IPD 500 Product Engineering Basics
The course targets non-engineering majors interested in understanding engineering approaches to product fabrication. The course covers a broad variety of engineering topics including mechanical, electrical, computer, and material science. Many of these topics would normally be full courses in themselves. This course intends to teach familiarity with a focus on hands-on practice as applied to products. Students will briefly use equipment such as MTS materials testing machines, mills, lathes, oscilloscopes, laser cutters, photodiodes, motors, servos, microcomputers as well as engineering software such as Solidworks, C compilers, Labview, Matlab, and Cambridge Engineering Selector. The course develops basic design skills. Course not offered every year. Prerequisites: MEAM 101, MEAM 150, and MEAM 210, or graduate standing in the School of Engineering, Design, or Wharton with similar experience. Activity: Lecture 1.0 Course Unit

IPD 501 Integrated Computer-Aided Design, Manufacturing and Analysis
The majority of today's engineered products move through an advanced computer-aided workflow which greatly speeds design and process time. This course will explore the fundamental components of this workflow through a combination of lectures, hands-on exercises, and a semester design project. General course topics include: fundamental design principles, project definition and needfinding, advanced computer-aided design, rapid prototyping techniques, computer-controlled machining, and an in-depth exploration of the modern analysis and simulation tools that have revolutionized the way in which products are designed. Enrollment is limited. Course not offered every year. Prerequisites: MEAM 101, MEAM 150, and MEAM 210, or graduate standing in the School of Engineering, Design, or Wharton with similar experience. Activity: Lecture 1.0 Course Unit

IPD 503 Design Fundamentals
The creation of a successful product requires the integration of design, engineering, and marketing. The purpose of this intensive studio course is to introduce basic concepts in the design of three-dimensional products. For purposes of the course, design is understood as a creative act of synthesis expressed through various modes of 2-dimensional and 3-dimensional representation. The course develops basic design skills ranging from hand sketching to the use of digital modeling software and rapid prototyping. Fulfills the requirement for a design background course in the interdisciplinary graduate program in Integrated Product Design (IPD). Taught by: Richard Wesley. Course usually offered summer term only. Also Offered As: ARCH 303 Activity: Studio 1.0 Course Unit

IPD 504 Rehab Engineering and Design
Students will learn about problems faced by disabled persons and medical rehabilitation specialists, and how engineering design can be used to solve and ameliorate those problems. The course combines lectures, multiple design projects and exercises, and field trips to clinical rehabilitation facilities. Students will have substantial interaction with clinical faculty, as well as with patients. Prerequisite: Graduate students or permission of the instructor. Course usually offered in fall term. Also Offered As: BE 514 Activity: Lecture 1.0 Course Unit

IPD 509 Needfinding
Needfinding is an approach that puts people and their needs at the center of product development and business strategy creation. Over 90% of new products introduced into the marketplace fail. A good portion of these failures are due to lack of understanding of end consumers and their needs. To develop truly successful new products, it’s not enough just to ask people what they need or want. Designers and engineers need tools and techniques to get beyond what people can explicitly state and determine their implicit needs. Needfinding is an approach for developing deep insights that provide strategic direction for corporations and open up new possibilities for product development. In this class students will gain a toolset from which to develop their own approaches to conducting research for design: learning how to think about other people, about culture, and about new perspectives. They will also learn tactical skills: how to define research questions, how to conduct observations and interviews, how to interpret results, how to synthesize them into fodder for design, and how to communicate their findings in a way that is compelling and actionable for designers, marketers, and business strategists. This class is designed for graduate students and upper level undergrads with a specific interest in product design or design thinking. One-term course offered either term. Activity: Lecture 1.0 Course Unit

IPD 511 How to Make Things: Production Prototyping Studio
The course centers around a sequence of three projects that each culminate in the design and fabrication of functional objects. A 2D Design, 3D Design, and final "Micro-Manufacturing" project will introduce students to a wide variety of design, engineering, and fabrication skills made possible by the new Studios @ Tangen Hall. The micro-manufacturing final project will task interdisciplinary student teams to create a "micro-business" where they will design and utilize 3D printed molding and casting techniques to create a small-scale run of functional products. These products will then be showcased in an end of semester exposition, where the teams will merchandise and market their products to the Penn community. This exhibition will also be a wonderful inaugural use of the student and alumni retail space on the 1st floor of Tangen Hall and serve as a great university-wide event to show case the work of SEAS students. Requires proficiency in solid modeling software (e.g., SolidWorks, Maya, Rhino), practice with design process, and hands-on fabrication experience. Taught by: Dustyn Roberts. Also Offered As: MEAM 411, OIDD 411, OIDD 511 Activity: Studio 1.0 Course Unit
### IPD 514 Design for Manufacturability
This course is aimed at providing current and future product design/development engineers, manufacturing engineers, and product development managers with an applied understanding of Design for Manufacturability (DFM) concepts and methods. The course content includes materials from multiple disciplines including: engineering design, manufacturing, marketing, finance, project management, and quality systems. Prerequisite: Senior or graduate standing in the School of Design, Engineering, or Business with completed product development and/or design engineering core coursework or related experience.
Course usually offered in spring term  
Also Offered As: MEAM 101, 210  
Activity: Lecture  
1.0 Course Unit

### IPD 515 Product Design
This course provides tools and methods for creating new products. The course is intended for students with a strong career interest in new product development, entrepreneurship, and/or technology development. The course follows an overall product design methodology, including the identification of customer needs, generation of product concepts, prototyping, and design-for-manufacturing. Weekly student assignments are focused on the design of a new product and culminate in the creation of a prototype, which is launched at an end-of-semester public Design Fair. The course project is a physical good - but most of the tools and methods apply to services and software products. The course is open to any Penn sophomore, junior, senior or graduate student.
Also Offered As: MEAM 415, OIDD 415, OIDD 515  
Activity: Lecture  
1.0 Course Unit

### IPD 516 Advanced Mechatronic Reactive Spaces.
This course combines performance art and advanced mechatronics concepts that include the design and implementation of large-scale actuation, advanced sensing, actuation and control. This course pairs design school and engineering students to form interdisciplinary teams that together design and build electro-mechanical reactive spaces and scenic/architectural elements in the context of the performing arts. The two disciplinary groups will be treated separately and receive credit for different courses (ARCH746 will be taught concurrently and in some cases co-located) as they will be learning different things. Engineering students gain design sensibilities and advanced mechatronics in the form of networked embedded processing and protocols for large scale actuation and sensing. Design students learn elementary mechatronics and design reactive architectures and work with engineering students to build them. The class will culminate in a some artistic performance (typically with professional artists) such as a Shakespeare play, robotic ballet, a mechatronic opera.
Course not offered every year  
Also Offered As: MEAM 516  
Prerequisite: MEAM 510  
Activity: Lecture  
1.0 Course Unit

### IPD 519 Introduction to Embedded Systems
An embedded system is the product of a marriage between hardware and software. Embedded systems have grown to be ubiquitous in the modern world - from simple temperature controlled kettles to intricate smart watches with a plethora of functions squeezed into one small package to complex rovers for space exploration. This course introduces the theory and practice of developing embedded systems through exploration of modern microcontroller architectures and culminates in a final project where students have the opportunity to synthesize and apply their knowledge in a project of their own design. Previous programming experience (Preferably C), Some exposure to circuit/electronics; Undergraduates who have taken ESE350 are not permitted to take this course.
Taught by: Kim Luong  
Course usually offered in fall term  
Also Offered As: ESE 519  
Activity: Lecture  
1.0 Course Unit

### IPD 521 Designing Smart Objects for Play and Learning
Today's children enjoy a wide array of play experiences, with stories, learning, characters and games that exist as physical stand-alone objects or toys enhanced with electronics or software. In this course, students will explore the domain of play and learning in order to develop original proposals for new product experiences that are at once tangible, immersive and dynamic. They will conduct research into education and psychology while also gaining hands-on exposure to new product manifestations in a variety of forms, both physical and digital. Students will be challenged to work in teams to explore concepts, share research and build prototypes of their experiences in the form of static objects that may have accompanying electronic devices or software. Final design proposals will consider future distribution models for product experiences such as 3D printing, virtual reality and software-hardware integration. Instruction will be part seminar and part workshop, providing research guidance and encouraging connections will subject matter experts throughout the Penn campus.
Course usually offered in fall term  
Also Offered As: ARCH 721  
Activity: Seminar  
1.0 Course Unit

### IPD 525 Ergonomics/Human Factors Based Product Design
Human Factors and Ergonomics knowledge is a critical component of a product designer or design engineer’s toolbox. This course teaches the direct application of existing human factors/ergonomic data to the creation of new product designs. Applying human factors knowledge to problem solving for product design happens throughout the design process. It is a useful input as initial ideas begin to ut and as a way to verify completed concepts through directly documented user testing and design iteration. The course would be a mini-lecture/studio style course in which the students will work in class on assigned projects, finding, analyzing, extrapolating and applying data to design solutions and creating mockups, modeland prototypes for user testing of their designs.
Course usually offered in fall term  
Activity: Lecture  
1.0 Course Unit
IPD 527 Industrial Design I
This course provides an introduction to the ideas and techniques of Industrial Design, which operates between Engineering and Marketing as the design component of Integrated Product Development. The course is intended for students from engineering, design, or business with an interest in multi-disciplinary, needs-based product design methods. It will follow a workshop model, combining weekly lectures on design manufacturing, with a progressive set of design exercises.
Course usually offered in spring term
Also Offered As: ARCH 727
Activity: Lecture
1.0 Course Unit

IPD 528 Design of Contemporary Products: Mass Customization
Personalization is quickly becoming the norm for mass production in a variety of consumer-centric industries. From retail to food, the idea of designing and making custom-made products tailored to fit one's lifestyle will be our exploration. Utilizing digital design innovations, we are able to incubate ideas, prototype, test and be entrepreneurial in design to create these individualized products. Cues from these industries will be used to shift both cultural and experiential product design from a regional discovery to a global focus. This course will embrace digital design and utilize its engagement with manufacturing solutions for a physical output. Through research and a series of design exercises, the approach will be built upon several strategies including adaptability, materiality, fabrication, modularity, and human-centric design. The final project will interpret the research and result in the creation of a design strategy for a mass customized product or system. This course will explore product design solutions through a combination of physical and digital design methods. Beginning with an examination of case studies, students will gain a sense of the breadth of product and interaction design practice as it applies to smart objects. Through a series of lectures and hands-on studio exercises, students will explore all aspects of smart object design including expressive behaviors (light, sound and movement), interaction systems, ergonomics, data networks and contexts of use. The course will culminate in a final project that considers all aspects of smart object design within the context of a larger theme.
Course usually offered in spring term
Also Offered As: ARCH 728
Activity: Seminar
1.0 Course Unit

IPD 529 Designing Connected Objects and Experiences
The objective of this course is to introduce students to a more conceptual, creative, and meaningful approach to creating interactive functional objects utilizing analog, digital, and electronic skillsets acquired through the core engineering curriculum. This course will cover basics of design as an art form, wearables design, electronic sensors, and creating connected devices. Students will be challenged to create 3 pieces of work both individually and in teams culminating in a gallery show of the students' work. Visit the course website at www.ipd529.com to view previous student work.
Course usually offered in fall term
Activity: Lecture
1.0 Course Unit

IPD 544 Postdigital Craft
As we have entered a postdigital era, the dominance of a purely technological approach as a vehicle for design innovation has waned. Questions of substance and disciplinary autonomy have found their way back into the contemporary cultural discourse, enriching the way we examine and deploy advanced technologies towards novel expressions in architecture. This seminar will investigate, through the production of estranged objects, opportunities for design that are being generated at the intersection of machinic and human minds, and speculate on possible futures in which concepts of nature and technology have been inseparably intertwined.
Course usually offered in spring term
Also Offered As: ARCH 744
Activity: Seminar
1.0 Course Unit

IPD 545 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
One-term course offered either term
Also Offered As: EAS 545
Activity: Lecture
1.0 Course Unit

IPD 551 Design Processes
This studio is structured for IPD students as an intensive, interdisciplinary exploration of Design as purposeful for Integrated Product Design. The goal of the studio is to give students a firsthand experience of various processes involved in creating successful integrated product designs. This first semester of the four-semester studio sequence focuses on giving students experience developing designs based on a range of starting points: form, function, materiality and manufacturing process. Students will practice design through rigorous, consistent processes for thinking through the evolution of their ideas. In this course, they will go through an entire design process from conceptualization to design to producing prototypes. They will be taught to focus on the specifics of their designs, causing them to be conscious of what drives their choices as designers and providing them with a wider range of tools to design from in successive projects. Course work will involve readings, assignments, class participation, in-class exercises, a mid-term presentation and a final submission.
One-term course offered either term
Activity: Lecture
1.0 Course Unit
IPD 552 Problem Framing
In the second semester of the four-semester studio sequence, we ask students to take a step back from what and how they are designing and ask the question of why they are designing it. We will teach them a rigorous process for understanding stakeholder needs and for translating those needs into implications for product design. They will begin to develop greater awareness of the personal, social, competitive and technological contexts that their products fit into, and to learn how to design for those contexts. They will develop the ability to dive into a topic and frame a design problem, and to understand the implications of how they frame the problem on what they design. Ideally, they will use this process to identify a problem or opportunity to work on for their final project. Course work will involve readings, assignments, class participation, in-class exercises, and a final submission.
Course usually offered in spring term
Activity: Lecture
1.0 Course Unit

IPD 568 Integrative Design Studio: Biological Design
This course is a research-based design studio that introduces new materials, fabrication, and prototyping techniques to develop a series of design proposals in response to the theme: Biological Design. The studio introduces life sciences and biotechnologies to designers, artists, and non-specialists to develop creative and critical propositions that address the social, cultural, and environmental needs of the 21st century. The course will be a pilot study of the first biodesign challenge organized by CUT/PASTE/GROW. The final projects will be submitted to a competition and the winning entry will be featured at Biofabricate in Summer 2017.
One-term course offered either term
Also Offered As: FNAR 268, FNAR 568
Activity: Studio
1.0 Course Unit

IPD 572 Design Thinking
Creating new product concepts was once a specialized pursuit exclusively performed by design professionals in isolation from the rest of an organization. Today's products are developed in a holistic process involving a collaboration among many disciplines. Design thinking - incorporating processes, approaches, and working methods from traditional designers' toolkits - has become a way of generating innovative ideas to challenging problems and refining those ideas. Rapid prototyping techniques, affordable and accessible prototyping platforms, and an iterative mindset have enabled people to more reliably translate those ideas into implementable solutions. In this course, students will be exposed to these techniques and learn how to engage in a human-centered design process.
Course usually offered in fall term
Also Offered As: ARCH 725
Activity: Seminar
1.0 Course Unit

IPD 590 Special Topics in Integrated Product Design
This course will be offered when demand permits. The topics will change due to the interests and specialties of the instructor(s). Some topics could include: Advanced Manufacturing, Design of Interactive Objects, Medical Devices and Sustainable Products.
Course not offered every year
Activity: Lecture
0.5 Course Units

IPD 599 Master's Independent Study
One-term course offered either term
Activity: Independent Study
1.0 Course Unit