ARCHITECTURE (ARCH)

ARCH 0110 Design, Race, and Climate Justice
Through a critical and historical lens, students will examine material, spatial, and ecological practices in architecture and design that perpetuate racial inequities and exacerbate climate injustices. This course will challenge students to consider the ways in which design decisions negatively impact black, indigenous, and other people of color, while also causing harm to the environment. The extraction of raw materials for production often leads to the displacement of communities, destruction of habitats and ecosystems, and the depletion of finite natural resources. Historically, urban planning and design has been used to enforce racial segregation and deny access to services and amenities to non-whites. The siting of toxic waste facilities, highways, and industrial zones in low-income communities of color has had devastating impacts on public health and quality of life. Probing the intersectional relationships between design, race, and climate change, students will engage with a range of texts, multimedia content, case studies, and hands-on projects. By the end of the semester, they will have a deeper understanding of the ways in which design impacts communities and the environment and be equipped with knowledge to advance a more just, equitable, and resilient future.

Fall
1 Course Unit

ARCH 0111 Architecture in the Anthropocene
This course will use architecture and the built environmental as a lens to investigate the emerging field of the environmental humanities. Our goal will be to analyze and understand these new intellectual frameworks in order to consider the relationship between global environmental challenges and the process of constructing the built environment. As such, we will oscillate between social and political theory, environmental history, and architectural history and theory. Issues of importance will include: theories of risk, the role of nature in political conflicts; images, design and environmental communication; and the relationship between speculative design and other narratives of the future. These conceptual frameworks will be read alongside examples of related creative projects in art, literature, and architecture, and will be amplified through presentations and discussions with studio faculty and other visitors to the course.

Fall
1 Course Unit

ARCH 0118 Topographical Stories: Architecture, Literature, and Cities
This course will argue a simple thesis: that the spaces of our lives record the stories of our lives. Architecture and literature will be studied, through built works and texts, the latter from both author-architects and fiction writers (novelists, short story writers, and poets). Urban settings throughout the world will occupy our attention, in Berlin, New York, Paris, Milan, London, Venice, Vienna, Chicago, and Shanghai. In much the same way that literacy is both cultivated and preserved in books, cultural memory obtains legible shape in buildings, persisting as long as they do. In a time when so much in life seems in flux social norms, family structures, political allegiances, and so on the power of architecture to give practical affairs orientation and stability is especially important. This course will study how architectural settings provide palpable structure for the events of our lives, particularly those events that occur in cities and their institutions, for cities have always been and remain culture’s most efficient and eloquent articulation. Unlike literature, film, or advertising, architecture performs its signifying role rather quietly and unobtrusively; but this fact does not diminish its capacity to allow us to feel “at home” in many and varied settings. This will be clear to non-architects as soon as they reflect on the role played by domestic arrangements, for even the most prosaic events cannot unfold unless the settings in which they are to occur are “in order.” Less clear perhaps, but no less important is the role that architecture plays in our understanding and experience of community, civility, and the common good. The course will be structured in two parts. The first part, much shorter than the second, will be thematic and a-historical. In the opening lectures the basic topics of the course will be introduced, as will the questions to be asked of the writings, images, buildings, and cities taken up in part two. The second group of studies will look at a number of cities in Europe, the USA, and China. To make the volume of study materials manageable, we will concentrate on developments in the last hundred to hundred and fifty years. The writings of author architects will provide us with some insight into the ways architecture has served a “narrative” function in these cities, but we will also read stories, poems, and parts of novels that augment and enrich those architectural accounts. The idea is that stories about spaces will clarify the ways that spaces are stories.

Spring
1 Course Unit

ARCH 1010 Introduction to Design
An investigation of an object-oriented design process utilizing digital drawings, rapid prototyping, and digital fabrication techniques. This course introduces design as a creative act marking out a synthesis based on observation of a problem, interpretation of possibilities, and translation of a concept into meaningful three-dimensional objects that engage with society and social justice. The course includes a weekly lecture and studio component.

Fall
Also Offered As: DSGN 1011
1 Course Unit
ARCH 1020 Introduction to Architecture
An exploration of the design process utilizing drawing and model-making techniques. Skills of representation and fabrication are introduced in the context of the development of each student’s capacity to observe, interpret, and translate design concepts into physical form. The course includes a weekly lecture and studio component. The primary purpose of this course is to introduce the fundamental concepts and basic skills necessary in the design of a work of architecture. Fundamental concepts include a basic understanding of description, projection, and fabrication – in both two and three dimensions. Basic skills include freehand sketching and drawing, computer-aided drawing (orthographic and axonometric) and the fabrication of scale models using hand, power, and digital tools.
Spring
1 Course Unit

ARCH 2010 Design Fundamentals I
This studio course develops drawing and model-making skills with emphasis on digital representation and digital fabrication. The capacity of nature-inspired design is explored as a foundation for the creative production of new forms of expression. As the second course in the five-semester cumulative sequence of required design studios, ARCH 2010 is preceded by ARCH 1020, an exploration of orthogonal geometry and orthographic and axonometric projection. ARCH 2010 focuses on the non-orthogonal geometries of animate form as the basis for the development of analogical and prototypical structures utilizing 3D digital modeling software and digital fabrication. In ARCH 2020, the design studio following ARCH 2010, students explore the movement of the body as a basis for design.
Fall
Prerequisite: ARCH 1010 AND ARCH 1020
1.5 Course Unit

ARCH 2020 Design Fundamentals II
A studio course exploring the relationship between two-dimensional images and three-dimensional digital and physical models. This studio course develops advanced techniques in digital representation and fabrication through an investigation of the theme of inhabitation in architecture. In the previous semester (ARCH 2010), you looked to nature to study, analyze and then translate complex geometry as it occurs in the natural world. This biomorphic study laid the foundation to learn how to describe non-Euclidean geometries through drawing techniques. Building on this knowledge, in ARCH 2020 you will learn to collect data by carefully mapping a body’s movement during a specific activity. You will analyze, document and ultimately represent this data through drawing. Through this process, you will build an understanding of how a body in motion inhabits space. The range of motion your body maps will be the frame of reference to design a site-specific architectonic enclosure. You will continue to expand your knowledge of digital drawing and fabrication tools using Rhino as your primary 3D modeling software as well as V-Ray for rendering.
Spring
Prerequisite: ARCH 2010
1.5 Course Unit

ARCH 3010 Architecture Design I
An introduction to the design of architecture in the city. Students explore the relationships between two-dimensional patterns and their corresponding three-dimensional interpretations through the orthographic drawings of plan, section, and elevation and three-dimensional digital and physical models. ARCH 3010 focuses on Architecture’s connective role as a whole comprised of parts (a building comprised of components) a contributing part of a whole (a building within an urban, suburban, or rural environment).
Fall
Prerequisite: ARCH 2020
2 Course Units

ARCH 3020 Architecture Design II
An introduction to the design of architecture in the landscape. Issues of mapping, placement, scale, and construction are explored through studio design projects, site visits, and discussions. Course work focuses on the preparation and presentation of design projects emphasizing analytical skills along with the development of imaginative invention and judgment.
Spring
Prerequisite: ARCH 3010
2 Course Units

ARCH 3030 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).
Summer Term
1 Course Unit
ARCH 3101 Spatial Reparations: Material and Territorial Practices of Justice
This interdisciplinary seminar will look at the ways in which acts of historical repair and justice have been materially negotiated through landscapes, sites, buildings, and objects. Historic and collective trauma—from the injustices of colonialism, slavery, war, dispossession, genocide, and ecocide—often involves multiple, interconnected scales of harm, and accordingly demands responses that consider multiple forms of healing. Forms of repair might include the restoration of a local ecosystem, the establishment of an archive, the preservation of a building or street, legal acknowledgement of heirs, the transfer of property rights, or the repatriation of artworks. This course will consider these interdisciplinary approaches and strategies of redemption through both readings and case studies. Case studies will be international in scope and will focus on the ways in which an engaged approach to history can inform responses through landscape, community activism, architecture, monuments, artworks, exhibitions, or archives. Students are not required to have a background in architecture, and students from different disciplinary backgrounds and interests are encouraged to participate. One of the goals of this course is to explore how architectural, urban planning, and landscape approaches to reparations offer forms of knowledge that are productive for other fields. But we will also look at how different disciplines can contribute unique responses to addressing historical trauma and injustice. Classes will consist of weekly discussions of readings, peer feedback on final projects, and student presentations chosen from suggested case studies. As a final project, students may write a research or critical essay, or may produce a visual or graphic work that includes a written component.
Spring
1 Course Unit

ARCH 3110 Theory I: Geometry in Architecture
Following a brief historical overview of Euclidean, stereotomic, projective and descriptive geometry in pre-modern architecture and design, the course examines the writings and works of early 20th-century designers who used regulating lines and numerical harmonic scales to generate and regulate architectural form in accordance with the golden section ratio and the dynamic symmetry of root rectangles. Also examined are works of mid 20th-century architecture and design based on traditional geometric constructions—conic sections (circles, ellipse, hyperbola and parabola) and ruled surfaces (cylinders, cones, hyperboloids, and hyperbolic paraboloids), as well as those derived from polyhedral and geodesic structures. Following an introduction to the geometry of free-form curves characteristic of the digital turn in late 20th-century architecture—including Bezier, B-spline, NURBS (non-uniform rational B-spline), and developable surfaces—the course concludes with an overview of recent efforts to utilize curvature in contemporary architecture within a set of more definitive geometrical and disciplinary boundaries.
Fall
1 Course Unit

ARCH 3120 Theory II: Architecture as Cultural Ecology
This course will study and argue a single thesis: that the architects of the early 20th century did not neglect the environmental and cultural context of their buildings because they were narrowly focused on the production of free-standing and radically new objects of design, but developed designs that combined attention to environmental issues with both imaginative approaches to social and cultural purposes and a new understanding of aesthetic content. A review of contemporary ecological mandates will begin the course. That will then be contrasted with historical and ancient conceptions. In depth studies of specific buildings will follow, viewed as cultural ecologies. The course will then turn to the materials and elements of architecture that have been used to construct cultural ecologies. With a more nuanced view of our inheritance we will ask what is not only possible but necessary for architecture in our time, in both its landscape and urban contexts.
Spring
1 Course Unit

ARCH 4010 Advanced Design Workshop
Advanced design course that engages contemporary contexts of architecture through historical, socio-cultural, and environmental frameworks. Students develop skills for collaboration, self-evaluation, and peer critique while learning how to effectively communicate design ideas to a public audience.
Fall
Prerequisite: ARCH 3020
2 Course Units

ARCH 4020 Advanced Design Seminar
ARCH 4020: Advanced Design Seminar builds on projects and student work completed in ARCH 4010: Advanced Design, refining the studio projects in consideration of real-life constraints and opportunities. It allows students to develop in-depth research and design skills in partnership with community groups and/or industry partners. Addressing questions of design feasibility that extend beyond the scope of an architecture design studio, students will learn how issues such as economics, financing, constructability, design standards, zoning, and building codes ultimately impact the evolution of a project. Students will sharpen their communication and representation skills while creatively responding to the constraints and opportunities inherent within the practice of architecture.
Spring
1 Course Unit

ARCH 4110 Theory I: Geometry in Architecture
Following a brief historical overview of Euclidean, stereotomic, projective and descriptive geometry in pre-modern architecture, the course examines the writings and works of early 20th-century modern architects who used regulating lines and numerical harmonic scales to generate and regulate architectural form in accordance with the golden section ratio and the dynamic symmetry of root rectangles. Also examined are works of mid 20th-century architecture based on traditional geometric constructions—conic sections (circles, ellipse, hyperbola and parabola) and ruled surfaces (cylinders, cones, hyperboloids, and hyperbolic paraboloids), as well as those derived from polyhedral and geodesic structures. Following an introduction to the geometry of free-form curves characteristic of the digital turn in late 20th-century architecture—including Bezier, B-spline, NURBS (non-uniform rational B-spline), and developable surfaces—the course concludes with an overview of recent efforts to utilize curvature in contemporary architecture within a set of more definitive geometrical and disciplinary boundaries.
Spring
1 Course Unit

ARCH 4120 Theory II: Architecture as Cultural Ecology
This course will study and argue a single thesis: that the architects of the early 20th century did not neglect the environmental and cultural context of their buildings because they were narrowly focused on the production of free-standing and radically new objects of design, but developed designs that combined attention to environmental issues with both imaginative approaches to social and cultural purposes and a new understanding of aesthetic content. A review of contemporary ecological mandates will begin the course. That will then be contrasted with historical and ancient conceptions. In depth studies of specific buildings will follow, viewed as cultural ecologies. The course will then turn to the materials and elements of architecture that have been used to construct cultural ecologies. With a more nuanced view of our inheritance we will ask what is not only possible but necessary for architecture in our time, in both its landscape and urban contexts.
Spring
Prerequisite: ARCH 4110
1 Course Unit
ARCH 4310 Construction I
Lecture course exploring the basic principles of architectural technology and building construction. The course is focused on building material, methods of on-site and off-site preparation, material assemblies, and the performance of materials. Topics discussed include load bearing masonry structures of small to medium size (typical row house construction), heavy and light wood frame construction, sustainable construction practices, emerging + engineered materials, and integrated building practices. The course also introduces students to Building Information Modeling (BIM) via the production of construction documents.
Fall
Mutually Exclusive: ARCH 5310
0.5 Course Units

ARCH 4320 Construction II
A continuation of Construction I, focusing on light and heavy steel frame construction, concrete construction, light and heavyweight cladding systems and systems building.
Spring
Mutually Exclusive: ARCH 5320
1 Course Unit

ARCH 4330 Building Systems Integration
What makes buildings livable and buildable. After the initial concept design and massing studies are complete the next step is detailing. This seminar will examine the detail, how they can inform and enhance a building's design. The primary goals of a building is that it stands up to external forces, protects inhabitants from the elements and provides a healthy environment. This course will look at the individual components of structure, skin and systems. More importantly though, it will examine the connections between them. The class will begin with lectures examining the different systems and then progress into applying these ideas as a whole to individual studio projects. The final results of this course will be a 3D wall section with accompanying details. These details will be developed in a variety of software as chosen by the student.
Recommended options are Revit, Rhino, AutoCAD.
Fall
0.5 Course Units

ARCH 4350 Structures I
Theory applied toward structural form. A review of one-dimensional structural elements; a study of arches, slabs and plates, curved surface structures, lateral and dynamic loads; survey of current and future structural technology. The course comprises both lectures and a weekly laboratory in which various structural elements, systems, materials and technical principles are explored.
Fall
Mutually Exclusive: ARCH 5350
0.5 Course Units

ARCH 4360 Structures II
A continuation of the equilibrium analysis of structures covered in Structures I. The study of static and hyperstatic systems and design of their elements. Flexural theory, elastic and plastic. Design for combined stresses; prestressing. The study of graphic statics and the design of trusses. The course comprises both lectures and a weekly laboratory in which various structural elements, systems, materials and technical principles are explored.
Spring
Mutually Exclusive: ARCH 5360
0.5 Course Units

ARCH 4998 Senior Thesis
The architecture senior thesis provides students with the opportunity to undertake an independent critical and speculative exploration of a chosen theme. The theme is required to connect architecture with at least one other discipline or subject in the College of Arts and Science. In addition, the questions formulated should establish a concrete link to debates that can be identified as architectural, whether belonging to the realm of individual buildings, urbanism, or product design. This means, that departing from a humanistic question, students should seek to establish clear connections to architectural discourse in the process of conducting their thesis. The thesis project initiates a set of issues and methods that students may continue to develop as they embark on their future professional and intellectual careers. Although the thesis is conceived independently, it is conducted under the supervision of faculty advisors and the thesis coordinator. For additional information, please contact the Chair of Undergraduate Architecture.
Spring
Prerequisite: ARCH 3010
1 Course Unit

ARCH 5000 Summer Preparatory Design Studio
The Summer Preparatory Studio offers an intensive drawing and design experience to candidates for admission to the Graduate Program in Architecture who have not completed the necessary design studio prerequisites or who are required to have additional design experience to qualify for matriculation into the Master of Architecture Professional Degree Program in September. Enrollment in this program does not count towards the Master of Architecture degree. The intent of the drawing component of the course is to familiarize the student with primarily black and white mediums (pencil, charcoal, ink, etc). Exercises are designed to sharpen the student's ability to see selectively and to transform image to paper through both line and tonal renditions in freehand sketch form. Exercises will also familiarize the student with basic drafting skills necessary for architectural communication and provide an introduction to computer-aided design through applications of the intensive Rhino and Illustrator tutorials given in the Digital Navigation course. The design part of the course presents a rhythm of basic three-dimensional design studies and simple architectural studio investigations. These are intended to build fundamental skills and acquaint the student with the architectural issues of form/space, conceptualization, transformation of scale, simple functional and constructional problems and a sensitivity to context. Course enrollment is by permit only.
Summer Term
2 Course Units

ARCH 5010 Design Studio I
An introductory architectural design studio through which students develop critical, analytical and speculative design abilities in architecture. Students develop representational techniques for the analysis of social and cultural constructs, and formulate propositions for situating built form in the arena of the urban and suburban environment. The studio initiates innovation through a sequence of projects, spatial models and rule sets that introduce each student to rule-based design processes--in which a reversal of expectations leads to the creation of novel spaces and structures. It introduces computation, geometric techniques, and digital fabrication. Projects explore the formation of space in relation to the body, and the developments of small scale public programs.
Fall
Corequisite: ARCH 5210
2 Course Units
ARCH 5020 Design Studio II
This studio explores urban architecture as an embodiment of cultural values. Siting, enclosure of space and tectonic definition are stressed in order to challenge students to project relevant and inventive architectural situations.
Spring
Corequisite: ARCH 5220
2 Course Units

ARCH 5110 History and Theory I
The first of three required courses in the history and theory of architecture, this is a lecture course with discussion groups that meet weekly with teaching assistants. The course explores fundamental ideas and models of architecture that have emerged over the past three hundred years.
Fall
1 Course Unit

ARCH 5120 History and Theory II
How do architecture, urbanism, and the environment reflect the dominant social, economic, and political changes of the twentieth and twenty-first centuries and how did its vast geopolitical shifts such as Imperialism, Fascism, the Cold War, Neoliberalism, the "War on Terror," and Nationalism reshape architecture culture? How might architecture culture respond and help construct its resistant variants, anti-fascism, anti-imperialism, decolonization, and making "quieter places" in Donna Haraway's sense? How do critical frameworks to rethink positivism, efficiency, standardization, and even utopian thinking become revised through the lenses of queer, postcolonial, critical race, and eco-feminist theory in postwar architectural production? And how do these frameworks allow us to conceive of more equitable ways of being in the world while thinking with a varied pasts? This course provides twelve discursive and theoretical frameworks to rethink architectural history in the twentieth and twenty-first century. Through twelve lectures the course traces critical questions confronting architectural modernity from the violence of settler colonialism to the possibilities of making kin. While we will trace instances of architecture, city planning, landscape and infrastructural developments that corresponded to dominant ways of conceiving modernity and its analog progress narratives, the course is mainly interested in considering resistant paradigms that elide attempts to speak of a unified or homogenous notion of modernity. The course will be active and interactive and will include building a collaborative dictionary of architectural terms.
Spring
1 Course Unit

ARCH 5210 Visual Studies I
The study of analysis and projection through drawing and computer visualization
Fall
Corequisite: ARCH 5010
0.5 Course Units

ARCH 5220 Visual Studies II
A continuation of the study of analysis and projection through drawing and computer visualization.
Spring
Corequisite: ARCH 5020
0.5 Course Units

ARCH 5310 Construction I
Lecture course exploring the basic principles of architectural technology and building construction. The course is focused on building material, methods of on-site and off-site preparation, material assemblies, and the performance of materials. Topics discussed include load bearing masonry structures of small to medium size (typical row house construction), heavy and light wood frame construction, sustainable construction practices, emerging + engineered materials, and integrated building practices. The course also introduces students to Building Information Modeling (BIM) via the production of construction documents.
Fall
Mutually Exclusive: ARCH 4310
0.5 Course Units

ARCH 5320 Construction II
A continuation of Construction I, focusing on light and heavy steel frame construction, concrete construction, light and heavyweight cladding systems and systems building.
Spring
Mutually Exclusive: ARCH 4320
1 Course Unit

ARCH 5350 Structures I
Theory applied toward structural form. A review of one-dimensional structural elements; a study of arches, slabs and plates, curved surface structures, lateral and dynamic loads; survey of current and future structural technology. The course comprises both lectures and a weekly laboratory in which various structural elements, systems, materials and technical principles are explored.
Fall
Mutually Exclusive: ARCH 4350
0.5 Course Units

ARCH 5360 Structures II
A continuation of the equilibrium analysis of structures covered in Structures I. The study of static and hyperstatic systems and design of their elements. Flexural theory, elastic and plastic. Design for combined stresses; prestressing. The study of graphic statics and the design of trusses. The course comprises both lectures and a weekly laboratory in which various structural elements, systems, materials and technical principles are explored.
Spring
Mutually Exclusive: ARCH 4360
0.5 Course Units

ARCH 5990 First Year Technology Lab
ARCH 5999 is a required lab/workshop that accompanies the core technology sequence in the M.Arch program in both the Fall and Spring terms. This non-graded lab section will offer additional instruction, workshops, lab time, and other support to the first year technology courses. Enrollment in ARCH 5999 is required for all undergraduate and graduate Architecture students taking ARCH 4350/5350, ARCH 4356/5356, ARCH 4310/5310, and/or ARCH 4320/5320.
0 Course Units
**ARCH 6010 Design Studio III**
In this studio, students engage architecture in its role as a cultural agent and examine the way buildings establish and organize dynamic relationships between site, program and material. The design of a complex building of approximately 50,000 SF provides the pedagogical focus for this research. Students extend skills in geometrical organization, site analysis and building massing/orientation to relate to program organization, circulation and egress, building systems and materials. The conceptual focus centered on the program of dwelling and how this program can be employed to develop and promote dynamic relationships and conditions through time, both within the building and between the building and the context. Through research and experimentation students integrate ecological processes into their design methodology to support design innovations in the building’s structure, its construction assemblies, environmental systems, and materials. Students work towards a high level of design resolution and visual representation, including the articulation of the building structure and its material assembly/enclosure.

Fall
Corequisite: ARCH 6210
2 Course Units

**ARCH 6020 Design Studio IV**
This studio enables students to develop and resolve the design of a building in terms of program, organization, construction and the integration of structures, enclosure and environmental systems as well as life safety issues. Students select from a range of individually-directed studios within this overall framework. Each instructor develops a different approach and project for their section of this studio. Studios incorporate the expertise of external consultants in advanced areas of technology, engineering and manufacturing.

Spring
2 Course Units

**ARCH 6110 History and Theory III**
This is the third and final required course in the history and theory of architecture. It is a lecture course that examines selected topics, figures, projects, and theories from the history of architecture and related design fields during the 20th century. The course also draws on related and parallel historical material from other disciplines and arts, placing architecture into a broader socio-cultural-political-technological context. Seminars with teaching assistants complement the lectures.

Fall
1 Course Unit

**ARCH 6210 Visual Studies III**
The final of the Visual Studies half-credit courses. Drawings are explored as visual repositories of data from which information can be gleaned, geometries tested, designs refined and transmitted. Salient strengths of various digital media programs are identified and developed through assignments that address the specific intentions and challenges of the design studio project.

Fall
Corequisite: ARCH 6010
0.5 Course Units

**ARCH 6310 D3 Data, Design, Delivery**
A study of the active integration of various building systems in exemplary architectural projects. To deepen students' understanding of the process of building, the course compares the process of design and construction in buildings of similar type. The course brings forward the nature of the relationship between architectural design and engineering systems, and highlights the crucial communication skills required by both the architect and the engineer.

Fall
0.5 Course Units

**ARCH 6330 Environmental Systems I**
An introduction to the influence of thermal and luminous phenomenon in the history and practice of architecture. Issues of climate, health and environmental sustainability are explored as they relate to architecture in its natural context. The classes include lectures, site visits and field exploration.

Spring
0.5 Course Units

**ARCH 6340 Environmental Systems II**
Considers the environmental systems of larger, more complex buildings. Contemporary buildings are characterized by the use of systems such as ventilation, heating, cooling, dehumidification, lighting, communications, and controls that not only have their own demands, but interact dynamically with one another. Their relationship to the classic architectural questions about building size and shape are even more complex. With the introduction of sophisticated feedback and control systems, architects are faced with conditions that are virtually animate and coextensive at many scales with the natural and man-made environments in which they are placed.

Spring
.5 Course Units

**ARCH 6360 Material Formations**
Material Formations introduces robotic production and material dynamics as active agents in design rationalization and expression. The course investigates opportunities for designers to synthesize multiple performance criteria within architecture. Theory, Case-Studies and practical tutorials will focus on the incorporation of analytical, simulation, generative computation and robot fabrication concerns within design. While production is traditionally viewed as an explicit and final act of execution, the course explores the potential for all aspects of building production and use to participate within the creative design process, potentially producing performance and affect. Students will develop skills and experience in computer programming, physics-based simulation, and robot motion planning. A design research project will be undertaken through a number of discrete assignments that require the synthesis and structural performance along with material and robotic production constraints. The course will explore design as the outcome of materially formative processes of computation and production. Structure: the course will commence with weekly lectures and computer-based tutorials, and culminate in a series of intensive incremental learning, and prepare groups to work on a final assignment which involves the robotic fabrication of a small design prototype.

Spring
1 Course Unit
ARCH 6710 Professional Practice I
The course consists of a series of workshops that introduce students to a diverse range of practices. The course goal is to gain an understanding of the profession by using the project process as a framework. The course comprises a survey of the architectural profession - its licensing and legal requirements; its evolving types of practice, fees and compensation; its adherence to the constraints of codes and regulatory agencies, client desires and budgets; and its place among competing and allied professions and financial interests. The workshops are a critical forum for discussion to understand the forces which at times both impede and encourage innovation and leadership. Students learn how architects develop the skills necessary to effectively communicate to clients, colleagues, and user groups. Trends such as globalization, ethics, entrepreneurship, sustainability issues and technology shifts are analyzed in their capacity to affect the practice of an architect.
Spring
0.5 Course Units

ARCH 6741 Curricular Practical Training: Academic Year
Course Description This course provides international Architecture department students the opportunity for practical training in architecture in the United States (CPT). The course develops critical thinking about the organization, operation, and ethics of professional practice in city planning. This course will allow international M.Arch/MSD students to work in an internship in the United States during the academic year without shortening their limited OPT time. The course is offered for .20 course units. The employment must relate to the major and the experience must be part of the program of study. Course enrollment is by permit only.
0.2 Course Units

ARCH 6850 Environmental Readings
In this seminar, we will explore this green thread and analyze its influence on how we shape our environments through design and planning. The course has three parts. Throughout, the influence of literature on design and planning theory will be explored. The first part will focus on three most important theorists in environmental planning and landscape architecture: Frederick Law Olmstead Sr., Charles Eliot and Ian McHarg. The second part of the course will critically explore current theories in environmental planning and landscape architecture. The topics include: frameworks for cultural landscape studies, the future of the vernacular, ecological design and planning, sustainable and regenerative design, the languages of landscapes, and evolving views of landscape aesthetics and ethics. In the third part of the course, students will build on the readings to develop their own theory for ecological planning or, alternatively, landscape architecture. While literacy and critical inquiry are addressed throughout the course, critical thinking is especially important for this final section.
Fall
Also Offered As: CPLN 6850, LARP 6850
1 Course Unit

ARCH 6980 Architectural Association (AA), London
An advanced Architectural Design Studio taught by Homa Farjadi in London at the Architectural Association's School of Architecture. Topics engage aspects of urban life and urban form in London, and vary from year to year. During the fifth term of the Master of Architecture program, up to fifteen students a year may enroll for the semester abroad program in London, England. This is coordinated by Prof. Homa Farjadi and is housed at the Architectural Association (AA), located on Bedford Square in the heart of Bloomsbury. Students enroll in a special design studio, ARCH 702, taught by Prof. Farjadi, and in two elective courses offered by the faculty at the AA.
Fall
2 Course Units

ARCH 6999 Second Year Technology Lab
ARCH 6999 is a required lab/workshop that accompanies the core technology sequence in the M.Arch program in both the Fall and Spring terms. This non-graded lab section will offer additional instruction, workshops, lab time, and other support to the second year technology courses. Enrollment in ARCH 5999 is required for all Master of Architecture students taking ARCH 6330, ARCH 6340, ARCH 6310, and/or ARCH 6360.
0 Course Units

ARCH 7010 Studio V
These advanced elective studios provide opportunities for focused exploration of particular themes in contemporary landscape architecture. Important emerging and accomplished designers, often from divergent points-of-view, interests and backgrounds, are invited to run these studios. Collaborative options (between Landscape and the Departments of Architecture or City Planning) are sometimes offered across the School. In addition to our own faculty who offer some of these studios (Fabiani Giannetto, Gouverneur, Marcinkoski, Mathur, M’Closkey, Neises, Olin, Pezvner, Sanders, Tomlin), visitors have included Paolo Burgi (Switzerland), Peter Latz (Munich), Bernard Lassus (Paris), Margie Ruddick (Philadelphia), Chris Reed (Boston), Peter Beard (London), Nicholas Quennell (New York), Ken Smith (New York), Raymond Gastil (New York), Alessandro Tagliolini (Italy), Ignacio Bunster (Philadelphia), Perry Kulper (Los Angeles), James Wines (New York), Lee Weirntraub (New York), Charles Waldheim (Chicago), Stanislaus Fung (Australia), Dennis Wedlick (New York), Sandro Marpillero (New York), Peter Connolly (Australia), and former associate professor Anita Berrizbeitia. More recent visitors have been Claire Fellman (New York), Catherine Mosbach (Paris), Nanako Umemoto/Neil Cook (New York), Valerio Morabito (Italy), Carol and Colin Franklin (Philadelphia), Keith Kaseman (Philadelphia), Silvia Benedito (New York), Claudia Taborda (London), Mark Thomann (New York), Jerry Van Eyck (New York), and Martin Rein-Cano (Berlin).
Fall
2 Course Units

ARCH 7030 Advanced Architectural Design Studio
An Advanced Architectural Design Studio specifically tailored to post-professional students. Through this studio, students engage in the challenges and opportunities presented by changes in society, technology, and urban experience. Through design projects, they explore alternative modes and markets for practice, along with new directions and new tools for design.
Fall
2 Course Units
ARCH 7040 Advanced Design: Research Studio
In the final semester of the program, students select from three options: 1) an elective design studio, selected from among the advanced architectural design studios offered by the Department of Architecture; 2) a research studio, the exploration of a topic or theme established by an individual faculty member or group of faculty members; or 3) an independent thesis, the exploration of a topic or theme under the supervision of a thesis advisor.
Spring
2 Course Units

ARCH 7050 MSD-AAD Design Research Studio
Students learn from industry leaders by electing their Design research Studio. The second semester design research studio focuses on large scale detail leading to a building design.
2 Course Units

ARCH 7060 Independent Thesis
In the final semester of the program, students select from three options; 1) An elective design studio; selected from among the advanced architectural design studios offered by the Department of Architecture; 2) a research studio, the exploration of a topic or theme established by an individual faculty member or group of faculty members; or 3) an independent thesis, the exploration of a topic or theme under the supervision of a thesis advisor.
Spring
2 Course Units

ARCH 7070 AAD Fabrication Studio
The final studio course in the MSD-AAD sequence. Through this studio, students engage in the challenges and opportunities presented by changes in society, technology, and urban experience. Through design projects, they explore alternative modes and markets for practice, along with new directions and new tools for design.
Summer Term
2 Course Units

ARCH 7080 Bioclimatic Design Studio
An advanced design studio for the MSD-EBD program that synthesizes the concepts and techniques of environmental building design. Topics and materials for the studio are developed in ARCH 7520: EBD Research Seminar, and summarized in a research report at the end of studio.
Summer Term
Prerequisite: ARCH 7510 AND ARCH 7520 AND ARCH 7530
2 Course Units

ARCH 7090 Environmental Building Design Research Studio
Architecture is a process of discovery, of deciding what to work on, before it ever becomes a matter of design (disegno, drawing). For environmental building design, the process of discovery is even more profound, involving issues of resource consumption, modes of living and working, and of ecological interconnectedness that have to be explored before questions of performance can even be addressed. This design studio uses research at multiple scales to identify the topic of the studio, then student teams develop design for buildings of maximum (ecological) power.
Fall
Prerequisite: ARCH 7080 AND ARCH 7510 AND ARCH 7520 AND
ARCH 7530
2 Course Units

ARCH 7100 Contemporary Theory 1989-Present
A chronological overview of the approaches and attitudes adopted by architects, theorists and inter-disciplinary writers from 1993- today that have helped shape the current discourse of architecture. This course will introduce and contextualize key projects, and polemics over the last 25 years. Central themes in this course include the impact of digital technologies and methods of design, production and materiality. These are explored through texts, movements, projects and buildings that help form an overview that has shaped the contemporary condition that we live in. There have been a myriad of different approaches and through a select set of readings and lectures students will be exposed to crucial texts, projects and buildings making students versatile and knowledgeable in the important concepts that shape our current discourse. A focus will be the organization, configuration and articulation of buildings and the conceptual and cultural arguments they are associated. Formal, organizational and material characteristics of this period will be explored. This class will develop students’ knowledge and provide a platform from which they can continue the discussions surrounding architectural thought and practice. The students will learn to communicate their ideas verbally and in writing. Contemporary topics in architecture theory and projects are introduced in a weekly lecture format critical to the shaping of our discipline today. A weekly recitation session allows students to engage with the readings critically in the subject matter. A mid-term and final paper are required to pass this class. (Topics to be covered: Seminal projects and buildings in the last 25 years, situating the architects work within a culture of debate and discourse identifying the important readings surrounding each building/project.)
This course is a requirement of the MSD-AAD curriculum.
Spring
1 Course Unit

ARCH 7110 Topics in Architecture Theory I
A seminar on advanced topics in architectural design and theory. Topics and instructors will vary.
Fall
1 Course Unit

ARCH 7120 Topics in Architecture Theory II
A seminar on advanced topics in architectural design and theory. Topics and instructors will vary.
Spring
1 Course Unit

ARCH 7121 Topics in Architecture Theory II
A seminar on advanced topics in architectural design and theory. Topics and instructors will vary.
1 Course Unit

ARCH 7122 Topics in Architecture Theory II
A seminar on advanced topics in architectural design and theory. Topics and instructors will vary.
1 Course Unit

ARCH 7123 Topics in Architecture Theory II
A seminar on advanced topics in architectural design and theory. Topics and instructors will vary.
1 Course Unit
ARCH 7130 Ecological Thinking in Art and Architecture
This seminar will address the diverse narratives of ecological thinking in the history of art, architecture, and urban planning during the 20th century. The course will contextualize and interrogate contemporary disciplinary discourses as well as historical assumptions related to ecological thinking in art and architectural history and environmentally-conscious practices. By mapping received trajectories of Eco Art, Ecocritical Art History, and Ecological Histories of Architecture and Urban Planning, the course will work from a subtly hidden foundation of eco-historical knowledge that connects these fields of inquiry, while also critiquing these trajectories and seeking to provide more focused and robust alternatives for knowledge production in the present. It aims to attract students from the School of Arts and Sciences and the Weitzman School of Design in a discussion on the interconnected histories of art and architecture during the 20th century.

Also Offered As: ARTH 5770
1 Course Unit

ARCH 7140 Museum as Site: Critique, Intervention and Production
In this course, we will take the museum as a site for critique, invention, and production. As architecture, cultural institution, and site of performance, the museum offers many relevant opportunities. Students will visit, analyze, and discuss a number of local exhibitions and produce their own intervention in individual or group projects. Exhibition design, design of museum, the process of curating, producing artworks ranging from paintings to installation and performance, as well as attention to conservation, installation, museum education, and the logistics and economics of exhibitions will be discussed on site and in seminar. These topics and others will be open for students to engage as part of their own creative work produced for the class and an online exhibition.

Spring
1 Course Unit

ARCH 7150 Contemporary Aesthetic Theory
This course offers a framework for a provocative history of ideas about beauty as they relate to contemporary thinking and their production of form in architecture. In a world increasingly defined by visuality, the concepts of beauty and visual sensation are not mere intellectual exercises but standards that define the very nature of design practice across disciplines, and that are essential to the worlds of objects, automobiles, furniture and architecture in the twenty-first century. Aesthetic theory is about beauty and about form and how it affects us every day. As architecture practice changes, the tools that are used to create form change due to new technologies, new materials and new tools for fabrication and aesthetics gives us an important way in to understanding the relationship between the object created and the user. This occurs in contemporary cultural landscapes in which we exist, and aesthetics is the organizing element. Through lectures and discussions of aesthetics readings in recitations focused on the object, students will work on a term paper that brings a clear understanding of aesthetics and its role in participating in culture through the objects of the automobile, furniture and architecture industries.

1 Course Unit

ARCH 7180 History and Theory of Architecture and Climate
This seminar will explore the history of buildings as mechanisms of climate management, and the theoretical and conceptual frameworks that pertain. In particular, we will examine how visual and mediatic interventions became a crucial aspect of architectural engagement with climate systems, and how, simultaneously, architectural image-making techniques became an important interdisciplinary site for understanding the cultural effects of scientific knowledge.

Spring
1 Course Unit

ARCH 7190 Archigram and Its Legacy: London, A Technotopia
Acknowledging the ubiquitous proliferation of "Hi-Tech" architecture in contemporary London, this research seminar examines the scope of technology as it emerges and re-emerges in the work of various architects currently dominating the city. This scope includes the last strains of post-war urbanism which spawned a legacy of radical architecture directly contributing to the Hi-Tech; a particular focus of the course will be the contributing and contrasting influence provided by the counter-cultural groups of the 60's - Archigram, Superstudio, the Metabolists and others. Using the premise of Archigram's idea of infrastructure, both literal and of event, the course will attempt to discover relational networks between works of the present day (Rogers, Foster, Grimshaw, etc.). As this work practices upon and within public space, an understanding of the contribution of technology to urban theatricality will evolve which is relevant to contemporary spheres of technological design practices. Students will be required to produce and present a term research paper.

Fall
1 Course Unit
ARCH 7200 Visual Literacy and its Culture

The digital turn in the creative fields resulted in profound transformations of techniques, aesthetics and underlying concepts in the development of contemporary visual culture. The dissemination and consumption of information through images and media platforms influence and re-define (for better or worse) all aspects of our culture and reality. It is vital to develop a deep knowledge of the current visual concepts and techniques in arts, photography, cinema, product design and architecture to claim a critical stance through which we can positively contribute to the evolution of contemporary culture. The discipline of architecture has been deeply influenced by the digital shift in modes of design and visualization which yielded a wide array of directions within the architectural discourse, especially with questions and problems regarding representation. One clear outcome of this transformational period is the diversity of new representational strategies to seek alternative modes of visualization. It is clear that no one representational medium can be defined as the locus of architectural thought and architecture, as a cultural practice, can no longer be defined through the output of a single medium. The reality of our discipline is that we work through collective mediums and conventions of drawings, models, images, simulations, texts, prototypes and buildings to visualize architectural concepts. These mediums all require degrees of expertise in techniques that are necessary for their execution: they all involve conceptual depth that define their disciplinary positions; they all require translations across each other to enable subjective work-flows; they all require aesthetic attitudes to influence the development of visual culture in architecture. This course will introduce the AAD majors to contemporary topics of visualization in arts, photography, cinema and architecture. They will explore multiple mediums of representation to help them gain the vital visual literacy to excel in the program. Students will be introduced to discursive background and contemporary concepts of line drawing, fabricated object and constructed image as they work through 3 distinct projects during the semester. Each exercise will be initiated by a topical lecture and be followed by weekly pin ups to advance student projects. (Topics to be covered: Discourse of Contemporary Line Drawing, Multi-part 3D Printing, Vacuum Form/CNC Milling, Digital/Analog Surface Articulation, Rendering, Abstraction and Realism, Montage/Collage/Photorealism)

Fall
1 Course Unit

ARCH 7210 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.

Fall
Also Offered As: IPD 5210
1 Course Unit

ARCH 7240 Technology in Design

The aim of this course is to understand the new medium of architecture within the format of a research seminar. The subject matter of new media is to be examined and placed in a disciplinary trajectory of building design and construction technology that adapts to material and digital discoveries. We will also build prototype with the new media, and establish a disciplinary knowledge for ourselves. The seminar is interested in testing the architecture-machine relationship, moving away from architecture that looks like machines into architecture that behaves like machines: An intelligence (based on the conceptual premise of a project and in the design of a system), as part of a process (related to the generative realm of architecture) and as the object itself and its embedded intelligence.

Spring
1 Course Unit

ARCH 7250 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.

Fall
Also Offered As: IPD 5720
1 Course Unit

ARCH 7260 Furniture Design Strategic Process

Like architecture, furniture exists at the intersection of idea and physical form. Due to the specific scale that furniture occupies, however, this physical form relates not only to the environment in which the furniture is set, but also intimately to the physical bodies that interact with and around it. Additionally, as a manufactured product, often specified in large quantities, furniture must also address not only poetic considerations, but practical and economic ones as well. Instead of being seen as one-off objects, the furniture created in this seminar focuses on furniture development as a strategic design process where the designer's role is to understand the various responsibilities to each stakeholder (client/ manufacturer, market/customer, environment) and the additional considerations (materials, processes, manufacturability, etc.), and ultimately translate these points into a potentially successful product. In order to approach furniture in this manner, the course will be structured around specific design briefs and clustered into three distinct but continuous stages. First, through focused research into stakeholder needs and potential market opportunities, students will craft tailored design proposals and development concepts accordingly. Next, students will work toward visualizing a concept, complete with sketches, small mock-ups, scale- model prototypes, technical drawings, connections and other pertinent details in order to refine their proposals and secure a real world understanding of the manufacturing processes and the potential obstacles created by their decisions. From insights gained and feedback from these steps, students will ultimately develop a final design proposal for a piece, collection, or system of furniture that successfully leverages their understanding of a thoughtful and deliberate design strategy.

Spring
1 Course Unit
ARCH 7280 Design of Contemporary Products: Design for Equity, Inclusion and Accessibility
The power of design to shape the world we live in is increasingly obvious, as is the responsibility of designers to challenge our assumptions about who designs, who is included or marginalized by our designs, and how we can make sure that all design is inclusive design. This course will address issues around designing for equity, inclusion and accessibility and co-design. We will ask, What is inclusive design? Who does it serve? What should it look like? To answer these questions, we will engage with the current discourse around designing for equity, inclusion and accessibility, with a particular focus on accessibility. We will engage with disability justice frameworks and critical disability studies to challenge our assumptions about disability and engagement. And we will connect with members of the disability community and co-design along with them. This course is intended for anyone who considers themselves a designer of physical or digital products, places, or services who wants to prioritize inclusion in their practice.
Spring
Also Offered As: IPD 5280
1 Course Unit

ARCH 7300 Techniques, Morphology, and Detailing
The course will focus on design, morphology detailing, and the construction of a pavilion on a chosen site. The course will develop through hands-on workshops and will focus on acquiring knowledge through making, (Techne), understanding the morphological transformation of a given geometric packing, and building using readily available materials. The process consists of building and testing physical models that simulate the actual pavilion in order to ultimately realize the desired design. The second half of the semester will focus on using lightweight construction materials to fabricate the pavilion’s actual components, including structural elements, molded components, and joints, which are required for the pavilion’s final assembly. Additionally, students will learn to organize design and fabrication teams, control design and production schedules, and work with a set budget, which requires keeping track of construction costs and forecasting required procurements, including material quantities takeoff, ordering materials and scheduling deliveries.
Spring
1 Course Unit

ARCH 7310 Experiments in Structures
This course studies the relationships between geometric space and those structural systems that amplify tension. Experiments using the hand (touch and force) in coordination with the eye (sight and geometry) will be done during the construction and observation of physical models. Verbal, mathematical and computer models are secondary to the reality of the physical model. However these models will be used to give dimension and document the experiments. Team reports will serve as interim and final examinations. In typology, masonry structures in compression (e.g., vault and dome) correlate with “Classical” space, and steel or reinforced concrete structures in flexure (e.g., frame, slab and column) with “Modernist” space. We seek the spatial correlates to tensile systems of both textiles (woven or braided fabrics where both warp and weft are tensile), and baskets (where the warp is tensile and the weft is compressive). In addition to the experiments, we will examine Le Ricolais’ structural models held by the Architectural Archives.
Fall
1 Course Unit

ARCH 7320 Technology Designated Elective
Several sections are offered from which students make a selection.
Spring
1 Course Unit

ARCH 7321 Technology Designated Elective
Technology Designated Electives enable students to deepen their understanding of architectural issues, and M.Arch students must complete 1 CU of any ARCH 732x and/or ARCH 736x course(s). But these courses are not limited to students in the department of architecture any graduate student at Weitzman is invited to register for a Technology Designated Elective of interest, space permitting. Topics vary between semesters, and specific details can be found in the “Section Details” area in course search.
1 Course Unit

ARCH 7322 Technology Designated Elective
Technology Designated Electives enable students to deepen their understanding of architectural issues, and M.Arch students must complete 1 CU of any ARCH 732x and/or ARCH 736x course(s). But these courses are not limited to students in the department of architecture any graduate student at Weitzman is invited to register for a Technology Designated Elective of interest, space permitting. Topics vary between semesters, and specific details can be found in the “Section Details” area in course search.
1 Course Unit

ARCH 7323 Technology Designated Elective
Technology Designated Electives enable students to deepen their understanding of architectural issues, and M.Arch students must complete 1 CU of any ARCH 732x and/or ARCH 736x course(s). But these courses are not limited to students in the department of architecture any graduate student at Weitzman is invited to register for a Technology Designated Elective of interest, space permitting. Topics vary between semesters, and specific details can be found in the “Section Details” area in course search.
1 Course Unit

ARCH 7324 Technology Designated Elective
Technology Designated Electives enable students to deepen their understanding of architectural issues, and M.Arch students must complete 1 CU of any ARCH 732x and/or ARCH 736x course(s). But these courses are not limited to students in the department of architecture any graduate student at Weitzman is invited to register for a Technology Designated Elective of interest, space permitting. Topics vary between semesters, and specific details can be found in the “Section Details” area in course search.
1 Course Unit

ARCH 7325 Technology Designated Elective
Technology Designated Electives enable students to deepen their understanding of architectural issues, and M.Arch students must complete 1 CU of any ARCH 732x and/or ARCH 736x course(s). But these courses are not limited to students in the department of architecture any graduate student at Weitzman is invited to register for a Technology Designated Elective of interest, space permitting. Topics vary between semesters, and specific details can be found in the “Section Details” area in course search.
1 Course Unit
ARCH 7326 Technology Designated Elective  
Technology Designated Electives enable students to deepen their understanding of architectural issues, and M.Arch students must complete 1 CU of any ARCH 732x and/or ARCH 736x course(s). But these courses are not limited to students in the department of architecture any graduate student at Weitzman is invited to register for a Technology Designated Elective of interest, space permitting. Topics vary between semesters, and specific details can be found in the “Section Details” area in course search.  
1 Course Unit  

ARCH 7330 New Materials and Methods  
The primary goal of this course is to help students formulate a robust research proposal for their culminating design studio in digital large-scale fabrication and robotics manufacturing using new materials such as carbon fiber and other composites. The course provides a forum for critical discussion of contemporary design practices that is exploratory and speculative in nature. In addition to collaborative thinking and debate students will develop their own research interests to formulate contemporary positions in the making of architecture through the research of materials and their fabrication methods.  
Fall  
Corequisite: ARCH 7200  
1 Course Unit  

ARCH 7340 Ecological Architecture - Contemporary Practices  
Architecture is an inherently exploitative act - we take resources from the earth and produce waste and pollution when we construct and operate buildings. As global citizens, we have an ethical responsibility to minimize these negative impacts. As creative professionals, however, we have a unique ability to go farther than simply being "less bad." We are learning to design in ways that can help heal the damage and regenerate our environment. This course explores these evolving approaches to design - from neo-indigenous to eco-tech to LEED to biomimicry to living buildings. Taught by a practicing architect with many years of experience designing green buildings, the course also features guest lecturers from complementary fields - landscape architects, hydrologists, recycling contractors and materials specialists. Coursework includes in-class discussion, short essays and longer research projects.  
Spring  
1 Course Unit  

ARCH 7360 Technology Designated Elective  
Technology Designated Electives enable students to deepen their understanding of architectural issues, and M.Arch students must complete 1 CU of any ARCH 732x and/or ARCH 736x course(s). But these courses are not limited to students in the department of architecture any graduate student at Weitzman is invited to register for a Technology Designated Elective of interest, space permitting. Topics vary between semesters, and specific details can be found in the “Section Details” area in course search.  
Spring  
0.5 Course Units  

ARCH 7361 Technology Designated Elective  
Technology Designated Electives enable students to deepen their understanding of architectural issues, and M.Arch students must complete 1 CU of any ARCH 732x and/or ARCH 736x course(s). But these courses are not limited to students in the department of architecture any graduate student at Weitzman is invited to register for a Technology Designated Elective of interest, space permitting. Topics vary between semesters, and specific details can be found in the “Section Details” area in course search.  
0.5 Course Units  

ARCH 7362 Technology Designated Elective  
Technology Designated Electives enable students to deepen their understanding of architectural issues, and M.Arch students must complete 1 CU of any ARCH 732x and/or ARCH 736x course(s). But these courses are not limited to students in the department of architecture any graduate student at Weitzman is invited to register for a Technology Designated Elective of interest, space permitting. Topics vary between semesters, and specific details can be found in the “Section Details” area in course search.  
0.5 Course Units  

ARCH 7363 Technology Designated Elective  
Technology Designated Electives enable students to deepen their understanding of architectural issues, and M.Arch students must complete 1 CU of any ARCH 732x and/or ARCH 736x course(s). But these courses are not limited to students in the department of architecture any graduate student at Weitzman is invited to register for a Technology Designated Elective of interest, space permitting. Topics vary between semesters, and specific details can be found in the “Section Details” area in course search.  
0.5 Course Units  

ARCH 7370 Semi-Fictitious Realms: A History and Future of Virtual Reality  
The pursuit of immersive digital experiences has long been a goal of the computing industry. Early wearable displays designed in the 1960s depicted simple three-dimensional graphics in ways that had never been seen before. Through trial and error, digital pioneers reframed the relationship between user and machine, and over the last five decades, have made strides that advanced both the input and output mechanisms we are so comfortable with today. As a field, architecture has been reliant on these advancements to design and document buildings, but these tools still leave the architect removed from the physicality of the design, with their work depicted as 2D lines or 3D planes alone. This course will study the evolutionary advancements made that now allow us to fully inhabit digital worlds through Virtual Reality. Using the Unity Video Game Engine, students will generate immersive, photo-realistic models of unbuilt architectural works and explore digital/physical interactivity. These models will be designed to have compatibility with both 6-DOF and 3-DOF Virtual Reality equipment as well as flythrough-style experiences for keyboard and mouse using various web-hosting platforms. From the terraces of Paul Rudolph’s Lower Manhattan Expressway to Boullée’s Cenotaph for Newton, the goal of this course is to breathe new life into places and spaces that have, until this time, never been built or occupied.  
Fall  
1 Course Unit  

ARCH 7371 Remixed Realities  
This course will introduce students to workflows for authoring VR content in the Unity 3D Video Game Engine, teach them skills in developing custom interactions with the C# coding language, and challenge them to create speculative mixed reality scenarios. Students will explore several forms of mixed reality in a series of exercises leading up to a final narrative-based VR experience. We will speculate on the occupation of physical/digital hybrids by using a calibration routine to align digital geometry to physical spaces in VR; create volumetric documentary experiences using reality capture techniques to record existing spaces and objects; and develop rich VR experiences using remixed volumetrically captured geometry, digital geometry, and physical spaces.  
1 Course Unit
ARCH 7380 The Modern House: Technology Then and Now
In the current age of new fabrication methodologies, methods are emerging for the conception and design of the contemporary house which have radical potential for enclosure, habitation and practices of daily life. This course begins by examining the canonical houses of the original avant-garde -Adolf Loos, Frank Lloyd Wright, Le Corbusier, Mies van der Rohe and Alvar Aalto -on the premise that their houses were working manifestos for rethinking space, form and indeed ideas of life itself -all of which were prompted by new concepts of construction. From this spectrum of issues, contemporary houses and contemporary methods and materials will be studied extensively to develop equally new ideas between matter and quotidian life. As the primary task of the course, students will work in teams to develop highly detailed constructional proposals for a portion of a speculative home.

Spring
1 Course Unit

ARCH 7390 New Approaches to an Architecture of Health
Health care is taking on a new role in our society - with a refocusing from episodic care for those who are ill or symptomatic to providing life-long care geared towards maintaining wellness. These changes are evident across numerous areas of design, from wearable technologies that track and analyze, to large scale building initiatives that aim to create healthier environments and improve lives through strategic planning initiatives. A concrete, physical representation of this paradigm shift can be found within the hospital building itself and in the new manner in which hospitals are looking to serve their patients and care for their clinicians. Simultaneously both public and private spaces, hospitals are complex systems in which sickness, health, hospitality, technology, emergency, and community share space and compete for resource. In order to frame our present day understanding of the role of architecture (and design) in fostering health for individuals and within communities, this seminar will begin with an exploration of the historical and contemporary perspectives on the role of the architect and built environment on health. (Parallels between design and our ever-changing understanding of the biological, social, and environmental causes of sickness and disease will also be explored.) During this conversation, students will read articles and study recently constructed projects in order to examine the ways in which the architects approached these topics through built form. Following from this foundation, students will craft arguments for a new approach to the individual, the community, health, and architecture through a written response and architecturally designed scenario that argues for their perspective on how architecture can and should shape the health of those who inhabit it. Throughout the course, students will engage in weekly readings (and discussions) of critical texts exploring ideas around the role and impact of architecture on health. Various content experts will be included in the course to provide additional insights into key areas of theory and practice in order to lend additional perspectives and ground the conversation.

Fall
1 Course Unit

ARCH 7410 Architecture Design Innovation
The mastery of techniques, whether in design, production or both, does not necessarily yield great architecture. As we all know, the most advanced techniques can still yield average designs. Architects are becoming increasingly adept at producing complexity & integrating digital design and fabrication techniques into their design process - yet there are few truly elegant projects. Only certain projects that are sophisticated at the level of technique achieve elegance. This seminar explores some of the instances in which designers are able to move beyond technique, by commanding them to such a degree as to achieve elegant aesthetics within the formal development of projects.

Fall
1 Course Unit

ARCH 7420 Function of Fashion in Architecture
The Function of Fashion in Architecture will survey the history of fashion and the architectural parallels starting from Ancient Civilization to Present. The focus will be on the relevance of garment design, methods and techniques and their potential to redefine current architecture elements such as envelope, structure, seams, tectonics and details. The functional, tectonic and structural properties of garment design will be explored as generative platforms to conceptualize very specific architectural elements. One of the challenges in the course is the re-invention of a means of assessment, the development of notations and techniques that will document the forces and the production of difference in the spatial manifestations of the generative systems.

Spring
1 Course Unit

ARCH 7430 Form and Algorithm
The critical parameter will be to develop the potential beyond finite forms of explicit and parametric modeling towards non-linear algorithmic processes. We will seek novel patterns of organization, structure, and articulation as architectural expressions within the emergent properties of feedback loops and rule-based systems. This seminar will accommodate both introductory and advanced levels. No previous scripting experience is necessary. It will consist of a series of introductory sessions, obligatory intensive workshops, lectures followed by suggested readings, and will gradually focus on individual projects. Students will be encouraged to investigate the limits of algorithmic design both theoretically and in practice through a scripting environment.

Fall
1 Course Unit

ARCH 7440 Image, Object, Architecture
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.

Spring
Also Offered As: IPD 5440
1 Course Unit
ARCH 7460 Cinema and Architecture in Translation
Cinema and Architecture in Translation is a seminar that will survey key cinematic moments and techniques within the history of film and find new intersections between architecture and narratives. The focus will be on the relevance of mise-en-scène, the background and building figures of architecture and future speculations of the city, yet in relation to narrative dynamics. One of the challenges is to consider techniques that will affect both conceptualization and the production of spatial manifestations using potent visual platforms. Current pre and post-production techniques in film making methods are converging with architectural digital representation. This is an opportunity that provides fertile ground for architects to re-examine the 'digital' in a variety of scales in relation to impactful narratives and visualizations. These tools, specifically the technique of "matte-painting" will be explored in this course. There is a rich history in constructing images, speculative worlds and scenes for the film industry. We will explore the parallels between the tools and strategies of cinematic visualization as it relates to advanced architectural image making. Students will have the opportunity to analyze filmic scene making, learn advanced representation and techniques in matte painting and zbrush. Above all this course will engage students in the conceptual as well as practical complementarities of architecture and cinema, while watching some of the best films ever made and the most provocative and insightful books to help process them. An important aspect of this course will be to explore the differences between "real" architecture and the cinematic architecture. The expansive Space and Time in which cinematic architecture is located, creates an incubator where true innovated speculation can occur. This is an advanced representation course that produces 2D images and narrative texts.
Spring
1 Course Unit

ARCH 7470 Robotic Fabrication
Automation and robotics have helped manufacturing increase productivity by 1,500% since 1945 (McKinsey 2017). In contrast, however, construction productivity has remained relatively stagnant during the same time. The construction industry is facing pressure to change. For the robotics industry, construction presents potential use cases and unique applications that can utilize a variety of evolving technologies from drones, ground robotics, teleoperation, machine vision, additive manufacturing, and assistive robotics. These technologies take advantage of the digital revolution and utilize ideas in automobile and aerospace engineering. Our interest in these technologies is that they open new opportunities for design. Robotic fabrication will explore the theory and design of a project that will form a component of the culminating design studio for the MSD AAD program. Theory will be exolved through a series of lectures and the design component will focus on a one to one scale fabrication of a project determined by the design studio curriculum.
Summer Term
1 Course Unit

ARCH 7480 Architecture and the New Elegance
This design seminar will define and elaborate on the following topics for the digital discourse - the contemporary diagram, technique, structural thinking, systemic thinking and aesthetic projections. Technological innovations establish new status quos and updated platforms from which to operate and launch further innovations. Design research practices continually reinvent themselves and the techniques they use to stay ahead of such developments. Reinvention can come through techniques that have already been set in motion. Mastery of techniques remains important and underpins the use of digital technologies in the design and manufacturing of elegant buildings. But, ultimately, a highly sophisticated formal language propels aesthetics. The repositioning of design intent and the complex order generated by the behavioral techniques of multi-agent systems has implications for the affects which are generated as well as the nature of hierarchy within architecture. The distributed non-linear operation of swarm systems intrinsically resists the discrete articulation of hierarchies within Modern architecture and contemporary parametric component logic. The bottom-up nature of swarm systems refocuses tectonic concerns on the assemblage at the micro scale rather than the sequential subdivision of program or form. The seminar will explore strategies for high population agent models through the use of lightweight algorithmic environments, in particular the Java-based platform Processing.
Spring
1 Course Unit

ARCH 7490 Indeterminate Delineations
Architecture has always been closely entangled with modes of vision. Devices ranging from Durer’s perspective machine to the photographic eye have strongly shaped the way we think and design the built environment of our cities. A strange loop is in place here: our world-views provide the development of specific modes of representation, of engagement with the world, and in turn they begin to have an impact in that same world, becoming an active element in the way we understand it. Put more simply, it is the technologies through which we see and experience the built environment that define the way we construct it. In this class, we will focus on visual and physical points as anchors to tie modes of vision with modes of construction. Points play an important role in the history of visuality if during Impressionism and Pointillism they were devised to delineate the contrast and alignments between what we see and how we see it in an attempt to investigate the mechanics of vision, it was during the post war period that Max Wertheimer’s work at the Berlin School of Gesalt Psychology leveraged them as graphic elements to understand part to whole relationships central to Bauhaus’ design pedagogy. Today, imaging technologies are once again placing points as central elements in the construction of our contemporary visual language, transforming ever-growing datasets of partial images in three dimensional machine readable survey models: it is with points and aggregated clouds that we are constructing the figure of our cities. As such, they become a necessary site of design investigation to move beyong monolithic views of the world. This class leverages the bi-product of scanning technologies - point clouds and image making - to explore inclusive modes of delineations: a visual sensibility to engage with the multifaceted nature of the built environment.
Fall
1 Course Unit
ARCH 7500 Parafictional Objects
This representation/design seminar explores the aesthetics of estrangement in realism through various mediums. The reality of the discipline is that architecture is a post-medium effort. Drawings, Renderings, Models, Prototypes, Computations, Simulations, Texts, and Buildings are all put forward by architects as a speculative proposal for the reality of the future. Students will explore the reconfiguration of a "found object" in multiple mediums and represent parafictional scenarios in various techniques of realism. At a time when rendering engines enable the production of hyper-realistic images within the discipline without any critical representational agenda, it has become ever more imperative to rigorously speculate on realism.
Spring
1 Course Unit

ARCH 7510 Ecology, Technology, and Design
This course will examine the ecological nature of design at a range of scales, from the most intimate aspects of product design to the largest infrastructures, from the use of water in bathroom to the flow of traffic on the highway. It is a first principle of ecological design that everything is connected, and that activities at one scale can have quite different effects at other scales, so the immediate goal of the course will be to identify useful and characteristic modes of analyzing the systematic, ecological nature of design work, from the concept of the ecological footprint to market share. The course will also draw on the history of and philosophy of technology to understand the particular intensity of contemporary society, which is now characterized by the powerful concept of the complex, self-regulating system. The system has become both the dominant mode of explanation and the first principle of design and organization. The course will also draw on the history and philosophy of technology to understand the particular intensity of contemporary society, which is now characterized by the powerful concept of the complex, self-regulating system. The system has become both the dominant mode of explanation and the first principle of design and organization.
Fall
1 Course Unit

ARCH 7520 EBD Research Seminar
Directed student research of selected topics in environmental building design. These topics will be further explored in ARCH 7080: Bioclimatic Design Studio and will provide the basis for the research documents developed with each student’s design project. Course work will include lectures, discussions, weekly readings, and in-class exercises. Each student will be required to make a presentation and submit a research report.
Fall
1 Course Unit

ARCH 7530 Building Performance Simulation
The course provides students with an understanding of building design simulation methods, hands-on experience in using computer simulation models, and exploration of the technologies, underlying principles, and potential applications of simulation tools in architecture. Classroom lecturers are given each week, with a series of analysis projects to provide students with hands-on experience using computer models. This course is required and reserved for MSD-EBD students.
Fall
1 Course Unit

ARCH 7540 Performance Design Workshop
The workshop applies simulation and diagramming techniques to a series of discrete design projects at different scales. The emphasis is on refinement and optimization of performance based building design. Performance analysis techniques can provide enormous amounts of information to support the design process, acting as feedback mechanisms for improved performance, but careful interpretation and implementation are required to achieve better buildings. Energy, lighting, and air flow are the three main domains covered in the workshop. Students will learn how to utilize domain tools at an advanced level, and utilize them as applications to examine the environmental performance of existing buildings. Using the results of analytical techniques, the students will develop high-performance design strategies in all three domains. Lectures will be given on specific topics each week. A series of analytical class exercises will be assigned to provide students with hands-on experience in using the computer models. A case-study building will be provided at the beginning of the course and students will model different components each week throughout the semester. Every week students present the progress of their work, which will be used to correct methodological and technical issues. Energy, lighting, and air flow are the three main domains covered in the workshop. Students will learn how to utilize domain tools at an advanced level, and utilize them as applications to examine the environmental performance of existing buildings. Using the results of analytical techniques, the students will develop high-performance design strategies in all three domains. Prerequisite: ARCH 7530 Lectures will be given on specific topics each week. A series of analytical class exercises will be assigned to provide students with hands-on experience in using the computer models. A case-study building will be provided at the beginning of the course and students will model different components each week throughout the semester. Every week students present the progress of their work, which will be used to correct methodological and technical issues.
Spring
Prerequisite: ARCH 7530
1 Course Unit

ARCH 7550 Environmental Innovation and Prototyping
The MSD-EBD students will develop research papers related to the work done in ARCH 7080 Bioclimatic Studio and ARCH 7540. The students will learn how to plan and conduct experiments and will develop the tools to write research papers based on these experiments. During the semester, exemplar case-studies of novel work in architectural technology will be presented to the students by the instructor and guest lecturers. The prototype developed during the course may be a digital prototype such as a simulation tool, or a physical prototype which will be tested using sensing techniques.
1 Course Unit

ARCH 7580 Resilience: Project Energos, Nevada, Japan, Taiwan
This seminar explores a broad range of topics around the subject of Resilience and Sustainability. We will use a green infrastructure property development currently under construction in real time as our focus, Project Energos, a massive green field site in Nevada by Los Angeles developer TerraScale. This research seminar will support a subsequent 700-level studio offering in Fall. Students are welcome to enroll in this seminar with or without taking the studio. The subject is relevant to all students interested in understanding how action is currently being taken in the United States through a global lens advancing a resilient agenda.
Spring
1 Course Unit
ARCH 7610 Introduction to Real Estate Development for Architects
The course introduces students to the participants and components to the development process, as well as specific development strategies and design tools for engaging them. Design in this sense is not simply a vision, or a concept utilized for obtaining approvals, it is understood as an encompassing set of procedures that both allow for and ensure that goals are being met at all stages of a project, from early conception through the approval process and building construction. Students will learn how to engage municipal land-use laws and regulations, produce strategies for geometric development based on land-use and environmental constraints, and use simulation to perform value-adding operations to a development proposal. Through lectures and exercises, students will have the opportunity to analyze a building and the redevelopment procedures surrounding it, and develop a geometric response and then parse data from that model to drive a series of documents relating to project cost, funding, and schedule. These documents will be analyzed against a variety of construction means and funding models so time- and cost-effective basis that meets design intentions can be developed. This course is primarily intended for Architecture Students who wish to enroll in the Real Estate Design and Development Certificate.
1 Course Unit

ARCH 7620 Design and Development
This course provides an overview of the real estate development business looked at in relationship to urban design, city planning, and architectural design. It provides exposure to the many real-world considerations of private sector development as well as an introduction to the language of real estate. The class focuses on various commercial building types and product offerings with examples of how planning, architectural and other design professions fit into creation of real estate value and the development process. This will cover the practical considerations and typical trade-offs of commercial business practices and real estate investment parameters and how these influence the ways developers and designers work. Industry sectors may include housing (single, multifamily and affordable), office, retail, hospitality, and industrial, with project types ranging from greenfield, adaptive reuse, downtown development, mixed-use projects, and planned communities. Through exercises, lectures and case studies, we’ll address what drives the decisions designers and non-designers make in the development process, and provide insight to help designers understand what makes developers tick. Visiting lecturers (typically architects and developers) will provide real-world examples. Weekly written exercises, case studies and presentation assignments stress critical thinking, evaluating projects by how well they do their job and analyzing how that job is defined.
Spring
Also Offered As: CPLN 6430
1 Course Unit

ARCH 7650 Project Management
This course is an introduction to techniques and tools of managing the design and construction of large, and small, construction projects. Topics include project delivery systems, management tools, cost-control and budgeting systems, professional roles. Case studies serve to illustrate applications. Cost and schedule control systems are described. Case studies illustrate the application of techniques in the field.
Spring
1 Course Unit

ARCH 7680 Real Estate Development
This course evaluates “ground-up” development as well as re-hab, re-development, and acquisition investments. We examine raw and developed land and the similarities and differences of traditional real estate product types including office, R & D, retail, warehouses, single family and multi-family residential, mixed use, and land as well as “specialty” uses like golf courses, assisted living, and fractional share ownership. Emphasis is on concise analysis and decision making. We discuss the development process with topics including market analysis, site acquisition, due diligence, zoning, entitlements, approvals, site planning, building design, construction, financing, leasing, and ongoing management and disposition. Special topics like workouts and running a development company are also discussed. Course lessons apply to all markets but the class discusses U.S. markets only. Throughout the course, we focus on risk management and leadership issues. Numerous guest lecturers who are leaders in the real estate industry participate in the learning process. Format: predominately case analysis and discussion, some lectures, project visits.
Also Offered As: REAL 8210
Prerequisite: REAL 7210 OR FNCE 7210
1 Course Unit

ARCH 7710 Professional Practice II
A continuation of ARCH 6710. Further study of the organizational structures of architectural practices today, especially those beyond the architect’s office. The course is designed as a series of lectures, workshops and discussions that allows students and future practitioners the opportunity to consider and develop the analytical skills required to create buildings in the world of practice.
Fall
1 Course Unit

ARCH 7820 Architecture Study Abroad Program
A four to six week program of study in various locations. For program details: www.design.upenn.edu/architecture/graduate/graduate-architecture-study-abroad
0-1 Course Unit

ARCH 7910 ARCH Summer Institute: Digiblast
This is a non-credit course for entering Master of Architecture students. The course will cover digital modeling and workflow and will prepare students for techniques used in the Architecture program’s 5000 and 6000 level design studios. Course enrollment is by permit only.
Summer Term
0 Course Units
ARCH 7920 ARCH Summer Institute: Advanced Architectural Design Digital Workshop
This is a non-credit course for entering Master of Science in Design: Advanced Architectural Design students. The Digital Methods workshop provides a comprehensive introduction to four elements critical to the workflow of the graduate studios at PennDesign: 3D modeling, scripting, visualization and fabrication. Short daily lectures situating digital technologies in contemporary design practice are followed by hands-on tutorials in Maya and Rhinoceros. The first half of the workshop provides an operative knowledge of the many geometry types, modeling techniques, scripting languages and simulation tools available for studio work. Visualization techniques are also introduced, and students will learn to efficiently produce presentation-quality renderings, animations and technical line drawings from digital models. Students also learn protocols for transferring data between various design software packages and how to create data compatible with PennDesign's digital fabrication equipment. Course fee: $750.00. Course enrollment is by permit only.
Summer Term
0 Course Units

ARCH 7930 ARCH Summer Institute: History of Architecture
This is a non-credit course for entering Master of Architecture students. The course will cover western architecture from ancient Egypt to the modern age and will satisfy the history pre-requisite condition for matriculation in the fall. Course fee: $750.00. Course enrollment is by permit only.
Summer Term
0 Course Units

ARCH 7940 ARCH Summer Institute: Physics for Architects
This is a non-credit course for entering Master of Architecture students. The course will cover the following: mechanics, heat, light, sound and electricity. The course will satisfy the physics pre-requisite condition for matriculation in the fall. Course fee: $750.00. Course enrollment is by permit only.
Summer Term
0 Course Units

ARCH 7990 Environmental Building Design Summer Preparatory Workshop
This is a required, non-credit course for entering Master of Science in Design: Environmental Building Design students. The workshop provides an introduction to digital modeling and scripting techniques for environmental performance analysis. Students also learn protocols for transferring data between various design software packages and how to create data compatible with the School of Design's plotting and digital fabrication equipment. Course fee: $750.00. Course enrollment is by permit only.
0 Course Units

ARCH 8000 Introduction to 3D Programming
ARCH 8000 is a two week required introductory course for matriculating RAS students. This course integrates computer programming (Python, Grasshopper, etc.) within a 3D modelling/simulation environment, and introduces students to Penn's ARI Robotics Lab.
0 Course Units

ARCH 8010 Material Agencies: Robotics & Design Lab I: Part I
Material Agencies Section 1 is the half-semester introductory studio to the Master of Science in Design: Robotics and Autonomous Systems (MSD-RAS) program at the University of Pennsylvania Stuart Weitzman School of Design. This course will introduce students to the Robotic Lab through a software / hardware routine to engage the ABB IRB4600-60 6-axes industrial robot with a hot-wire foam cutting end effector. The studio focuses exclusively on working with an industrial robotic arm and a large-scale hot-wire cutter end-effector to cut foam. This relatively simple robotic extension quickly introduces students to the robotic lab, robot interface and ultimately produces tangible results quickly, yet also highlights the designer's need to develop designs within geometrical constraints that are tightly related to specific manufacturing processes – in this case, the hot-wire cutter's production of ruled surface geometries. Operating through ruled surface geometries enables the designer to have maximum control over the manufactured output whilst removing the need for post-design geometric rationalization or value engineering activities. The architectural project for the studio is a speculative ceilingscape re-design for one of the large galleries in Meyerson Hall that currently features a ubiquitous hung acoustical tile system.
1 Course Unit

ARCH 8011 Material Agencies: Robotics & Design Lab I: Part II
The Fall Material Agencies course consists of two half-semester long sections and is supported by two aligned Core Technical Seminars of half-semester length each. Students will typically work in pairs. Section 1: Programmed Matter. Introduces students to a generative approach to digital design and robotic manufacturing with the goal of unifying design and production within one creative process. The studio will commence with students gaining first-hand experience programming and operating Penn’s industrial robots. 3d design models will be developed in parallel to fabrication experiments and digital simulations. The design brief will focus on a small scale design prototype that is explored at a micro-scale of resolution relative to normative architectural practice. Material placement and material affect will be considered intrinsic to design expression and integral to considerations of space, form, structure and production concerns. The brief will focus on a small scale object or architectural part design with ornamental features. The course introduces material dynamics, robot programming, 3d modelling and computer programming within design. Section 2: Manipulative Matter explores both robotic fabrication and the use of sensors and actuators within responsive fabricated objects or architectural elements. Design Prototyping involving manipulation-based Manufacture. Eg. Sheet metal folding. This will complement the first studio by requiring more pre-determined design intent, fabrication rationalization and robot sensor and electrical integration. A final design prototype will demonstrate embodied material intelligence - through an integrative approach to material organization, electronic circuitry, production and design. Electronic wiring and parts will be integrated within larger material prototypes through fabrication methods such as: inlays, additive manufacturing, casting, soldering, painting, laser-cutting, or milling.
Fall
1 Course Unit
ARCH 8020 Material Agencies: Robotics & Design Lab II
This course will leverage knowledge gained by students in the Fall and set an ambitious aim for the experimentation, development and demonstration of a robotically manufactured design prototype that is intrinsically related to a bespoke production process. The end product will involve a 1:1 part or whole, physically fabricated work that will be accompanied by either a live demonstration or video production. During the first half of the semester students will engage in the development of bespoke robotic tooling, sensor and programming capabilities in order to create novel manufacturing processes that explore ideas of intelligent or autonomous manufacturing with an emphasis on responsive or manipulation based processes. Industry processes will be leveraged yet re-cast through creative engagement with manufacturing materials, tools and production operations. Participants will follow a brief that specifies a line of inquiry or scenario, whilst allowing some degree of self-direction. Projects will engage in a speculative and critical approach to architectural design, production and use while leveraging robotics platforms, methods for machine vision, sensing and learning, in addition to an engagement with material dynamics and computer programming within design research. A successful project is expected to: demonstrate a rigorously crafted design artifact; explore novel approaches to design, material fabrication and user engagement, questioning the role and nature of architecture’s physical and cultural contribution; and explore novel forms of robotic production and representation. Some proposals will involve live or filmed demonstrator performances. All projects will require a computer simulation or animation that demonstrates a temporal consideration for design, manufacture or use. The course introduces robot tooling, sensor-feedback procedures, 1:1 material prototyping, and building design with tectonic considerations. Examples of relevant industry processes include: sheet-metal bending, incremental metal forming, additive and subtractive manufacturing.
2 Course Units

ARCH 8030 General Overview of Algorithmic Design and Robotic Fabrication
Directly supports ARCH 8010 Material Agencies I: Section 1. This seminar will teach students computer and robot programming skills that will be utilized to deliver a complimentary and integral aspect of design-prototyping and fabrication work. Topics will vary in application to suit the studio brief. Participants will be introduced to the Robotics Lab, and will learn to set up ABB Industrial Robot tasks. Design algorithms will be developed that establish a conceptual relationship to the manufacturing process and attempt to leverage it for creative forms of design expression whilst addressing material and production performance constraints. Examples include computer programming that simulates a material placement and robotic manufacturing process such as additive manufacturing, filament winding or weaving, and utilizes these tasks in a generative design methodology, where design character, variation in material organization is evaluated relative to performance criteria such as material quantities, production time, etc. Submissions will be technical in nature and will also be implemented within ARCH 8010 prototypes. The course provides a foundation for more specialist technical development in Semester 2.
0.5 Course Units

ARCH 8040 Advanced RAS Programming
This course will support ARCH 8020 Material Agencies II with a greater level of technical competency and detail. More ambitious functionality will be developed that will enable student’s greater degrees of freedom and creativity in their engagement with design and production processes. While students will not engage in science/engineering development, research and software developed in such disciplines will be applied within design, fabrication and user occupation orientated scenarios. Topics will vary in application to suit studio briefs and shifting capabilities within industry and academia. Examples include mechanical and electrical design for bespoke robot tooling, use of Computer Vision for real-time sensing and live behavior-based adaptation, machine learning in design or fabrication applications, or deeper engagement in robot communication and control (E.g. Linux ROS Robot programming framework).
1 Course Unit

ARCH 8050 Intro to Cyberphysical Systems
Directly supports ARCH 8010 Material Agencies I: Section 2. This seminar will teach participants to design and assemble electronic circuits using sensors/actuators and micro-controllers, and to program digital and analogue means of data exchange. Students will develop a closed or open loop reactive system that consists of embedded sensor systems that will operate within the Design Studio project prototype, and utilizes feedback from sensors to drive designed affects (E.g. kinetic, lighting, variations in porosity.). The course will consider degrees of control, feedback, energy and force in relation to interactions of matter, space and active bodies (human and non-human). Participants will learn how to design electric circuits, solder and weld these and to integrate circuits with micro-processors, sensors and actuators. Exact equipment and methods will vary over time as these technologies evolve rapidly. At present possible micro-controllers utilized include Arduino, Raspberry Pi, Odroid, Intel Nuc, Atom and others. Sensors such as flex, pressure and proximity sensors will be utilized. Possible forms of actuation include servo and stepper motors, linear actuators, NiTinol muscle wire, pneumatic actuators. A Programming Language will be utilized to for the writing of simple control algorithms that clarify how input and output data is processed and acted upon, with a particular focus on leveraging physical world actions within a designed control loop where possible.
0.5 Course Units

ARCH 8060 Experimental Tooling
This course aims to extend knowledge into state of the art materials, material applications and fabrication methods and contribute research and experimental results towards ARCH 8020 Material Agencies II course prototypical projects. Operating predominantly through research and controlled physical experiments, students will develop a material strategy for their ARCH 8020 Material Agencies II work, investigating scientific research papers, industry publications and precedent projects in order to develop know-how in materials and material applications. A material application method will be proposed and experimented with to evaluate and develop use within a robotic fabrication process. Submissions will incorporate experimental test results, methods and precedent research documentation.
1 Course Unit
ARCH 8070 RAS Theory
This seminar provides a theoretical context to the program, relating autonomous robotics and fabrication research to architectural discourse, philosophy, science and technology. The course commences with a historical overview of scientific topics including cybernetics, complexity theory, emergence/self-organization, evolution/developmental biology, behaviour-based robotics. The course also critically assesses present and future societal trajectories in relation to technology, exploring socio-political, ethical and philosophical arguments that concern a broader technological shift that has occurred during the last decade which has given rise to our unquestioned reliance on algorithms within our everyday lives (social media, shopping, navigation), and similar impact from Urban OS's, Industry 4 and driverless car technologies. Readings cover philosophy, computer science, cybernetics, robotics, sociology, psychology, and will be discussed in relation to their consideration within the domain of architectural design and building technology. Examples include: Blaise Aguera y Arcas, Maurice Conti, Norbert Weiner, Kevin Kelly, Ray Kurzweil, Ed Finn, Donna Haraway, Andre Gorz, Bruce Sterling, Daniel Kahneman, Timothy Morton, Levi Bryant. A theoretical written statement related to ARCH 801 Material Agencies I Section 1 or 2 will be produced by participants within this core seminar.
1 Course Unit

ARCH 8080 Scientific Research and Writing
Following a framing of architectural design-research and theory in Semester 1, this course aims to provide students with knowledge of state of the art robotics and design taking place in the research community and to introduce methods to evaluate and demonstrate academic research that encompasses both creative and technical work. Submissions will include a technical written statement related ARCH 8020 Material Agencies II work, which will be produced by participants under direction within this core seminar. This will train students for additional technical career opportunities and raise the level of discourse and prospects for further research from the program and its participants to a level suitable for continuation within PhD studies.
1 Course Unit

ARCH 8110 Theories of Architecture: Environments, Techniques, and Expressive Means
This theory seminar provides an in-depth review and discussion of key architectural texts on the topics of space, place, climate, networks, form, tectonics, surface, materiality, craft, technology, and digital landscapes. It unfolds the ways in which ideas condition and inspire the practice of architecture, and how architectural creation contributes to the way one thinks discursively about the world. The seminar equips those embarking on careers in teaching, scholarship, and research in architecture with the practices and methods of scholarly inquiry that are typical in the field. Students will read various texts on each topic, respond to the readings, present them, lead discussions, and write a research paper. The seminar is a core requirement for students in the PhD and Master of Science in Architecture programs, who come from both technology and history and theory backgrounds. The seminar is open for registration to all graduate level students. The assignments for non-PhD / MS students are adapted to their level of study.
Fall
1 Course Unit

ARCH 8020 Material Agencies II
This course is designed for students who have completed ARCH 801 Material Agencies I Section 1 or 2. It aims to provide students with the knowledge and skills necessary to continue within PhD studies. The course will cover a range of topics, including the history and development of material agencies in architecture, as well as the latest research and trends in the field. Students will be expected to produce a technical written statement related to the course material. The seminar will be open to all graduate students in Architecture.
1 Course Unit

ARCH 8120 Methods In Architectural Research
Methods in Architectural Research is a seminar aimed at first year, second semester PhD and MS students in Architecture who aim to develop their field definition (biblio + statement) and/or research proposal in pursuit of their advanced research degree. The course is also of interest to M.Arch students interested in advanced forms of academic research. The course will cover the full context of research methods in both the humanities and sciences attendant to architecture. Students will be tasked with identifying and naming a field of study, an initial research question to investigate, a methodology they will employ, and a value proposition for their work.
Spring
1 Course Unit

ARCH 8130 Qualifying Research
This is an independent study course for first year Ph.D. and M.S. students, supervised by a member of the Graduate Group in Architecture. A course of readings and advisor sessions throughout the semester will result in an independent study paper, which will also be used as the student's qualifying paper for the Qualifying Examination. This research paper will be prepared as if for scholarly publication.
Spring
1 Course Unit

ARCH 8140 The Concept of an Avant-Garde
No historian of architecture has written as intensely about the contradictions of architecture in late-modern society or reflected as deeply on the resulting problems and tasks of architectural historiography as Manfredo Tafuri (1935-1994). For many, the Italian historian's dismissal of "hopes in design" under conditions of advanced capitalism produced a disciplinary impasse. This in turn led to call to obliterator Tafuri - to move beyond his pessimistic and lacerating stance. The seminar will undertake a close reading of one of Tafuri’s most complexly conceived and richly elaborated books, The Sphere and the Labyrinth: Avant-Gardes and Architecture form Piranesi to the 1970s. Initially published in Italian in 1980 and translated into English in 1987, the book represents the first effort to define and historicize the concept of an avant-garde specifically in architecture. Its content centers on the radical formal and urban experiments of the first three decades of the twentieth century. Yet Tafuri surprisingly begins his account with the eighteenth-century inventions of Piranesi, and he concludes with an examination of the “neo-avant-garde” of his own day. In addition to traversing The Sphere and the Labyrinth chapter by chapter - starting with the extraordinary methodological introduction, “The Historical “Project”” - we shall also read a number of primary and secondary sources on the historical contexts under discussion and consider a number of important intertexts that shed light on Tafuri’s position. The objectives of the course are at once historical and historiographic: we shall be concerned both with actual events and with how they have been written into history. Finally, we shall reassess the role of an avant-garde in architecture and compare Tafuri’s conception to that advanced in other disciplines. Is the concept of an avant-garde still viable today? Or should it be consigned to the dustbin of twentieth-century ideas? Assignment for first class: read the introduction to The Sphere and the Labyrinth, pp. 1-21, "The Historical ‘Project.’" A copy of the book is on reserve at the library. Note: the book is out of print. For future classes please make every effort to purchase a used copy or obtain one via interlibrary loan. Copies of individual chapters will also be made available on our class website.
Spring
1 Course Unit
ARCH 8150 Research Report
The candidate for the M.S. in Architecture degree shall prepare a research report in his or her subject of study. The topic of this report must be approved by an advisor. This report will be developed in the independent study courses, undertaken after the eight units of course work has been completed, normally in the summer semester. The purpose of these courses is to give the student an opportunity to synthesize their previous coursework at Penn. Course enrollment is by permit only. Please contact Sarah Lam (ARCH Dept.) at sarahlam@design.upenn.edu.

Fall
2 Course Units

ARCH 8160 Advanced Topics in Architecture Culture from World War II through 2001
This seminar will be taught as an advanced section of ARCH 5120. It is primarily for students who are in their first year of the PhD program in Architecture but it is open to other upper-level students with instructor permission. In addition to the weekly discussion-format seminar on Tuesday afternoons (1.5 hours), students are also expected to attend the lectures associated with ARCH 5120 on Tuesday mornings (10:30-12). Assigned readings will go beyond those on the ARCH 5120 syllabus to include more complex and sophisticated source material. The subject of both ARCH 5120 and ARCH 8120 is the evolution of the culture of architecture from World War II to the turn of the twenty-first century. Starting with the period of wartime planning and postwar reconstruction in the 1940s, we will move decade by decade up to the present century, considering the transformations of modernist culture under the impact of social, political, technological, and urban changes. We will address the challenges posed to architecture from inside as well as outside the discipline and from around the world, attending to material and ideological developments and to relations between individual protagonists and larger historical and institutional forces. Among the wide range of issues at stake are the impact of research and technology coming out of the world war; the intensifying critique of interwar functionalism and debates over monumental humanism, regionalism, history, aesthetics; the effects of suburbanization, expanded mobility, changing demographics, and environmental factors; the phenomena of consumer culture and mass media; the impact of the Cold War and decolonization; the emergence of a "global village" and its intensifying cultural exchanges; the rise of a new architectural avant-garde in the 1960s and the advent of postmodernism; plus more recent ramifications. At the level of theory and methodology, the seminar will be especially concerned with issues of periodization and documentation. We will discuss and debate the question of how "architecture culture" is produced and reproduced at particular moments in history. Seminar discussions will be focused around specific case studies, some to be determined by the instructor, the rest based on in-depth individual research products to be carried out by the members of the class. Each student will work on his or her case-study project over the course of the semester, leading to an in-class presentation and a term paper of 25 pages.
Spring
1 Course Unit

ARCH 8510 Field Bibliography
This course is essentially an independent study, undertaken by doctoral students in preparation for the Candidacy Examination. This course should be taken in conjunction with ARCH 8520 after all other courses have been completed. Normally a member of the student’s Dissertation Committee supervises this course.

Two Term Class, Student may enter either term; credit given for either 1 Course Unit

ARCH 8520 Dissertation Proposal
This course is essentially an independent study, undertaken by doctoral students in order to write the Proposal for the Dissertation. The Proposal is prepared before and defended during the Candidacy Examination. This course should be taken in conjunction with ARCH 8510 after all other courses have been completed. Normally a member of the student’s Dissertation Committee supervises this course.

Two Term Class, Student may enter either term; credit given for either 1 Course Unit

ARCH 9950 Dissertation
Writing and submitting a dissertation are among the final steps leading to the award of the PhD degree. At the University of Pennsylvania, a student presents and defends the dissertation publicly, and then, with the approval of the dissertation committee and graduate group chair, submits the final manuscript for publication. Finally, the PhD degree is awarded to the candidate upon the recommendation of the Graduate Council of the Faculties.

Two Term Class, Student may enter either term; credit given for either 0 Course Units

ARCH 9980 Independent Thesis Study
Independent Thesis Study
1 Course Unit

ARCH 9999 Independent Study
This course enables students to undertake self-directed study on a topic in Architecture, under the supervision of a faculty member. Students are required to make a proposal for the study to the Department Chair, outlining the subject and method of investigation, and confirming the course supervisor at least two weeks prior to the beginning of the semester.

Fall or Spring
0.5-2 Course Units