Project
The Senior Capstone Project is required for all BAS degree students, in lieu of the senior design course. The Capstone Project provides an opportunity for the student to apply the theoretical ideas and tools learned from other courses. The project is usually applied, rather than theoretical, exercise, and should focus on a real world problem related to the career goals of the student. The one-semester project may be completed in either the fall or spring term of the senior year, and must be done under the supervision of a sponsoring faculty member. To register for this course, the student must submit a detailed proposal, signed by the supervising professor, and the student’s faculty advisor, to the Office of Academic Programs two weeks prior to the start of the term.
Fall or Spring
1 Course Unit
The objective is to introduce students to the major aspects of renewable energy, with its foundations in technology, from a quantitative sustainability viewpoint with its association to economics and impacts on environment and society. This introduction is intended both for general education and awareness and for preparation for careers related to this field, with emphasis on explaining the technological foundation. The course spans from basic principles to applications. A review of energy consumption, use, and resources; environmental impacts, sustainability and design of sustainable energy systems; introductory aspects of energy economics and carbon trading; methods of energy analysis; forecasting; energy storage; electricity generation and distribution systems (steam and gas turbine based power plans, fuel cells), fossil fuel energy (gas, oil, coal) including nonconventional types (shale gas and oil, oil sands, coalbed and tight-sand gas), nuclear energy wastes: brief introduction to renewable energy use: brief introduction to solar, wind, hydroelectric, geothermal, biomass; energy for buildings, energy for transportation (cars, aircraft, and ships); prospects for future energy systems: fusion power, power generation in space. Students interested in specializing in one or two energy topics can do so by choosing them as their course project assignments.
Fall
Mutually Exclusive: EAS 4010
1 Course Unit

The objective is to introduce students to the major aspects of renewable energy, with its foundations in technology, association to economics, and impacts on ecology and society. This introduction is intended both for general education and awareness and for preparation for careers related to this field. The course spans from basic principles to applications. A review of solar, wind, biomass, hydroelectric, geothermal energy, and prospects for future energy systems such as renewable power generation in space.
Spring
Mutually Exclusive: EAS 4020
1 Course Unit

EAS 5030 Energy Systems and Policy
This is a survey course that will examine the current U.S. energy industry, from production to consumption, and its impacts on local, regional, and the global environment. The course will seek to provide a fuller understanding of existing energy systems, ranging from technical overviews of each, a review of industry organization, and an exploration of the well-established policy framework each operates within. Near-term demands upon each energy supply system will be discussed, with particular focus on environmental constraints.
Fall or Spring
Mutually Exclusive: EAS 4030
1 Course Unit

EAS 5050 Climate Policy and Technology
The course will exam Pacala and Socolow's hypothesis that "Humanity already possesses the fundamental scientific, technical and industrial know-how to solve the carbon and climate problem for the next half-century." Fifteen "climate stabilization wedges" i.e., strategies that each have the potential to reduce carbon emissions by 1 billion tons per year by 2054, will be examined in detail. Technology and economics will be reviewed. Socio-political barriers to mass-scale implementation will be discussed. Pacala and Socolow note "Every element in this portfolio has passed beyond the laboratory bench and demonstration project; many are already implemented somewhere at full industrial scale".
Fall or Spring
Mutually Exclusive: EAS 3010
1 Course Unit

EAS 5060 Electricity and Systems Markets
The course discusses the existing electricity system from technical, economic, and policy perspectives. Basic power system engineering will be reviewed early in the course. Generation, transmission, distribution, and end-use technologies and economics will be discussed. Additional topics will include system operation, industry organization, government regulation, the evolution of power markets, environmental policy, and emerging technologies.
Spring
Mutually Exclusive: EAS 3060
1 Course Unit

EAS 5070 Intellectual Property and Business Law for Engineers
Engineers are often on the front line of innovation. The goal of this course is to introduce engineering students to the basics of Intellectual property (IP) and business laws that they will encounter throughout their careers. Understanding these laws is critical for the protection of IP and for the creation and success of high-tech start-up ventures. Market advantage in large part springs from a company's IP. Without legal protection and correct business formation, proprietary designs, processes, and inventions could be freely used by competitors, ruining market advantage. A basic understanding of IP laws, contractual transactions, employment agreements, business structures, and debt-equity financing will help engineering students to become effective employees or entrepreneurs, to acquire investors, and to achieve success. Though open to students of all disciplines, the course will use case studies particular relevance to students of engineering and applied science.
Fall or Spring
1 Course Unit

EAS 5100 Technical Communication and Academic Writing for Non-native Speakers of English
EAS 510 is a writing course designed for graduate students at both the master's and Ph.D. levels. The features of academic writing used in American universities will be explored by analyzing sample texts, papers in various academic disciplines, and the students' own writing. A variety of rhetorical patterns will be practiced. Attention will be paid to organization, development of ideas, clarity, coherence, style, grammar, and mechanics. Instructor permission required for undergraduates.
Fall or Spring
1 Course Unit
EAS 5110 Societal Grand Challenges at the Interface of Technology and Policy
This new collaborative course – co-taught by faculty from the Kleinman Center for Energy Policy, Weitzman School of Design and School of Engineering and Applied Science – uses societal grand challenges as scenarios for identifying repeatable, process-oriented best practices for solving complex, systemic problems in the energy transition. This course is intended for graduate students with a background in either the social sciences (economics, political science, law, or policy) or who are in STEM programs (science and engineering). This course will complement the material covered in the Kleinman Center Introduction to Energy Policy course (ENMG 5020) taught in the fall. It will be an opportunity to learn from one another and build a holistic understanding of the technical and policy dimensions of the energy transition and the global response to climate change and environmental degradation. The course will be broken into three chapters. For the first third of the semester, we will focus on basics of policy and engineering literacy, with each student bringing their own expertise to the table. The best way to truly understand a topic is to teach it, and this chapter of the course will focus on learning how to talk across disciplines and approach challenges in new and unfamiliar ways. The middle third of this course will be built around case studies of grand societal challenges; some of which have seen considerable progress towards being solved, others which are still the subject of great uncertainty and disagreement. Among other topics, this course will explore: The impact of sweeping standards on building and appliance efficiency; the rapid development and mutual reinforcement of renewable energy technologies and policy; the ability of policy to facilitate healthy competition between technologies (hydrogen vs batteries, for example). The allocation of scarce CCUS resources to abate difficult to decarbonize products like cement, steel, and plastics; the importance of grid regulation and market design in ensuring future energy reliability and affordability; and the need for transition-ready environmental policies that protect ecosystems and communities without hindering access to critical resources (metals, minerals, land, etc.). The final third of the semester will be structured largely around group projects for which students with diverse expertise will work together to identify a grand societal challenge and isolate the technical and policy barriers to solving this challenge. These groups will give regular updates to the rest of the class and will work towards making a meaningful contribution to solving their challenge through collaborative problem solving, design, and research. This course will deliver content learning outcomes about technical, societal, and policy aspects of focal grand challenges, while providing all participants (including instructors) experience and skills to address community-derived problems in teams composed of members from disciplines that rarely collaborate. Over time, this course will serve as a working, iterative “laboratory” on parameters that affect the success of convergence style research and problem solving. Spring
Also Offered As: ENMG 5100
1 Course Unit

EAS 5120 Engineering Negotiation
The goal of this course is to teach students of engineering and applied science to be effective negotiators. It aims to improve the way these students communicate virtually any human interaction. The course intends to improve the ability of engineers and other technology disciplines to gain more support more quickly for projects, research product and services development, and marketing. For those wanting to be entrepreneurs or intrapreneurs, the course is designed essentially to find the most value possible in starting up and running companies. Based on Professor Diamond’s innovative and renowned model of negotiation, it is intended to assist those for whom technical expertise is not enough to persuade others, internally and externally, to provide resources, promotions and project approvals; or to resolve disputes, solve problems and gain more opportunities. Rejecting the 40-year-old notions of power, leverage and logic, the course focuses on persuasion by making better human connections, uncovering perceptions and emotions, and structuring agreements to be both collaborative and fair. This course is entrepreneurial in nature and can provide many times more value than traditional persuasion. The Getting More book has sold more than 1 million copies around the world and is also used by universities, corporations (Google), and U.S. Special Operations (SEALs, Green Berets, Special Forces, Marines) to save lives and reduce conflict. From the first day, students will do interactive cases based their own engineering-related problems and based on current problems in the news. There will be diagnostics enabling every student to assess his/her skill and improvements. Fall or Spring
1 Course Unit

EAS 5450 Engineering Entrepreneurship I
Engineers and scientists create and lead great companies, hiring managers when and where needed to help execute their vision. Designed expressly for students having a keen interest in technological innovation, this course investigates the roles of inventors and founders in successful technology ventures. Through case studies and guest speakers, we introduce the knowledge and skills needed to recognize and seize a high-tech entrepreneurial opportunity - be it a product or service - and then successfully launch a startup or spin-off company. The course studies key areas of intellectual property, its protection and strategic value; opportunity analysis and concept testing; shaping technology driven inventions into customer-driven products; constructing defensible competitive strategies; acquiring resources in the form of capital, people and strategic partners; and the founder’s leadership role in an emerging high-tech company. Throughout the course emphasis is placed on decisions faced by founders, and on the sequential risks and determinants of success in the early growth phase of a technology venture. The course is designed for, but not restricted to, students of engineering and applied science and assumes no prior business education. Prerequisite: Third or Fourth year or Graduate standing Fall or Spring
Also Offered As: IPD 5450
1 Course Unit
EAS 5460 Engineering Entrepreneurship II
This course is the sequel to EAS 545 and focuses on the planning process for a new technology venture. Like its prerequisite, the course is designed expressly for students of engineering and applied science having a keen interest in technological innovation. Whereas EAS 545 investigates the sequential stages of engineering entrepreneurship from the initial idea through the early growth phase of a startup company, EAS 546 provides hands-on experience in developing a business plan for such a venture. Working in teams, students prepare and present a comprehensive business plan for a high-tech opportunity. The course expands on topics from EAS 545 with more in-depth attention to: industry and marketplace analysis; competitive strategies related to high-tech product/service positioning, marketing, development and operations; and preparation of sound financial plans. Effective written and verbal presentation skills are emphasized throughout the course. Ultimately, each team presents its plan to a distinguished panel of recognized entrepreneurs, investors and advisors from the high-tech industry.
Fall or Spring
Prerequisite: EAS 5450
1 Course Unit

EAS 5490 Engineering Entrepreneurship Lab
Engineering Entrepreneurship Lab applies the principles of engineering and engineering entrepreneurship to a real-world problem of your specific field of study or professional interest. You will develop a venture based on a high-tech concept of your choosing (the one that you submitted as part of your application to the course). Like its prerequisite, EAS545 Engineering Entrepreneurship I, the course is designed expressly for students of engineering and applied science having a keen interest in technological innovation. Throughout the course you will formulate and test hypotheses using Lean Startup methodologies to develop key aspects of the venture including product development, customer and market development, team building and operations, and financial modeling and planning. The primary objective of the course is to develop a venture characterized by market-driven, high-tech product-service offering with a clear and validated product-market fit, an operational plan to bring your offering to market, and a plan to secure the resources required for execution of your plan. As discussed in EAS545, primary market research is essential to achieving product-market fit and validating all aspects of your business model. The success of your venture and your grade in the course will depend on the results of this research and testing process. Ideally, your work in this course results in your high-tech venture outside of class and beyond the hallowed halls of Penn!
Spring
Prerequisite: EAS 5450
1 Course Unit

EAS 5740 How to Use Data
This course is an introduction for those who want to learn about the mechanics of data, performing data analysis to gain insights, applying data science techniques to make predictions, and applying data analytics to answer questions and to address interesting business problems. Students will learn how to interpret and frame business problems to be addressed by analytics. The course will also cover different elements of the data analytics process, including data wrangling and cleaning, data exploration and descriptive analytics, data modeling, machine learning, predictive analytics, data visualization and the presentation of analysis and insights using data storytelling.
Prerequisite: CIT 5910
.5 Course Units

EAS 5830 Blockchains
This course is an introduction to the technology that powers blockchains like Bitcoin and Ethereum. We will cover the key cryptographic tools that enable blockchains – collision-resistant hash functions and digital signature schemes. We’ll learn about the architecture of different blockchains, their consensus mechanisms, economics and how to interact with them. The assignments in this course are primarily coding-based. We will learn to read and write from the blockchain using Python libraries, and write our own smart contracts in Solidity. At the end of this course, students should understand the power and limitations of blockchain technology and be able to develop software that interacts with current blockchain platforms.
Prerequisite: CIT 5910 AND CIT 5920
0.5 Course Units

EAS 5900 Commercializing Information Technology
EAS 590 provides real world, hands-on learning on what it's like to actually start a high-tech company. We do that by using the Lean LaunchPad framework for Web start-ups. This class is not about how to write a business plan. Instead you will be getting your hands dirty talking to customers, partners, competitors, as you encounter the chaos and uncertainty of how a start-up actually works. EAS 590 provides real world, hands-on learning on what it’s like to actually start a high-tech company. We do that by using the Lean LaunchPad framework for Web start-ups. This class is not about how to write a business plan. Instead you will be getting your hands dirty talking to customers, partners, competitors, as you encounter the chaos and uncertainty of how a start-up actually works.
Fall or Spring
1 Course Unit

EAS 5910 Leading Technology Teams
Engineers routinely work in teams collaborating with experts from multiple fields to address increasingly large complex problems/opportunities. EAS 591, Leading Technology Teams, focuses on the dynamics of innovative, interdisciplinary, cross-functional teams. We examine ways to improve team performance by exploring technology leadership issues from multiple perspectives (i.e., the individual, the team, and the organization). Developing skills to be an effective technology team member, leader, and/or sponsor will provide you with a competitive advantage, not only for getting your first job but also for success throughout your career.
0.5 Course Units

EAS 5920 Service Learning and Leadership
This course is designed to train the student leaders for service learning programs and exposes students to relevant skills, including leadership, risk management, cultural competency, and organizational dynamics.
1 Course Unit
EAS 5950 Foundations of Leadership
The goal of EAS 595 is to increase your capacity to effectively lead throughout your career and wherever you find yourself in an organization. This involves understanding and learning about yourself and about working effectively with others. The course starts with an identification of values, strengths, preferences and passions. It then proceeds with the personal and interpersonal and moves through the strategic aspects of leadership by bringing together aspects of management science, social psychology, psychology of personality and behavioral economics. Topics include teamwork and team dynamics, identifying life's goals and dreams, decision making, valuing differences, understanding the dynamics of influence, using power with integrity, giving and receiving feedback, leading change, and discovering where we can make our contribution.
Fall or Spring
1 Course Unit

EAS 8950 Professional Master's Academic Field Studies
This class allow master's students to pursue full-time internship opportunities in the Fall semester to apply what they have learned in practice. The student is required to work 20-40 hours a week, 12-15 week long full-time internships. International students under this academic field study track will be eligible for full-time CPT. As part of the application for field studies, students have to attach their coursework plan and receive approval from their program director to make sure they can meet all program requirements in 10 CU's (11 CU's for BIOT). Prerequisites: This class is restricted to SEAS Master's students only. Students can apply after their first two semesters of academic work at Penn. Students must complete at least 6 CU's (course units) between their first two semesters during their first year. Academic field studies can only be done once for the duration of a master's student studies at Penn. For students pursuing a single Master's degree, the field study period is usually the summer and continuing into the Fall semester of the second year. This option is not permitted in the final semester in which the student is graduating. As part of the application for field studies, students have to attach their coursework plan and receive approval from their program director to make sure they can meet all program requirements in 10 CU's (11 CU's for BIOT). Students on a single master's degree have to graduate within 2 years. Dual degree masters students have to graduate within 3 years. Student must be in good academic standing (minimum GPA 3.0) with their program and the University. Those that are not, are unable to apply for the track. It is the student's responsibility to apply for CPT through ISSS. Students have to submit an academic field study proposal at least one month before the Spring term ends. Students that receive an offer to extend their Summer internship, must turn in their proposal no later than August 1st. Proposal requires details on internship work, explain relevance to student’s field of study, and requires a supervising faculty member. Students apply for field study has to have an internship offer from company. It is not the responsibility of Penn to help students find an internship.
1 Course Unit

EAS 8960 Professional Master’s Career Development
This class on professional career development broadly exposes students to organized workshops and seminar talks related to career development and research development. In career development, workshops will be held by career services staff related to identifying career interests, interview strategies, and career fair preparation. The research seminar talks are geared toward giving students exposure to research activities at Penn. The research seminar talks will be offered by individual departments and research programs, and include invited talks by external or internal faculty members. Students will receive a S/U grade and submit a final report at the end of the semester. Prerequisite: This class is restricted to SEAS Master's student only. Master's students can take the class at any time. However, the recommendation time to take this course is Fall semester of the second year.
1 Course Unit

EAS 8980 CPT Research Practicum.
Fall or Spring
1 Course Unit

EAS 9000 Responsible Conduct for Research in Engineering
Fall or Spring
1 Course Unit