School of Architecture Courses

About Course Numbers:
Each Carnegie Mellon course number begins with a two-digit prefix that designates the department offering the course (i.e., 76-xxx courses are offered by the Department of English). Although each department maintains its own course numbering practices, typically, the first digit after the prefix indicates the class level: xx-1xx courses are freshman-level, xx-2xx courses are sophomore level, etc. Depending on the department, xx-6xx courses may be either undergraduate senior-level or graduate-level, and xx-7xx courses and higher are graduate-level. Consult the Schedule of Classes (https://enr-apps.as.cmu.edu/open/SOC/SOCServlet) each semester for course offerings and for any necessary pre-requisites or co-requisites.

48-025 First Year Seminar: Architecture Edition I
Fall: 3 units
The main objective of this first-year seminar course is on how students learn, develop, and make decisions as they transition into architecture education. The goal of this course is to promote academic success and encourage connections within the School of Architecture and the University at large. Teaching and learning strategies will be introduced to help support the transition into architecture and the development of independent critical thinkers. Students will be introduced to campus resources that support their academic/social/personal integration into the campus community. Topical areas to be covered in the seminar will include teaching and learning strategies in architecture education, academic development, career planning, mentorships, academic and personal support services, and the aspects of professional practice in architecture. * 

48-026 First Year Seminar: Architecture Edition II
Spring: 3 units
The first year seminar (part 2) introduces students to opportunities at Carnegie Mellon University and beyond. The goal of this course is to encourage students to pursue their interests inside and outside of the School of Architecture by introducing a range of opportunities, including study abroad experiences, internships, athletic/minors/additional majors, and graduate study. The introduction of the study abroad process and travel options will encourage students to consider a study away experience into their academic curriculum. Students will explore their additional academic interests by identifying their psychological preferences through the Myers-Briggs Type Indicator and matching these preferences with academic minors/additional majors at CMU. The presentation of the Intern Development Program (IDP) will engage students in considering future plans for earning IDP hours and understanding the process of securing an architectural internship. Students will be introduced to the process of developing an independent research project. Additional topical areas to be covered in the seminar will include an evaluation of the previous semester, scholarship/academic funding opportunities, graduate studies, and schedule planning for upcoming semesters.

48-095 Spatial Concepts for Non-Architecture Majors
Fall and Spring: 10 units
This course serves as an introduction to the spatial concepts of architecture for students from other disciplines. The course is focused entirely on project design work (this is not an Historical survey, technical or lecture course). This course is very hands-on Projects will explore the design and experience of spatial environments through a series of creative investigations. The semester will be broken in to 3 parts:Intro/Exploration and a long term project. In Intro/Exploration, students will have many hands on opportunities to start to build a common language to describe spatial investigations as well as creating them. This will consist of short projects, with each design investigation progressively building upon the previous exploration; these early projects will consist of both individual and group work. They will focus on Making. The second half of the semester will consist of one long term project to be created individually, incorporating students? personal theories of architecture based on an overarching question. Studio work will be supported by group discussion based upon critical review of student work, readings, slide presentations, videos and films. There will also be a few field trips. Students are encouraged to explore their own areas of interest with respect to their work in class. Self-motivation, class attendance and an open mind is mandatory, however, no prior architectural, engineering or artistic experience is required. Students are expected to perform work both inside and outside of class. Students should be prepared to purchase various supplies throughout the course. This course is in partial fulfillment of requirements for an Architecture Minor.

48-100 Architecture Design Studio: Poeisis Studio 1
Fall: 15 units
As the first architectural design studio course, the Poeisis studio 1 establishes a fundamental understanding of representation and abstraction to which more of your own thoughts and ideas about spatial thinking can be added. This will involve, by means of the architectural studio, a reiterative investigation into the relationship of technique, form, and meaning through study, invention, testing, and evaluation. During this semester a series of short problems will be given to expose you to the complexities of visual communication and the design act; to develop skills of spatial manipulation; to give you the self-confidence in making valid decisions within set time limits; to develop the skills of graphic presentation necessary for interpreting and communicating your architectural intentions; and above all, to instill the ability to combine insight with the rigorous analytical study in a design process that is efficient, personally effective, and which becomes second nature to you as a working process.

48-104 Shop Skills
Fall
TBD

48-105 Architecture Design Studio: Poeisis Studio 2
Spring: 15 units
The 48-105 studio, called Poeisis Studio 2, is the second studio in CMU’s professional B.Arch program. It builds on the lessons from 48-100 about clear architectural communication and abstract spatial-definition, but adds a greater emphasis on the material and experiential understanding of how architecture is made and used. We continue to emphasize architectural drawing and models (both analog and digital) as the primary means of architectural communication, but also as a method of creatively exploring and rigorously testing fundamental architectural ideas. We investigate, research, analyze, diagram, and apply lessons from local architecture, and great architecture of the past, in studio, and in the parallel survey of architectural history. We introduce the use of 3d modeling tools (Autodesk, Rhinoceros) in the design process to create order, deal with a range of parameters, and satisfy specific performance criteria. Beginning with more abstract formal design exercises, and ending with the design of a small building, we explore how tectonics, joinery, materials, as well as site, orientation, context, and human use can be harnessed to inspire great design. The design process is still carefully controlled, but students are encouraged to begin to speculate and take careful risks.
Prequisite: 48-100 Min. grade C

48-116 Building Physics
All Semesters: 9 units
This course is composed of two parts related to fundamental building physics concepts, namely, the lighting performance of buildings (first part) and the thermal performance of buildings (second part). In the first part of the course, we will introduce fundamental lighting principles and the context of performance-based architectural design and diagnostics. The course will cover relevant aspects of lighting environment that affect the physiological and psychological experience of buildings, performance metrics, design and benchmarking methods, and contemporary simulation tools. Topics include a review of physiological and psychological response to the visual environment, analytical and numeric methods for the prediction of lighting conditions in interior spaces, lighting engineering and design methods, and application of computer-aided lighting simulation tools in architectural design. In the second part of the course, the course will introduce fundamental thermal principles in the context of performance-based architectural design and diagnostics. The course will cover relevant aspects of thermal environment that affect the physiological and psychological experience of buildings, performance metrics, design and benchmarking methods, and contemporary simulation tools. Topics include a review of basic theory of heat transfer, thermal dynamics, thermal comfort, analytical and numeric methods for the prediction of building thermal load and energy consumption, and application of computer-aided thermal simulation tools for building thermal design. Demonstration of a set of environmental measurement and sensing devices will also be included in the thermal part of this lecture. DWA-for-Rhino and ArchSim-for-Grasshopper/Rhino software platforms will be used for lighting and thermal performance simulations.
Prerequisites: 62-126 and 62-125 and 62-123 and 62-122
48-120 Digital Media I
Fall: 6 units
IDM is a required course for all first year architecture students. The course introduces students to a wide range of digital methods and concepts available to architects for design, representation, and documentation. The coursework is directly coordinated with Studio assignments providing the students with the opportunity to master their digital skills in a meaningful manner. Due to the amount of content covered there is no single text for this course, but the course is supported by materials created by the instructor. IDM addresses topics such as digital image editing, vector illustration, HTML coding, and 3D modeling.

48-121 Drawing I
Fall: 6 units
Architects draw and build models for a variety of reasons: to record and reference; to analyze and reveal order, intent, and relationships; to speculate; and to visualize new propositions. The study of architecture requires the connection between the mind, the eye and the hand, so that the nature of ideas and their relationship to physical form can be investigated. The connection of the mind, hand and drawing skills requires considerable time and effort. This course introduces why architects use these forms of representation. Students are introduced to how to do basic academic research as well direct assignments that apply the fundamentals of freehand drawings and drafting techniques as it pertains to plans, sections, elevations and paraline drawing, analytical diagraming and model making.

48-125 Digital Media II
Spring: 6 units
IDM2 is a required course for all first year architecture students. This course is the continuation of IDM. IDM2 introduces students to measured drafting and the process of creating a construction drawing set. The coursework is directly coordinated with Studio assignments providing the students with the opportunity to master their digital skills in a meaningful manner. Due to the amount of content covered there is no single text for this course, but the course is supported by materials created by the instructor. IDM2 addresses topics such as digital drafting, construction drawings, advanced 3D modeling and HTML programming. Prerequisite: 48-120

48-126 Drawing II
Spring: 6 units
Drawing and Appearance? is a traditional course in free-hand architectural drawing. Its central learning objective is building a capacity for visualizing three-dimensional space through the making of hand-made drawings. Two secondary objectives foster visual literacy: the ability to use line, tonal values and color to represent architectural space and the ability to use drawing to represent architectural proposals at various levels of abstraction. Coursework includes free-hand and constructed perspective, shade and shadow projection, chiaroscuro drawing in colored pencil and color drawing in pastel. Work is submitted in three portfolio submissions of two weeks duration each. Coursework is built around exercises in the required course text: Drawing and Perceiving, John Wiley and Sons.

48-175 Descriptive Geometry
Spring: 9 units
This course is offered only at Carnegie Mellon's campus. This is a manual construction course for solving problems in three-dimensional geometry through working with two-dimensional planes using basic mechanical drawing tools. The course covers basic concepts of descriptive geometry; solving problems involving lines and planes in space and their spatial relationships; rotations in three dimensions; locating points and tangents on solids and surfaces; intersection of solids; shades and shadows; perspectives; and development of surfaces.

48-200 Architecture Design Studio: Poiesis Studio 3
Fall: 18 units
This studio is an introduction to architectural design stressing concept generation and the development of a rich design process to create evocative spatial experiences through architecture. Building on the explorations of form and space in the 1st year, we investigate in greater depth the role that program, context, and the "imagination of architecture" play in creating meaningful architecture. We seek to understand design principles underlying the buildings of the past and present, from the broadly theoretical and conceptual, to the real implications of technology and sustainability, and mapping of ideas with intent and significance. We will focus on developing challenging architectural ideas, profound building details, and effective ways of communicating them in order to explore architecture's potential for creating poetic expressions, appropriate shelter, or exalted experiences, as well as its ability to embody ideas and impart meaning to the world around us. Prerequisites: 48-105 Min. grade C and 62-122 and 62-123 and 62-126 and 62-106 and 48-025 and 62-125 and 48-100

48-205 Architecture Design Studio: Spring: 18 units
Building on the fall studio, the spring semester is concerned with more in-depth understanding and development of designs for small-scale buildings, now informed by greater knowledge related to materials, fabrication, and the act of construction. Following the "New Materiality" evident in architecture today, and acknowledging the importance of materials and assembly techniques for sustainable design, we seek to explore the aesthetic and experiential implications of materials (WHY?), and the technical knowledge related to the use of materials and the processes of construction (HOW?). The creative opportunities and design implications of using varied materials, structural systems, fabrication and assembly techniques—both analogue and digital—are elaborated, especially as they determine the artistic, conceptual, poetic, creative, spatial, and experiential aspects of architecture. The studio projects, lectures, and the required building study will focus on the application and integration of knowledge acquired in a parallel "Materials and Assembly" course 48-215. Prerequisite: 48-200

48-215 Materials & Assembly
Spring: 9 units
48-215/48-647 introduces and examines the fundamentals between design intent and construction materials, the science of materials (performance) and their assemblies. Learning how materials and techniques inform spatial and form making decisions will be a central theme for the semester. Lectures and discussions will focus on the meaning, aesthetics and techniques related to the use of materials and the process of construction. Prerequisite: 48-100

48-217 Structures
Spring: 9 units
Structures is a required course taught in the second year. It is a successor course to Statics, complementing that previous course by emphasizing structural member design in wood, steel, and reinforced concrete; spatial synthesis of hierarchical one-way systems for gravity load; structural types for lateral load including braced frames, shear walls, and rigid frames; introduction to geometric structures such as cable nets, domes, shells, and air-supported structures.

48-240 Historical Survey of World Architecture and Urbanism I
Fall: 9 units
This course cuts a broad swath through time, geography and cultures, surveying critical episodes in the built environment of Europe, the Middle East, Asia, and the Americas from antiquity through the 19th century. Reflecting the inseparable relation between building and human needs, this course is not only a history of architecture, but also a history through architecture. It examines architectural and urban design as a form of cultural expression unique to its time and place. The historical survey 48-240 leaves off. It focuses attention on the 20th-century, and investigates the web of interwoven ideas and issues that characterize the modern age and "modernism." We begin with a look at the "crisis of modernity" that plagued most of western civilization in the late 19th-century, and then survey the major movements of the avant-garde and other responses to modernity, and end with what came to be known as "Post-Modernism." We will look more closely at the increasing divide between the disciplinary, edge of architecture, and architecture's increasing professionalism? in the last century, focusing on how architecture has influenced culture through experimentation and provocative thinking, even when the primary intent was functional, technological, social, political, etc. Emphasis will be placed on the relationship of buildings to the more general cultural, intellectual, and historical circumstances in which they were created. Special attention will be devoted to the important manifestoes, theoretical, and critical writings that so determined the project of modern architecture.

48-250 Urbanism and the Social Production of Space
Fall: 9 units
Formerly titled "Case Studies in Architecture and Cities" (CSE STD ARC CIT).
48-300 Architecture Design Studio: Praxis Studio I
Fall: 18 units
Praxis Studio I: Building and Site is a required course taught in the third year. The subject for the Third Year Fall Seminar are the reciprocal orders of buildings and landscapes and the design of the building site. The work builds on knowledge gained in prerequisite and co-requisite courses including 48-312 Site Engineering. This course asks students to continue their investigations into the formal and spatial composition and enquiries of previous semesters with a focus on the following concepts: Social and cultural phenomena, dimension/measurement and cycles of time relating to human and non-human occupancy Site assessment: site inventory at many scales Grading and surface manipulation: compatibility of living with related technical considerations for water management, ground structures, surfacing, plants, and maintenance Road alignment: design of roads and parking to support construction, service and the anticipated occupancies, design of roads to connect to other roads with appropriate sight lines, stack spaces, and turning requirements, layout and sizing of parking spaces for vehicles Stormwater: volume and direction of runoff water on both the undisturbed and developed areas, storm water systems, Plants: selection of plants and plant communities with consideration for regional, local, and site-specific factors.
Prerequisites: 62-225 and 48-116 and 48-215 and 48-205 Min. grade C and 48-200 Min. grade C and 48-324 and 62-275

48-305 Architecture Design Studio: Integration II
Spring: 18 units
The basis for the CMU studio course sequence is the expectation that the student retains and applies knowledge gained each semester to the current studio. The spring semester of the third year of architectural studies at Carnegie Mellon University is concerned with the detailed development and refinement of an architectural design as informed by the technical knowledge of structural systems, enclosure systems and the process of construction. The student is expected to articulate concepts and develop designs with more precision and in greater detail than done in previous studios and courses. In addition to criteria related to the development of design skills appropriate to one's sixth semester of the studio sequence, the following criteria are an explicit part of the evaluation of the student work: Aesthetics: The degree to which the design responds to formal issues as articulated in prior design studios. Structural System: The degree to which the proposed building is presented as a statically stable structure which defines the spatial order and satisfies the architectural intentions made explicit in the project. Enclosure System: The degree to which the proposed enclosure system satisfies the design requirements and responds to the physical phenomena of the environment into which it is placed. Material Selection: The degree to which the selected building materials and their implementation are appropriate to the occupancy, articulate the architectural order, and satisfy the physical design requirements. Constructability: The degree to which the proposed building is developed in response to an understanding of the processes of construction. Presentation: The clarity, craft and completeness of the presentation.
Prerequisite: 48-300

48-313 Kalla Visiting Faculty Elective
All Semesters: 9 units
No course description provided.

48-314 Thomas Visiting Faculty Elective
All Semesters: 9 units
Coming Soon.

48-315 Environment I: Climate & Energy in Architecture
Fall: 9 units
This course introduces architectural design responses for energy conservation, human comfort, and the site-specific dynamics of climate. Students will be expected to combine an understanding of the basic laws of comfort and heat flow with the variables of local climate to create energy design guidelines for their own work. The state of the art in building energy conservation and passive heating and cooling technologies will be presented, with take-home readings and assignments. To stress the significance of architectural design decision-making on energy consumption and comfort, full design specifications and calculations will be completed for a residential-scale building. Students will compile a professional energy consultant's report, designing the most viable energy conservation retrofit measures for their client from siting, massing, organization, enclosure detailing, opening control, to passive system integration and management. A survey of world energy conservation in buildings and energy design standards will be challenged by lectures on building energy conservation successes, and emerging demands for a broader definition of sustainability. The course will end with a focus on the design integration of natural and mechanical systems in small- and large-scale buildings.

48-324 Structures/Statics
Fall: 9 units
To be provided by department

48-332 Teaching and Learning
Intermittent: 6 units
In this course, students will learn about effective strategies for teaching architecture and the built environment. Topics include the cognitive differences between novices and experts, instructional techniques, and goal alignment. As part of the coursework, each student will implement these teaching strategies to design and teach a lesson. Elements of developmental psychology, learning theories, and classroom practices will inform the architectural education lesson. Teaching and learning techniques can be generalized for communication with clients, practice, and the community.

48-338 European Cities in the XIX Century: Planning, Architecture, Preservation
All Semesters: 9 units
The history of the main cities of Europe during the XIX century is a history of change and transformation. The physical environment and the political, financial and administrative structures adapt to the needs of new masses of population and to the challenges of metropolitan life. In some cases, cities even acquire new representative functions, as they become a national capital. This course traditionally offers an overview of the urban culture of XIX century Europe, reconstructing aspects of the broader historical context and then focusing on reading the effects of the XIX century urban transformations on the (architectonic) appearance, structures and image of present-day European cities, such as Paris, London, Berlin, Barcelona, Vienna and Rome. This semester we will add to this analysis, acquired by learning and applying a set of essential questions about XIX century urban transformations, a second look at the image of the city - the issue of how the city is represented and described in the various moments of its Nineteenth century transformation (from historical maps, to paintings, from postcards to literary descriptions). We will try to consider its changing visual representation and the different perception of its character and peculiarities over time, finally discussing how the Nineteenth century image of each city still affects how it is viewed today. We will rely, along with the usual reading materials (articles, book excerpts) also on visual documentation, such as photography and film. The course is based on lectures and discussions and requires personal elaboration, as well as a fair amount of reading and writing.
Prerequisite: 48-240

48-339 IDeATe: Making Things Interactive
Spring: 12 units
In this hands-on design-build class you will learn the skills to embed sensors and actuators (light, sound, touch, motion, etc.) into everyday things (and places etc.) and to program their interactive behavior using a microcontroller. You’ll also dive into the fields of VR/AR/MR and experiment with combining these disciplines with physical computing. Through weekly exercises and a term project the class will introduce basic analog electronics, microcontroller programming, projection mapping and virtual reality; as well as exploration into using kinetics and materials to make the things you design perform. Emphasis will be on creating innovative experiences. The graduate version of this course will require this final work including a paper that can be submitted to a peer-reviewed interaction design conference such as CHI, UIST, or TEI. Students from all disciplines are welcome: but please note that the class demands that you master technical material. Experience in at least one of: programming, electronics, or physical fabrication is strongly recommended. (Participants will provide their own supplies and materials.)
Prerequisites: 16-223 or 60-223

48-340 Modern Architecture and Theory 1900-1945
Intermittent: 9 units
This architectural history lecture course surveys the modern buildings and literature of the first half of the twentieth century, focusing primarily on Europe but extending also to non-western countries. We begin with a look at the “crisis of modernity” that plagued most of western civilization in the late 19th century, and then focus on the major movements of both the avant-garde and other responses to modernity from 1900-1945. The course includes lectures, readings, and discussions about a broad range of issues, including 1) Formal tendencies; 2) Theoretical issues; 3) National traditions; 4) Biographical sketches; 5) Significant technologies and materials; 6) Political motivations; 7) Social and cultural influences. Emphasis will be placed on the relationship of buildings to the more general cultural, intellectual, and historical circumstances in which they were created, especially the important manifestoes, theoretical and critical writings that so determined the project and architecture. Work for the course involves extensive reading and a major research paper.
Prerequisite: 48-240

School of Architecture Courses
48-341 Expression in Architecture
Intermittent: 9 units
This architectural history seminar will explore expression in architecture in its many forms, particularly in written works of architectural theory through the ages. We will start with the premise that architecture is not merely pragmatic, technical, or functional: it can express or communicate like a language, it can represent and inspire like many of the arts, it can shape behavior and emote, it can trigger memories, emotions, or meanings. As Isozaki put it: "Architecture is a machine for the production of meaning." We will investigate many ways that architects have theorized the design process, as well as the forms, materials, and contexts of architecture, to express a myriad of ideas and sensibilities. We will also look at the ways that buildings can communicate and have meaning, often beyond the intent of the architect, and usually changing over time. Some of the topics to be explored include the classical orders, gothic geometry and mystical light, the theatrical space of the Baroque, architecture parfante, character, and style in the Enlightenment, tectonics as structural expression, political architecture and morality, the aesthetics of functionalism, Expressionism, key terms such as ornament, representation, linguistics, and semiotics, as well as more recent theoretical constructs such as embodiment, materiality, atmosphere, and affect. The work of the seminar will include intensive weekly readings, especially of primary sources by the architects seeking to express ideas, weekly presentations and discussions about the sources, and a term paper on an important theory of expression in architecture of your choice.
Prerequisite: 48-240

48-348 Architectural History of Mexico & Guatemala
Intermittent: 9 units
Despite the leveling forces of mass culture and globalization, the geographic and social diversity of the U.S. has created distinctive regional mosaics of landscape and architecture. Say New England and images of English Pilgrims, town greens with white framed churches, and industrial mill villages may come to mind. The Southwest conjures different images, perhaps of adobe pueblos, Spanish friars, and ranches, and the color turquoise. The built environment of the Midwest, the California coast, the Mississippi Delta, and many places in between reflect particular regional identities that have been both unconsciously and consciously created over time. This course examines the historical development of regional patterns in the American built environment. It investigates how and why a regions architectural identity evolved in the ways that it did. To what degree is place something to respond to, to interact with, and to what degree is place something that is created? Our focus will be primarily pre-20th century when the forces of vernacular traditions were stronger, we will also examine more recent trends of regionalism as an aesthetic choice and a theoretical stance.
Prerequisite: 48-240

48-350 Postwar Modern Architecture and Theory
Intermittent: 9 units
This architectural history lecture course surveys the modern buildings and architectural theory of the post-World War II period. It begins with the cataclysm of WWII and the fundamental shifts it caused on the conception of modernism, technology, cities, and geo-politics. It proceeds to investigate themes such as rebuilding and reconstruction, grand modern masters such as Mies, Kahn, and Le Corbusier, the fascination with technology, megastructures and utopian thought, the need for monumentality, meaning, and regional identity, and the dissemination of modernism from corporate America to the third world. It ends with the rupture in modernism associated with the social revolutions and the rise of a post-modern architecture in the late 1960s and early 1970s. The course includes lectures, readings, and discussions to define the unique character of the postwar period, as modernism both reigned supreme, and began to be questioned. Emphasis will be placed on the relationship of buildings to the more general cultural, intellectual, and historical circumstances in which they were created. Special attention will be devoted throughout the course to the important manifestations, theoretical and critical writings that so determined the project of modernist architecture. Work for the course involves extensive reading, preparing for class discussions, and a major research paper.
Prerequisites: 48-240 or 48-241

48-355 Perspective
Intermittent: 9 units
Course addresses perspective on the basis of three distinct understandings of perceptual psychology: 1) A Kinesthetic Basis for Perspective, which is built on the drawing pedagogy of Kimon Nicolaides. It aligns with the transactionalist understanding of perception and considers perspective as partly invented and partly discovered truth. 2) The Order of Appearance, which is built on the early work of the perceptual psychologist, J.J. Gibson, and aligns with the ecological position of Gibson and his followers. It considers perspective as an absolute truth of the visual field. 3) Perspective Imposed, which aligns implicitly with the position of Gestalt psychology. It treats perspective as an imposed schema. Along the way some use is made of on-going design work for subject material. Work is submitted in 3 portfolio submissions of 3-4 weeks duration each.
Prerequisite: 48-105

48-356 Color Drawing
Intermittent: 9 units
Color Drawing builds knowledge and provides practice in the use of color in depicting architectural surroundings. Media used are pastels on gray backgrounds, colored pencil on white backgrounds and water color. In the interest of speed the principal technique used in watercolor is a moderate dry brush technique. Coursework assumes knowledge of linear perspective and basic use of color. Work consists of in-class exercises and weekend assignments built on these. Students can expect to spend up to 6 hours of work per weekend.
Prerequisites: (48-126 and 48-121) or (48-130 and 48-135) or (62-126 and 62-125) or (48-120 and 48-125)

48-359 Special Topics: Design Build / Building Systems
All Semesters: 9 units
In this studio we will consider Thoreau’s essay much of it about his own design/build experiences in today’s context. Collectively, we will design a cabin to meet the high standards of sustainability set by Eden Hall. After a round of prototyping, testing, and design development, the studio will create a set of construction documents and shop drawings. Covid and funding allowing, we will begin building the cabin at mid-term, with construction continuing into the summer or fall as required. This studio has a nine credit co-requisite, 48-358 Cabin Building Systems, which is also open to CEE students. Its focus will be on the building systems for the cabin that is being developed in the parallel studio. Topics include energy performance (e.g. production, renewable energy systems, passive and active ways to achieve efficiency, and modeling); integrated structural and engineering systems (e.g. building envelope, water treatment and management, heating and cooling systems, and electrical and lighting systems; and sensing for monitoring and control. The class will have a team-based format that is hands-on and lab-oriented rather than a seminar structure, and it will contribute directly to the build part of the studio.

48-367 Material Histories
All Semesters: 9 units
Materials have histories, and these histories deeply affect the ways they have been used and the meanings they carry” Jessica Sewell and Andrew Scott Johnston recently wrote on Platform. In this seminar we will look at the history of the architecture of the last two centuries by following the thread of the history of materials. Starting from case studies and critical readings, we will discuss the ways in which buildings of the past and the practice of architecture were affected by which materials were available, how they were produced, and the craft required to work them. Materials affect the way we engage with a building sensorially, and at key moments in the history of architecture there were many implications to the architects’ material choices. Materials carry cultural meanings connected with complex histories. We will reflect on how architects have interpreted, manipulated, or added to those meanings through their own work. Materials’ lifecycles and the networks of extraction, production, transportation, and reuse had an impact on the built environment in the past, just as they do today. We will learn from historical examples to critically assess the consequences of the choices we make as designers. We will highlight how the meanings attached to materials - such as timber, steel, brick, plaster and concrete - changed over time, as construction moved from craft-based to industrialized, and how these stories of change were deeply and at times messily connected with the social, political and ecological context. Finally, we will critically engage with the presence of history as a layer of complexity embedded in the material itself - an effect that is compounded in the practice of reuse of materials with patina, marked from their past use.
48-368 Rediscovering Antiquity: Travelers, Archeologists & Architects in Mediterranean
Spring: 9 units
The course proposes a journey in the Mediterranean, with special focus on Greece and Turkey, but also travel through time. In fact ancient cities and archeological sites, from the hills of Troy to the archeological sites of Pergamon and Ephesus, to the cities of Athens and Constantinople/Istanbul, will be studied not so much as signs of the important Greek and Roman past of the region, but as the object of late Eighteenth and Nineteenth century rediscovery. The rich vestiges of the mythical past of this region were then brought to the light, in the frame of complex and adventurous missions. The eyes of scholars, travelers and artists filtered and transformed the reality of the ancient objects and places, adding to their fascination and vitality and changing the way we perceive this legacy today. At the same time, a new political agenda, new biases and new aims were connected with the rediscovery. These in turn influenced not only the way the past of the region was explored and the way the finds were studied and exposed, but also the cultural debate in the rest of Europe, with important effects on the architecture of the main European cities.
Prerequisite: 48-205

48-369 TERRA COTTA ASSEMBLIES: Cultural Expression and Climate Change
All Semesters: 9 units
This seminar speculates that merging communication with environmental performance, a material like terra cotta can be instrumental in returning cultural expression to the building skin (Picon 2013). The ornamental nature of architectural terra cotta facades can not only move us towards a more sustainable future, but also express our milieu: we created problematic climates futures but as designers we also can envision and propose diverse and alternative relationships to our environment. An exploration of the topics that define the ecological turn and how to manifest them through form, technique, and material, will be the focus of the seminar which will culminate in a collective project. The group’s issues of concern that will be manifested in the design of an architectural ceramic assembly may range from the expression of conditions of scarcity, to patternings for biodiversity, or performances of energy flows, to an indexing of climate change, to mention a few. Following the methods of interaction with fabricators and manufacturers often found in practice, we will be working hands on (but remotely) with the techniques and technologies used in contemporary architectural terra cotta design and fabrication. The seminar will engage the Architectural Ceramic Assemblies Workshop -2021 (https://archceramicworkshop.com/), sponsored by regional industry partner Boston Valley Terra Cotta, to expose students to contemporary architectural terra cotta workflows from design concept to production. Through regular engagement with the projects and process of participating architectural firms the seminar will provide students exposure to architectural professionals, facade engineers, ceramics engineers and artists, and glaze experts. In consultation with these the group will develop a prototype to be presented in the upcoming Architectural Ceramics Workshop along with the professional teams.

48-371 American House and Housing, 1850-1975
Intermittent: 9 units
This architectural history course examines the development of American house and housing choices during the period 1850-1975. A recurring picture of the "American Dream" has typically included the image of a single-family, detached dwelling set within its own green yard in the suburbs. However powerful and durable that image is, the history of house and home in America is actually a far more complex story with many different twists and turns. In the course we will look at both urban and suburban housing choices and cultures, ranging from single family detached dwellings to multi-unit housing, and across a social spectrum income, class, race, and gender. Through the use of occasional field trips, we will use Pittsburgh as a touchstone for understanding broader national trends in the history of American urban and suburban housing. The course is organized as a lecture course supplemented with field trips and discussions based on field trips and primary source readings. The additional time slot on Thursday afternoons will be used only when field trips are scheduled. Student work will include a research paper and several shorter written assignments throughout the semester.
Prerequisite: 48-240

48-374 History of Architecture in the Islamic World- A Primer
Fall: 9 units
This course serves as an introduction to the architecture that developed in the Islamic lands over the centuries. The aim of the course is to provide a basic understanding of major periods and regional variations, examining the social and historical context within which Islamic art and architecture developed. Through lectures, discussion and guided research activities, the students will learn the function and meaning of the most important building types, examine how these types changed over time to adapt to the needs of changing societies, and consider influences and exchanges with other traditions. While the main geographical focus of the course will be on the Mediterranean area, from Moorish Spain to the modern Middle East, the students will have the opportunity to develop independent research projects on other areas of the Islamic world.

48-380 Real Estate Design and Development
Spring
This course will provide an overview of the real estate development process and explore the interdependence of real estate development and design. The course will introduce real estate development team members, processes, and phases, including feasibility, predevelopment, construction, and marketing. The course will include a substantial financial component that will introduce students to the basic techniques of property valuation, project budgeting, pro forma analysis, sourcing of financing, and investment analysis. Students will study how market demand, tenant requirements, site constraints, zoning restrictions, and available capital affect design solutions. Course work includes classroom learning, independent reading and exercises, guest lectures, and examination of case studies. The semester's effort culminates in the execution of a team development project based on a current Pittsburgh development project. Teams will complete a basic market analysis program evaluation, schematic design creation, project cost estimation, pro forma analysis, and evaluation of financial feasibility. Development practitioners will provide a critique of each team's project to offer real world guidance on student schematic designs and feasibility analysis prior to the final completion of the project.

48-381 Issues of Practice
Spring: 6 units
TBA

48-383 Ethics and Decision Making in Architecture
Intermittent: 6 units
Course description coming soon.

48-390 Physical Computing Studio
Spring: 10 units
This collaborative studio course will allow interdisciplinary teams to develop wearables with a focus on assistive technology. The ubiquitous nature of mobile devices coupled with low-cost and easily integrated sensors and actuators make this a good time to approach real problems for a range of users from the physically disabled to athletes. Teams will learn skills in hardware, software, fabrication, and design communication in order to effectively develop and share their ideas.
Prerequisites: 16-223 Min. grade C or 60-223 Min. grade C
Course Website: http://ideate.cmu.edu/

48-400 Advanced Synthesis Options Studio I
Fall: 18 units
Having proven competency in the spectrum of skills determined necessary for tomorrow's architect during the first three years of the program, students in their fourth and fifth year are permitted to select from a variety of studio options, each providing the opportunity to build upon or augment some of those skills with new or more nuanced perspectives. All advanced synthesis studios are open to both years, the vertical integration offering enhanced learning opportunities. The content and focus of each studio is governed by faculty interests, which run the spectrum of architectural pursuits, ranging in scale from the design of a piece of furniture to a city and in approach from a comprehensive and complex building program to a critically-driven speculation. They may also be interdisciplinary in nature, taking advantage of the unique juxtapositions made possible at Carnegie Mellon.
Prerequisite: 48-305 Min. grade C
48-405 Advanced Synthesis Options Studio II
Spring: 18 units
Having proven competency in the spectrum of skills determined necessary for tomorrow’s architect during the first three years of the program, students in their fourth and fifth year are permitted to select from a variety of studio options, each providing the opportunity to build upon or augment some of those skills with new or more nuanced perspectives. All advanced synthesis studios are open to both years, the vertical integration offering enhanced learning opportunities. The content and focus of each studio is governed by faculty interests, which run the spectrum of architectural pursuits, ranging in scale from the design of a piece of furniture to a city and in approach from a comprehensive and complex building program to a critically-driven speculation. They may also be interdisciplinary in nature, taking advantage of the unique juxtapositions made possible at Carnegie Mellon.
Prerequisites: 48-412 and 48-400

48-410 Advanced Synthesis Options Studio II
Spring: 18 units
Course Description coming soon.
Prerequisite: 48-305 Min. grade C

48-432 Environment II: Design Integration of Active Building Systems
Fall: 9 units
High performance buildings are achieved with designs that effectively integrate passive and active systems. Having been introduced to passive systems in prior semesters, students in 48432/48655 will focus on the active systems typically included in commercial buildings and strategies for their successful integration with passive components. The goal of the Design Integration of Active Building Systems course is to familiarize students with active building systems and integrative design strategies that should result in high levels of occupant comfort in commercial buildings that, in the US, are moving toward net zero energy and net zero carbon emissions. Active systems introduced in this class include: Electric lighting, Mechanical ventilation, Active heating and cooling, Water systems for interior and exterior use, and water heating, including solar. Onsite electricity generation with renewable energy Building transportation systems Active fire protection and smoke control. Because of the breadth of this subject area, the course will be focused on concentrating on design approaches and technologies that appear to be well suited to a net zero energy and net zero carbon future.

48-440 American Regions & Regionalism: An Architectural History of Place, Time, and Culture
Intermittent: 9 units
Despite the leveling forces of mass culture and globalization, the geographic and social diversity of the U.S. has created distinctive regional mosaics of landscape and architecture. Say New England and images of English Pilgrims, town greens with white framed churches, and industrial mill villages may come to mind. The Southwest conjures different images, perhaps of adobe pueblos, Spanish friars, arid ranches, and the color turquoise. The built environment of the Midwest, the California coast, the Mississippi Delta, and many places in between reflect particular regional identities that have been both unconsciously and consciously created over time. This course examines the historical development of regional patterns in the American built environment. It investigates how and why a region's architectural identity evolved in the ways that it did. To what degree is place something to respond to, to interact with, and to what degree is place something that is created? Our focus will be primarily pre-20th century when the forces of vernacular traditions were stronger, we will also examine more recent trends of regionalism as an aesthetic choice and a theoretical stance.
Prerequisite: 48-240

48-448 History of Sustainable Architecture
Intermittent: 9 units
The History of Sustainable Architecture investigates themes of nature, ecology, pollution and conservation in the built environment and visual arts. The term “sustainable architecture” is a comparatively recent one, arising in reaction to the destructive and toxic nature of the industrial era and its strident ambassador, Modern architecture. Yet, anesthetic and philosophical view of harmony with nature accompanies many forms of historical human activity in the built environment. Similarly, issues of waste removal, mechanical systems and natural materials that characterize current concerns have illustrative historical roots in numerous civilizations going back centuries and even millennia in pre-industrial or non-industrial cultures. This course will engage texts and examples relating to architecture, landscape and urban history, but also art, philosophy and popular culture as a means to understand the many precedents for today’s interest in sustainable architecture and planning. The course will examine texts and works by figures including Vitruvius, Pliny, Leon Battista Alberti, Thomas Cole, Frederic Law Olmsted, Buckingham Fuller, Reyner Banham, Ebenazer Howard, Hassan Fathy, Bernard Rudofsky, Norman Foster, Robert Smithson, Andy Goldsworthy and more. Students will be encouraged to apply principles from the class to understanding and execution of work in their own discipline.

48-452 Real Estate Design and Development
Fall: 6 units
This course will introduce the Real Estate development process and explore the interdependence of development drivers and the design process. Classroom learning, exercises and guest-lectures will introduce students to the concepts of market and financial analysis, as well as the basic techniques of budgeting, proforma development, and valuation. Parallel to this investigation, students will evaluate real world developments and interface with the development professionals that executed them to learn how development drivers shaped the development process and decision making. Students will study how market demand, tenant requirements, site constraints, and available capital affect feasibility, and through this the ultimate design solution. The semester’s effort culminates in the execution of a mini-development project. Students will work in teams to complete a basic market analysis, program evaluation, schematic design, construction and development cost estimate, proforma analysis, and a determination of financial feasibility. Development practitioners will interface with student teams during this mini-project to offer “real world” guidance on student schematic designs and feasibility analysis.
Prerequisite: 48-305

48-453 Urban Design Methods
Fall: 6 units
This undergraduate lecture course introduces urban design history, theory and methods. It is a required supporting course for the Urban Laboratory design studio, and similarly examines urban design at multiple scales: city form and networks, neighborhoods and block structures, streets, public spaces, and urban building typologies. Key issues introduced include the emergence and evolution of urban design as a discipline, and the structural and political factors affecting the contemporary city, and environmental sustainability at the urban scale. A wide variety of cities, projects, proposals and methodologies are examined. Assignments include readings from seminal texts, quizzes, and a final examination.
Prerequisite: 48-305

48-454 Futures of the City/Cities of the Future
Intermittent: 9 units
If all design can be read as attempts to predict and to shape the future, then no one looks further into the future than the urban designer and the urban planner. The work in which they are involved often does not materialize in their lifetimes; in fact, the duration of the projects are so long twenty, thirty, fifty and hundred year timeframes, it is more than likely that he or she will pass on before the project reaches fruition. The trouble with predicting the future is that it is so uncertain, so undecided, so unknowable. A brief look backwards reveals that we are not the first generation to consider the future. History is replete with predictions, some of which were actualized, the vast majority of which were not. Today’s forecasts for tomorrow vary wildly. A handful of optimists view the future through rose colored glasses, whereby humanity is delivered to salvation via technological wonders and the widespread adoption of common social values. A larger group predicts the end of the world as we now know it, but even they cannot agree on the cause of our demise, with those arguing that climate change will kill us, those arguing that we will be destroyed when robots take over and achieve technological singularity. Shy of total extinction, however, any vision of the future requires designers, and will likely occur in urban (or formerly urban) locations. As of this decade, for the first time in history, more than half of the world’s population, almost three and a half billion people, live in towns and cities. Estimates suggest that by 2030 this number will swell to almost five billion.
Prerequisite: 48-205
**48-470 The Depth of Surface**  
Fall: 9 units  
Lamination is the process of gluing wood together along the edge or face of a plank. There is unlimited variety in the ways to do this and to generate pattern in the process. This course will prescribe a few basic ways to laminate following standard rules of wood working and then introduce the possibilities of pattern generation. Generally lamination is unidirectional, however, in this class we will introduce ways to achieve cross directional patterning and the use of inlay to elaborate on the idea of patterning. Projects will be visual and sculptural statements. Their function will be limited and will not be furniture. Each exercise will present a series of basic wood working operations, which, when repeated and recombined will become products of compelling visual character. As visual idea statements you will be asked to experiment, invent and explore and take these standard operations in new directions. As visual idea statements the greatest clarity of vision will be achieved through careful construction.

**48-473 Hand and Machine Joinery, New Directions**  
Fall: 9 units  
In the Fall 2017 and Spring 2018 there will be some changes to the shop electives offered. First the Spring Furniture Design and Construction course #48564 will no longer be offered because that content is incorporated within the Furniture Studio in the fall. Next, the two shop mini courses previously offered in the fall will each be expanded to become full electives, one in the fall and one in the spring. The prerequisite for both of these classes is documentable experience with the band saw, table saw (ripping and crosscut), drill press and the belt and disk sander. The Hand and Machine Joinery, New Directions, is scheduled Tuesday and Thursday mornings 10:30 am to 11:50 in the spring 2018, and will be a 9 unit elective running the entire semester. The elective will focus on building a free standing (or hung) cabinet with doors. If enrolled students have taken the Exploring Pattern course in the fall the doors made in that class will be mounted on the cabinet. If students have not taken that course then a pair of simple doors will be made instead. The primary goal of this course will be to learn the steps of making a simple cabinet using hand and machine joinery. Quality of craft will be of great importance. Uniqueness of design will not be emphasized, however individuation of the cabinet will still be possible throughout the construction, starting with choices between a wall mounted or free standing (with legs) cabinet, the selection of hardwoods, the specific size of parts, and the selection of particular detail options. The construction process will be carefully staged with demonstrations continuing throughout the semester. The cabinet will be perpendicular and rectangular. Students will use standard mortise and tenons of various sizes, bridal joints, floating tenons, tongue and groove, spline and dovetail joints.

**48-478 Digital Tooling**  
All Semesters: 6 units  
This course serves as an immersive analysis of the available technologies located in the Digital Fabrication Lab at Carnegie Mellon and beyond. Students begin to understand equipment limits/boundaries, purposes and concepts; and the possibilities that arise from thoroughly comprehending how these tools work. During your Digital Experience, students begin to understand more systematically how to use these tools to their advantage. A better understanding of the equipment proves very useful towards a SoArch Student’s 3rd, 4th and 5th years at Carnegie Mellon; but more importantly provides a fundamental understanding of a leading edge technology that will certainly prove itself as an integral tool for any Designer throughout their professional career. It is based on the idea that pushing the limits of design fabrication; comes from knowing the limits of your tools. The course operates by discovering tooling extremes; thus indicating limits, and then incorporating these boundaries (and/or breaking them) with Digital Fabrication methods and tooling; ultimately providing a platform in which students begin to understand and incorporate project efficiency. Prerequisites: Imaginination, Laser Cutting, Milling and 3D-Modeling Experience required. (Rhinoceros 3D Preferred)  
Prerequisite: 48-205

**48-493 Representing Activism**  
Intermittent: 9 units  
Efforts to promote social, political, economic and environmental change range in form from written word to direct action. Sources of injustice that those efforts address are multi-dimensional and complex. Effective forms of activism are fueled by creativity that synthesize and distill complex constellations of information and foster understanding. REPRESENTING ACTIVISM explores the role of multi-media graphic representation as a lens through which change and social justice can be fostered. Exploration of efficacy in application will span four dimensions, 1) Social Media, 2) Film, 3) Poster/Graphic Design, and 4) Publication - all aspiring to achieve the status of art. Art and Activism are predicated on exposing the truth. Art has the unique power to convey messages across linguistic and cultural barriers that often divide. Part of the Activist’s challenge is to grip and inspire people to action. With the avalanche of information and media modern society absorbs every day, this is increasingly hard to do. Sometimes it is too much to ask people to stop and think; sometimes it’s too much just to ask them to stop. Successful art compels this, penetrating apathy and imploring the viewer to look deeper and explore the narrative that is embedded in what elicited a visceral response. This seminar aspires to compel action in the public interest through artful representation.

**48-494 Beyond Patronage**  
Intermittent: 9 units  
TBD

**48-497 Pre-Thesis**  
Spring: 3 units  
The primary goal of this mini is to help students formulate a robust proposal for the 5th year Thesis, but it could be used to create a proposal for any grant, scholarship or academic research project. A series of weekly workshops, readings, discussions, and guest lectures will help students move from wide-open initial ideas about issues they are curious about and seek to explore, to the development of a rigorous research process that builds on existing knowledge and attempts to develop new ideas and advances the discipline. The class will explore the difference between design and research in architecture, how different research methods and modes of representation can be leveraged, and how concepts of disciplinarity and “project” can focus a topic. Students will begin to identify precedents, key readings and a research bibliography, an overview of the general topic they will research in depth, a detailed plan for a years worth of independent thesis work, and a well-defined end-product, likely a design proposal. An important task will be to identify advisors who can support, guide, and critique your work, who can act as intellectual collaborators as much as evaluators. This course (or an equivalent approved by the Thesis coordinator) is a pre-requirement for doing a year-long Thesis or semester-long Independent Project in 5th year studio.

**48-500 Advanced Synthesis Options Studio III**  
Fall  
Having proven competency in the spectrum of skills determined necessary for tomorrow’s architect during the first three years of the program, students in their fourth and fifth year are permitted to select from a variety of studio options, each providing the opportunity to build upon or augment some of those skills with new or more nuanced perspectives. All advanced synthesis studios are open to incoming students, the vertical integration offering enhanced learning opportunities. The content and focus of each studio is governed by faculty interests, which run the spectrum of architectural pursuits, ranging in scale from the design of a piece of furniture to a city and in approach from a comprehensive and complex building program to a critically-driven speculation. They may also be interdisciplinary in nature, taking advantage of the unique juxtapositions made possible at Carnegie Mellon.

**48-410**  
Prerequisite: 48-410

**48-505 Advanced Synthesis Options Studio III**  
Spring: 18 units  
Having proven competency in the spectrum of skills determined necessary for tomorrow’s architect during the first three years of the program, students in their fourth and fifth year are permitted to select from a variety of studio options, each providing the opportunity to build upon or augment some of those skills with new or more nuanced perspectives. All advanced synthesis studios are open to incoming students, the vertical integration offering enhanced learning opportunities. The content and focus of each studio is governed by faculty interests, which run the spectrum of architectural pursuits, ranging in scale from the design of a piece of furniture to a city and in approach from a comprehensive and complex building program to a critically-driven speculation. They may also be interdisciplinary in nature, taking advantage of the unique juxtapositions made possible at Carnegie Mellon.

**48-105**  
Prerequisite: 48-105
**48-509 Architecture Design Studio: Thesis I/ Independent Project**  
Spring: 18 units  
Thesis is a year-long, independently defined research and design project that takes the place of upper level option studios. Thesis is an opportunity to develop skills, thoughts, and habits essential for future success, including mental discipline; independence of mind and judgment; working with advisors; the capacity to focus and pursue a subject in depth and over an extended time; the ability to design and execute a complex project; the skills of analysis, synthesis, and clear writing; and the self-confidence that grows from mastering a difficult challenge. Thesis topics and research agendas are generated by the student, but must be determined in collaboration with an advising team, and approved by a Thesis Coordinator. The School seeks to encourage an expansive range of rigorous and provocative inquiry as a culminating experience for the B.Arch education, including work that speculates, invents, or improves on existing ideas, practices, or systems through research and design; work that challenges the boundaries of the discipline and the profession, and moves beyond mere practice or solution-based work; work that engages with open-ended and generalizable ideas, as much as with specific situations; work that projects or imagines a better future and an improved world; work that leads to the new knowledge, ideas, understanding, or paradigms. Acceptance into Thesis is dependent on passing the 48-497 Thesis Prep course or its pre-approved equivalent, and submitting a rigorous thesis proposal to the Thesis Coordinator. Approval for the 2nd semester is contingent upon successful completion of the 1st.

**48-510 Advanced Synthesis Options Studio IV**  
Spring: 18 units  
Course description coming soon. 
Prerequisites: 48-400 Min. grade C or 48-410 Min. grade C

**48-519 Architecture Design Studio: Thesis II/ Independent Project**  
Spring  
This is a year-long, independently defined research and design project that takes the place of upper level option studios. Thesis is an opportunity to develop skills, thoughts, and habits essential for future success, including mental discipline; independence of mind and judgment; working with advisors; the capacity to focus and pursue a subject in depth and over an extended time; the ability to design and execute a complex project; the skills of analysis, synthesis, and clear writing; and the self-confidence that grows from mastering a difficult challenge. Thesis topics and research agendas are generated by the student, but must be determined in collaboration with an advising team, and approved by a Thesis Coordinator. The School seeks to encourage an expansive range of rigorous and provocative inquiry as a culminating experience for the B.Arch education, including work that speculates, invents, or improves on existing ideas, practices, or systems through research and design; work that challenges the boundaries of the discipline and the profession, and moves beyond mere practice or solution-based work; work that engages with open-ended and generalizable ideas, as much as with specific situations; work that projects or imagines a better future and an improved world; work that leads to the new knowledge, ideas, understanding, or paradigms. Acceptance into Thesis is dependent on passing the 48-497 Thesis Prep course or its pre-approved equivalent, and submitting a rigorous thesis proposal to the Thesis Coordinator. Approval for the 2nd semester is contingent upon successful completion of the 1st.

**48-525 Thesis Seminar**  
All Semesters: 9 units  
TBA

**48-527 5th-Year/Senior Seminar**  
Intermittent: 3 units  
Seminar for students graduating from the Bachelor of Architecture and Bachelor of Arts in Architecture programs.  
Course Website: http://soa.cmu.edu

**48-530 Human-Machine Virtuosity**  
Spring: 12 units  
Human dexterous skill embodies a wealth of physical understanding which complements computer design and manufacture. This project-oriented course explores the duality between hand and machine through the practical development of innovative design and fabrication systems. These systems fluidly combine the expressivity and intuition of physical tools with the scalability and precision of the digital realm. Students will develop novel hybrid design and production workflows combining analog and digital processes to support the design and fabrication of their chosen projects. Specific skills covered include 3D modeling (CAD), 3D scanning, algorithmic geometric modeling, digital and robotic fabrication (additive and subtractive manufacturing), motion capture and computer based sensing, and human-robot interaction design. Areas of interest include architecture, art, and product design.

**48-531 Fabricating Customization: Prototype**  
Intermittent: 9 units  
While architects continue to develop their work principally through mediated environments of drawing and modeling, computational design and fabrication methodologies offer opportunities to bolster design processes through the infusion of physical and virtual prototypes. More than a large model or mere three-dimensional rendering of form, the prototype is a tested and instrument of design projection. The prototype brings with it the physical instantiation of design ideas at larger scale and in actual materials to provide the designer with the feedback of material qualities and performance. The prototyping process is a potential vehicle for discovery in which affordances of fabrication processes and unanticipated results expand the realm of possibilities and challenge assumptions of linear design to fabrication processes. The course places great emphasis upon the reciprocity of design and prototyping, challenging students to leverage physical artifacts as tools for thinking. Prototyping is a means of exploration, not merely a method of production or fabrication. Selecting an architectural condition from a previous design project, students utilize modeling, prototyping, and simulating to develop a detailed architectural element. Students produce a series of versions of their architectural element culminating in a final prototype and collection of digital representations.

The course is structured as two modules. Module 1 provides a historical and theoretical background of digital fabrication in architecture, while asking students to identify significant references related to their architectural element, its potential material makeup, construction system, and fabrication process(es). Module 2 operates as a laboratory/workshop in which students produce a comprehensive collection of models, material tests, simulations and prototypes using both digital and analog methods of fabrication.

**48-541 The Cut, The Beach and Beyond**  
All Semesters  
The Cut, The Beach and Beyond will be a FALL design elective with a SPRING build option studio working with Campus Design and Facility Development, the Department of Civil and Environmental Engineering and campus constituents to improve the quality of life through design intervention(s) on campus.

**48-545 Design Fabrication**  
Spring: 9 units  
Using project-driven learning as its method, Making Intelligence will provide an immersive (re)introduction to the fundamentals of design fabrication by providing an applied overview of various methods of synthesizing traditional and digital modes of making. Intended primarily as a portal course for graduate students that plan to use the School of Architecture as digital fabrication lab, this course will give students the opportunity to learn how digital equipment works by discovering machine limitations and possibilities through design fabrication while also expanding on their understanding of the design development process. Students will apply their new knowledge by using the 3-axis router, 3D printing, laser cutters, and the vacuum former for the development of two highly-refined projects.

**48-550 Issues of Practice**  
Fall: 9 units  
Issues of Practice is a required course taught in the fifth year. It consists of three modules: Personal Promotion, Emerging Professional’s Companion, and Excursions. The Personal Promotion module provides the student with a framework to create a resume, cover letter, and portfolio. The EPC (Emerging Professional’s Companion) provides concentrated study in different aspects of professional practice. The Excursions require students to see how architecture relates to the wider world with architecturally related events that can include volunteer opportunities, lectures, mentorship, or teaching.  
Prerequisite: 48-305

**48-551 Ethics and Decision Making in Architecture**  
Spring: 9 units  
Ethical Decision Making in Architecture is a required course in the fifth year of the Bachelor of Architecture Degree. It is part of a sequence dealing with professional aspects of the field of architecture, alongside courses like Human Factors, Real Estate Design and Development, and Issues of Practice. It builds on an understanding of the issues of occupancy, economics and practice in design decision making. The course covers basic frameworks of decision making and ethical adjudication through several case studies including Fallingwater, Sydney Opera House, Citicorp Tower, Pruitt-Igoe housing development, Crystal Palace and Kansas City Hyatt. The textbook for the course is a manuscript by the instructor entitled “Ethical Decision Making in Architecture”.  
Prerequisite: 48-205

**48-554 NATURES OF NATURE: Moving towards an Eco-centric Design Practice**  
All Semesters: 9 units  
No course description provided.
48-555 Introduction to Architectural Robotics
Spring: 9 units
This course provides an introduction to industrial robotics and automated fabrication within the field of Architecture. A series of lectures will cover the basic components, as well as their workflow required to design flexible automation - while work sessions will develop skills in hands-on programming, RAPID, work flow simulation, fixtures, and sensors. We will also cover competency-building projects within the lab environment in order to provide students with hands-on experience using the equipment. Upon covering the fundamental software and hardware content, an end-of-semester project will challenge you to apply your newfound knowledge to solve a final problem. This is a portal course to all sanctioned coursework using the School of Architecture's Robotic Fabrication Lab. Upon successful completion, students will be eligible and prepared to enroll in advanced robotic fabrication courses.

48-558 Reality Computing
Fall: 12 units
Reality computing encompasses a constellation of technologies focused around capturing reality (laser scanning, photogrammetry), working with spatial data (CAD, physical modeling, simulation), and using data to interact with and influence the physical world (augmented reality / virtual reality, 3d printing, robotics). This semester the studio will focus on utilizing these technologies to capture places and objects to digitally recreate them for archives, artifacts, and interactive experiences. We will explore and analyze how to optimize these creations for real-time rendering and analyze how these platforms bridge the divide between "virtual" and "real."

48-564 Furniture Design & Construction
Spring: 9 units
This course is for students who already have a basic knowledge of hand tools and machines, and standard fabrication methods. Wood is the primary material, although other supplemental materials are permitted. One functional project will be built during the semester. Because all the equipment in the shop is traditional analog, the fabrication will remain analog. All operations will be done with hand tools or machine operated and controlled by hand. The emphasis of the design phases will also be non-digital. However recognizing the versatility of CAD, students will be permitted to advance and refine their ideas using their computer. One full scale orthographic drawing by hand will still be required, including plan, elevations, sections, and dimensions on 1/8" ply or mdf.
Prerequisites: 48-105 and (48-473 or 48-470)

48-568 Advanced CAD, BIM, and 3D Visualization
Fall: 9 units
This course is designed to introduce a student to 3D software tools, including AutoCAD 3D, Revit Architecture, and 3D Studio MAX. Building information and parametric modeling, Draughting, lighting, rendering, and animation concepts allow students to create integrated CAD/BIM projects, 3D video animations, and realistic renderings. At the conclusion of this course, students will have projects and animations created and architectural CAD/BIM standards outlined. Students should have some familiarity with basic AutoCAD 2D commands. Those who don't have AutoCAD 2D knowledge can contact the professor to arrange for on-line tutorials that need to be completed before classes begin.
Prerequisite: 48-305

48-569 GIS/CAFM
Spring: 9 units
A Geographic Information System (GIS) integrates displays, edits, analyzes, and shares spatial data for informing decision making. Industries benefiting from GIS include architecture, business, city planning, defense and intelligence, education, government, health and human services, natural resources, public safety, transportation, utilities and communications, and urban planning/design. GIS topics include map design and outputs, geodatabases, downloading and importing spatial and attribute data, digitizing, geocoding, and advanced spatial, 3D, and network analysis. Other topics such as automated vector integration and web-based GIS will also be covered. Facilities management is the practice of coordinating the physical workplace with the people and work of the organization. Computer Aided Facilities Management (CAFM) integrates software tools to streamline operations, boost productivity and develop strategic planning goals for an organization. CAFM topics include space management, asset management, building operations, emergency preparedness, environmental health and safety, telecommunications, and real property and lease management. This course prepares students to understand, maintain, and manipulate spatial and organizational data using world leading software applications. By the end of the course, students will have sufficient background to identify spatial characteristics of diverse application areas enabling them to integrate spatial thinking and analysis into their academic research and careers.
Prerequisite: 48-205

48-576 Mapping Urbanism
Intermittent: 9 units
This seminar provides the critical tools necessary to examine the city as both a representation and a reality in flux. Through an interdisciplinary framework, students study urban history, theory, visual thinking and spatial mapping. Contemporary urban issues are introduced through weekly lectures, readings, and class discussions. Parallel to these urban explorations, students learn to employ a diverse set of representational techniques to create inventive mappings. Upper-level (360 and 400 level) undergraduate students and graduate students are encouraged to register.

48-587 Architecture Lighting Design
Intermittent: 9 units
Through hands-on exploration in the light lab, lecture and discussion, students will develop a design process for lighting people and architecture. Topics will include: Role of the architectural lighting designer in the collaboration process; Establishing design goals and a point of view; Communicating design ideas; Lighting interiors (retail, restaurants, offices, museums, hotels); Lighting exteriors (landscape, buildings, bridges); Technical tools (luminaires, lamps, control and dimming) A large part of class time will be devoted to hands-on experimentation of light. Students will also spend time in the light lab outside of class preparing realized lighting designs. The final design project will include full-scale lighting mock-ups.
Prerequisite: 48-105

48-596 LEED Buildings and Green Design
Spring: 6 units
Green building and sustainable design have been rapidly gaining acceptance in all sectors of the building market. Global issues of energy use, emissions, resource depletion, and land use are forcing building professionals to re-evaluate standard design and construction processes, and look to more environmentally friendly practices. The U.S. Green Building Council (USGBC) developed green building rating systems entitled Leadership in Energy and Environmental Design (LEEDTM) in order to define “green building” by establishing a common standard of measurement. LEED considers green building methods and technologies in several categories including site, water, energy, materials, and indoor air quality, and awards points towards an overall green building rating of certified, silver, gold or platinum. Currently, LEED registered projects make up 3% of the current U.S. commercial building market, and Pennsylvania is the third leading state with LEED registered projects. There is now a demand for design professionals with knowledge and experience not only in sustainable design but specifically with the LEED rating system as well. This course will provide students with background knowledge of the USGBC, the LEED system, as well as referenced standards related to specific topics. The course will benefit greatly from the large number of LEED projects in the Pittsburgh region, which will serve as case studies. Upon completion of the course students will be prepared to take the LEED Professional Accreditation Exam, which is quickly becoming the standard of recognition for green building professionals.
Prerequisite: 48-315

48-604 Introduction to Architectural Robotics
Fall: 12 units
This course provides an introduction to industrial robotics and automated fabrication within the field of Architecture. A series of lectures will cover the basic components, as well as their workflow required to design flexible automation - while work sessions will develop skills in hands-on programming, RAPID, work flow simulation, fixtures, and sensors. We will also cover competency-building projects within the lab environment in order to provide students with hands-on experience using the equipment. Upon covering the fundamental software and hardware content, an end-of-semester project will challenge you to apply your newfound knowledge to solve a final problem. This is a portal course to all sanctioned coursework using the School of Architecture's Robotic Fabrication Lab. Upon successful completion, students will be eligible and prepared to enroll in advanced robotic fabrication courses.

48-576 Mapping Urbanism
Intermittent: 9 units
This seminar provides the critical tools necessary to examine the city as both a representation and a reality in flux. Through an interdisciplinary framework, students study urban history, theory, visual thinking and spatial mapping. Contemporary urban issues are introduced through weekly lectures, readings, and class discussions. Parallel to these urban explorations, students learn to employ a diverse set of representational techniques to create inventive mappings. Upper-level (360 and 400 level) undergraduate students and graduate students are encouraged to register.

48-587 Architecture Lighting Design
Intermittent: 9 units
Through hands-on exploration in the light lab, lecture and discussion, students will develop a design process for lighting people and architecture. Topics will include: Role of the architectural lighting designer in the collaboration process; Establishing design goals and a point of view; Communicating design ideas; Lighting interiors (retail, restaurants, offices, museums, hotels); Lighting exteriors (landscape, buildings, bridges); Technical tools (luminaires, lamps, control and dimming) A large part of class time will be devoted to hands-on experimentation of light. Students will also spend time in the light lab outside of class preparing realized lighting designs. The final design project will include full-scale lighting mock-ups.
Prerequisite: 48-105

48-596 LEED Buildings and Green Design
Spring: 6 units
Green building and sustainable design have been rapidly gaining acceptance in all sectors of the building market. Global issues of energy use, emissions, resource depletion, and land use are forcing building professionals to re-evaluate standard design and construction processes, and look to more environmentally friendly practices. The U.S. Green Building Council (USGBC) developed green building rating systems entitled Leadership in Energy and Environmental Design (LEEDTM) in order to define “green building” by establishing a common standard of measurement. LEED considers green building methods and technologies in several categories including site, water, energy, materials, and indoor air quality, and awards points towards an overall green building rating of certified, silver, gold or platinum. Currently, LEED registered projects make up 3% of the current U.S. commercial building market, and Pennsylvania is the third leading state with LEED registered projects. There is now a demand for design professionals with knowledge and experience not only in sustainable design but specifically with the LEED rating system as well. This course will provide students with background knowledge of the USGBC, the LEED system, as well as referenced standards related to specific topics. The course will benefit greatly from the large number of LEED projects in the Pittsburgh region, which will serve as case studies. Upon completion of the course students will be prepared to take the LEED Professional Accreditation Exam, which is quickly becoming the standard of recognition for green building professionals.
Prerequisite: 48-315
This graduate history and theory seminar starts with the conviction that Architecture is not only space, materials, technology, structure, form, program, site... but also culturally constructed discourses, meaning, communication, concept, and debate: or theory. Architects must draw from other disciplines, distinguish multiple positions on any issue, take a stance, act on, and be able to discuss, debate, and defend their ideas. The course will begin with the fundamental questions: What is theory in architecture? How has our understanding of architecture and theory evolved historically to get to this point? How will it continue to transform into the 21st century? Where is architecture going? Students will discover how architectural ideas and theories evolve and reoccur, and even the oldest theories have contemporary relevance. The topics covered will vary from year to year to acknowledge the dynamic nature of the program, profession, environment, and global context. The work of the seminar will focus on readings, weekly presentations and discussions about the sources, and a research paper on a theoretical aspect of architecture that might lead to a thesis or grant proposal. Thanks for syllabi. For NAAB clarity, but also for optics, I will ask all my colleagues teaching required courses for the M.Arch to issue a separate syllabus with the correct course number, and if they want, slightly different language about expectations, attendance, etc. I will also ask all faculty teaching required courses to list in their syllabus the SPC that are being demanded in the course... so students and faculty are clear.

Course Website: https://soa.cmu.edu/march (https://soa.cmu.edu/march/)

48-635 Environment I: Climate & Energy
Fall: 9 units
This course introduces architectural design responses for energy conservation, human comfort, and the site-specific dynamics of climate. Students will be expected to combine an understanding of the basic laws of comfort and heat flow with the variables of local climate to create energy design guidelines for their own work. The state of the art in building energy conservation and passive heating and cooling technologies will be presented, with take-home readings and assignments. To stress the significance of architectural design decision-making on energy consumption and comfort, full design specifications and calculations will be completed for a residential-scale building. Students will compile a professional energy consultant's report, designing the most viable energy conservation retrofit measures for their client from siting, massing, organization, enclosure detailing, opening control, to passive system integration and management. An overview of world energy consumption in buildings and energy design standards will be challenged by lectures on building energy conservation successes, and emerging demands for a broader definition of sustainability. The course will end with a focus on the design integration of natural conditioning systems and the potentially dynamic interface of mechanical systems in small- and large-scale buildings.

Course Website: https://soa.cmu.edu/march (https://soa.cmu.edu/march/)

48-641 Modern Architecture
Spring: 9 units
This survey of modern architectural history lecture course picks up where the historical survey 48-240 leaves off. It focuses attention on the 20th-century, and investigates the web of interwoven ideas and issues that characterize the modern age and 1Modernism. We begin with a look at the crisis of modernity that plagued most of western civilization in the late 19th-century, and then survey the major movements of the avant-garde and other responses to modernity, and end with what came to be known as ?Post-Modernism. We will look more closely at the increasing divide between the ?disciplinary? edge of architecture, and architecture?s increasing ?disciplinary? edge of architecture, and architecture?s increasing ?disciplinary? edge of architecture, and architecture?s increasing ?disciplinary? edge of architecture, and architecture?s increasing ?disciplina
48-723 Performance of Advanced Building Systems
Spring
Advanced Building Systems Integration This is a graduate level course that focuses on commercial building performance achieved through systems integration. In lectures, class discussion, and student projects, we will explore the topic of building performance, the design and technical strategies that support sustainable high performance; the design, construction and operation processes that are likely to produce sustainable high(e)r performance buildings; and the current state of theory versus practice. The course assumes a basic understanding of buildings' impact on the environment, of building design and materials performance, and the calculation of building heating and cooling loads. On that foundation, we will examine the concept of systems integration and how this approach can sustain the occupants and the environment far better than conventional design, construction and operation. Although US climate, building conventions and codes will be our reference point, we will broaden our discussion by using examples and data from many other countries. An essential aspect of our exploration will be identifying successful built projects and examining the factors that may have allowed those projects to succeed. If this course meets its objectives, students who successfully complete the material will understand and be able to discuss sustainable building performance characteristics, will understand the systems integration approach and how it differs from conventional approaches to building design, and will know how to positively affect architectural and engineering decisions to support the design, construction and operation of sustainable high performance buildings.

48-724 Scripting and Parametric Design
Intermittent: 10 units
This course prepares students for modeling geometry through scripted development of parametric schemes primarily for design applications that is, to introduce students to basic scripting in geometrical modeling environment with a focus on algorithms relating to form making and to reinforce and extend basic concepts of parametric modeling. Contemporary approaches to modeling geometry are computational reflected in designers wanting much more control over the generative process by varying parameters, in turn, enhancing the efficiency with which they navigate design variations, analyze design artifacts and explore design manifestations. This course has two parts: firstly, to supply the basics of object-oriented programming and algorithmic thinking using Python language constructs, and secondly, to supply the basics of scripting generative form making specifically, by customizing procedures for generative design via scripts in Grasshopper in conjunction with Rhino/Grasshopper objects. A number of different form-making algorithms are explored, e.g., fractals, rule-based models, cellular models, agent-based models, and optimization-based models. The course consists of lectures, computer instruction and weekly assignments. Prior exposure to Rhino/Grasshopper is required.

48-725 Graduate Real Estate Development
Fall
This course will provide an overview of the real estate development process and explore the interdependence of real estate development and design. The primary objective of this course is for you, the student, to understand how real estate development, public policy, and finance will affect your professional life when you enter the workforce. The course will introduce real estate development context, team members, processes, and phases. Students will study how market demand, tenant requirements, site constraints, zoning restrictions, and available capital affect development projects. The course will include a financial component that will introduce students to the basic techniques of property valuation, project budgeting, pro forma analysis, sourcing of financing, and investment analysis. We will also touch on societal issues including social equity and international real estate topics. The semester's effort will culminate in the execution of a team development project. The project client will be a nonprofit or government entity. The project will be a real project/site in the city of Pittsburgh. The project components may include a basic market analysis, program evaluation, schematic design, project cost estimates, pro forma analysis, and evaluation of financial feasibility. You will make a final presentation to the class and the client.

48-729 Sustainability, Health and Productivity to Accelerate a Quality Built Environments
Intermittent
Given the growing demand for green buildings by federal and private sector clients, professional practices are ?boiling up? all over the world to deliver high performance, environmentally responsive, ?green? buildings and communities. However, investments in green, high performance building solutions and technologies are still limited by first cost decision-making, and life cycle tools are still largely inaccessible to professionals. A building investment decision support tool ? BIDS - continues to be developed by the Center for Building Performance and Diagnostics at Carnegie Mellon University, with the support of the Advanced Building Systems Integration Consortium. This cost-benefit decision support tool presents the substantial cost-benefits of a range of advanced and innovative building systems designed to deliver ? privacy and interaction, air quality, ergonomics, lighting control, thermal control, network flexibility, and access to the natural environment - from field case studies, laboratory studies, simulation studies, and other research efforts. This course will explore the relationship of quality buildings, building systems, and land-use to productivity, health, well-being and the environment. The course will engage students in the literature that relates building design decisions to ten cost/performance impacts: energy, facilities management, organizational change, technological change, attraction/retention (quality of life) of employees, individual productivity, organizational productivity, salvage/waste, tax/insurance, litigation, and health.

48-738 Special Topics: Ecological Footprints
Fall: 6 units
The Ecological Footprint is a measure of the demand that human activity puts on the biosphere. More precisely, it measures the amount of biologically productive land and water area required to produce all the resources an individual, population, or activity consumes, and to absorb the waste they generate, given prevailing technology and resource management practices (Global Footprint Network 2010). This course will engage students in the metrics and impacts of our collective consumption and waste of: -Energy -Materials (Cradle to Cradle) -Food -Water -Transportation -The Integration of Systems towards Quality of Life Starting at the global context, this course will address challenges/opportunities to advance regenerative practices, improving our relationship to nature. Learning from international best practices, we will continue to explore ecological footprints at the global, national, regional, city, neighborhood, building and individual scale. The course will be based on lectures and readings, with assignments and student presentations to fully explore each of the footprint characteristics. Experts on water, energy, materials, food and other resources have been invited to lecture. By mid semester, an application project will be selected for ecological footprint analysis and the development of design, engineering, and operational guidelines towards reducing that footprint. The potential application projects include: the CMU campus footprint and Donner House retrofit; the Energy Innovation Center and education of the trades in reducing our regions footprint; or a new Net Zero building for Carnegie Mellon University. This will be a collaborative effort. Prerequisite: 48-305

48-739 Making Things Interactive (Graduate)
Fall: 12 units
In this hands-on design-build class you will learn the skills to embed sensors and actuators (light, sound, touch, motion, etc.) into everyday things (and places etc.) and to program their interactive behavior using a microcrotroller. You’ll also dive into the fields of VR/AR/MR and experiment with combining these disciplines with physical computing. Through weekly exercises and a term project the class will introduce basic analog electronics, microcontroller programming, projection mapping and virtual reality, as well as exploration into using kinetics and materials to make the things you design perform. Emphasis will be on creating innovative experiences. The graduate edition of this course will require additional work including a paper that can be submitted to a peer-reviewed interaction design conference such as CHI, UIST, or TEI. Students from all disciplines are welcome: but please note that the class demands that you master technical material. Experience in at least one of: programming, electronics, or physical fabrication is strongly recommended. (Participants will provide their own supplies and materials.)
48-743 Introduction to Ecological Design and Thinking
Intermittent
This seminar offers an overview of scholarly, design-based and research-based approaches to issues of ecology and sustainability in architecture and urban design. The seminar intends to question contemporary paradigms of sustainability within the built environment and includes inquiries from different disciplinary perspectives ranging from history, theory, technology, engineering, art and design. The goal of this seminar is to offer a platform for critical thinking, in-depth discussion and analysis of actionable methodologies related to sustainability, and procedures relevant to the shaping of our physical environment and social systems. Composed of a series of lectures, readings and short assignments, this seminar will lead students through a diverse collection of interdisciplinary views and positions towards defining what is our understanding of sustainability today, and what is a role of large scale ecology within the constructed environments. Students will be introduced to a wide overview of technical, analytical, practical, theoretical and intellectual inquiries that will help them to navigate varied fields of expertise and enable their future investigation of innovative sustainable strategies for the built environment. This seminar will consist of majority of lecture sessions and 2 project review sessions, spread across the fall semester. Each session will introduce set of readings and/or a small exercises related to the lecture theme. The invited lecturers come from both: academia and practice. Invited speakers’ areas of research and design work feature diverse approaches to issues of sustainability and technology. This seminar serves as a platform for development of a cross-disciplinary theoretical foundation to investigate varied methodologies towards sustainable design practice.

48-746 Shape Machine
Fall: 9 units
A shape machine is any computational technology that fundamentally expresses the way shapes are represented, indexed, queried and manipulated. In this course the shape machine is based on visual rules (shape rules) grounded in symbolic rules (programming language instructions) to provide a robust technology to individuals who use drawings and visual models to develop and communicate their ideas. A shape machine is intended to be a computational, visual and disruptive technology for shape cognition and computing, which intersects with such fields as design, artificial intelligence, computer science, and mathematics. We consider a particular kind of shape machine - spatial grammars - which have their origin in formal grammars for spatial composition. Grammatical approaches to designing offer an alternative to traditional approaches. The goal of grammars is not to produce a single design as the final outcome, but, rather, to provide an understanding of the underlying spatial relations that come into play in an eventual design. For nearly three decades, grammars have been studied extensively to understand style in architecture, engineering, design, fine art and ornament. Recently, there has been an increasing application of grammatical ideas to other disciplines. Specifically, there is resurgent interest in implementing shape grammars for application. This is the focus of this course.
Prerequisite: 48-724

48-749 Special Topics in Computational Design
Intermittent
This project-based course interrogates the confluence of robotics and artificial intelligence methods and their potential applications to design, manufacturing, and construction domains. In combination with a group of computational design and robotics faculty and PhD students, course participants will advance visions for the future of design that do not aspire to full automation, but instead at culturally-situated, algorithmically and robotically-supported cooperative processes. Course participants will be able to take advantage of new laboratory space and state-of-the-art equipment at CMU's new Mill 19 facility, and help envision, develop, and evaluate functional prototypes for robotically-supported design and construction.

48-752 Zero Energy Housing
Fall: 9 units
Net zero energy construction has gone from concept to policy in just a few years, but built examples are still rare. What does it take, technically, to achieve net zero and what else, beyond technical requirements, advances or impedes a net zero future? 48-752 is a graduate level class that explores net zero energy design and construction in the residential sector. Through case studies and applied projects, we will explore what it takes to achieve quantitative net zero in residential buildings while maintaining occupant comfort and satisfaction. In locations where net zero is now required, we will examine the results of those requirements. At the outset, we will discuss specific definitions of a net-zero building and the implications of each definition. Through case studies, lectures, field trips, outside reading and assignments, we will examine how a net-zero building is achieved, including the use of renewable energy to achieve the net-zero balance. We will apply lessons learned from metered examples to real sites and to new design or renovation projects in Pittsburgh and will use simulation software to test and quantify the impact of our design/renovation strategies. We will also compare our strategies to requirements in US codes and rating systems such as IECC-2012 and LEED for Homes to evaluate their impact in moving the US residential sector toward much higher performance buildings.

Although our focus is residential, many of the concepts and strategies we cover have parallels in the commercial sector. Students who enroll in the class must know how to calculate without software heat loss and heat gain for a small building. You are also expected to have a fundamental understanding of residential design and construction, plan reading and mechanical systems; US residential materials and construction methods for net zero will be covered in class.

48-753 Intro to Urban Design Media
Fall: 6 units
This course introduces urban design history, theory and methods of analysis and representation. Urban design is examined at multiple scales: city form and networks, neighborhood and block structures, streets, public spaces, and urban building typologies. A wide variety of cities, projects, proposals and methodologies are examined with a special focus on urban sustainability in the contemporary city. Assignments include readings from seminal texts, presentations and discussions, graphic assignments and a final project. A required course for Master of Urban Design students, it is also open to fourth and fifth-year architecture undergraduates as well as graduate students in related programs.

48-763 Protean Systems: Sustainable Solutions for Uncertain Futures
Intermittent
Uncertainty perpetually plagues the built environment. The inability of our buildings and cities to adapt to shifting circumstances has led to an enormous amount of waste. We will explore the various types and scales of change and review various concepts (Metabolism, Shearing Layers of Change, C2C, DfD, Open Building, Lifetime Homes, Resiliency, etc.), and a wide array of precedents, products, and dynamic materials that have attempted (with varying degrees of success) to respond to these forces over time. Students will produce sketches, animations, working physical models, short histories, and longitudinal effectiveness reviews of these exemplars. From this deep review students will begin designing their own Protean Systems by utilizing a scenario planning tool and day/year/decade(s)-in-the-life diagrams that will help address the often-overlooked social aspects of their technical solutions.

48-765 AECM Synthesis Project
Fall and Spring: 12 units
MS-AECM students in this project-based course will apply the diverse knowledge and skills they have acquired during the program through an active design challenge in Pittsburgh. Topics vary by year, but are generally focused on sustainability and health improvements to existing buildings. Students will work with the client, designers, contractors, funders, facilities personnel, government officials, local experts, potential users, and concerned citizens in transdisciplinary teams to plan and manage the effective execution of the project.
48-770 Learning Matters, Exploring Artificial Intelligence in Architecture and Design
Spring
With the recent blooming of artificial intelligence (AI) and machine learning (ML) came a renewed interest in how these technologies may impact architecture and other creative practices. Learning Matters introduces students to this emerging field, giving them the tools to make their own machine-learning based design tools by adapting state-of-the-art models, developing new models, and understanding how data shapes machine learning processes. The course places a particular emphasis on machine learning interfaces. Similar to other rule-based computational design approaches, users can interact with machine learning models through scripting. However, machine learning demands new approaches to interacting with data. By collecting, selecting, and generating data points, we will explore how bespoke interfaces can elicit new kinds of designing and making processes. Throughout this course, we explore this new field by curating data sets and training models on them. Four fields of machine learning and their potentials in design and making problems will be explored: 1) unsupervised generative models, 2) reinforcement learning, 3) multimodal machine learning, 4) machine learning for robotics. Students will be introduced to the fundamental concepts of each field and get hands-on experience with state-of-the-art research and tools to implement them.

48-779 Processes of Digital Design Fabrication
Intermittent: 3 units
Digital Fabrication techniques are well established and widely used across all stages of design to production. Contemporary pre-occupations with materiality, ornament, digital craft, and surface topology are tethered to the affordances of these workflows and their direct connection to digital design methods. The impact of these processes reverberates across scales and around the globe, its presence undeniable. Off-site, prefabrication techniques are increasingly reliant upon computational methods to achieve greater control and precision, while recasting traditional design to production workflows. The architects traditional conveyor of design intent, the working drawing, and its conventions of plan and section are increasingly supplemented with machine and robot code. Meanwhile the job site and field construction of buildings remains a largely human endeavor, reliant upon the skill of local labor to assemble the many components that constitute a building to produce the one-off piece of architecture. This tension between the promise of the factory floor and the messy reality of the job site reflects the evolving nature of construction and its regimes of labor. Building construction is an industry in flux rooted in traditions that pre-date the emergence of computation, yet also in the midst of digital disruption as seen in advancements in onsite architectural robotic fabrication. Last they succumb to greater marginalization, architects must engage these transformations and leverage their design affordances. Practitioners should be versed in the basic principles of digital fabrication and understand its affordances and potential influence upon the design process. Translations from drawing and model to building increasingly rely upon these modes of production. Emerging practitioners must be capable of engaging these modes of communication and leveraging these techniques in the realization of their design intent.

48-783 Generative Modeling (GRAD)
Fall and Spring: 9 units
This course introduces students to the fundamentals of generative modeling using computer aided design as practiced in the field of architecture. Core competencies will be developed through modeling projects and software intensive labs, while a broader critical framework for conceiving of contemporary and historical parametric practices will be encouraged through periodic lectures. Emphasis will be placed on careful consideration of digital mediums and developing a sense of craft related to digital modeling in the hope that students will become conscientious makers and consumers of digital content. Students will be encourage to understand and apply algorithmic problem solving to the many design constraints encountered in architecture. The course will explore the relationship of parametric workflows to design thinking and will situate contemporary trends in a broader framework of computational design. The course will also forefront complex form-making as a response to bio-mimicry, systems thinking, and mass-customization. Rather than positioning parametric modeling as a disruption of historical architectural design process, the course will encourage students to consider how new tools might augment the discipline’s historical commitments to orthographic projection, perspectival drawing, and physical modeling.

48-795 LEED, Green Design and Building Rating in Global Context
Spring: 6 units
48795, LEED, Green Design and Building Rating in Global Context is a graduate level mini-course that examines building rating system content, strategies, goals and outcomes. The course is organized within the framework of the US Green Building Council’s Leadership in Energy and Environmental Design (LEED) Rating Systems, which contains rating system prerequisites and credits in the following categories: location and transportation, site, water, energy, materials, and the interior environmental quality. Within that framework, we explore strategies promoted within LEED (and the new WELL standard) and compare/contrast them with strategies in the rating systems of other countries. We also consider the design of the rating system itself, its implementation, and the national context in which the system was created. The course is designed to develop your understanding of, and hone your critical thought about, sustainable building design and operation. Class lectures address the concepts and environmental issues underlying rating system requirements and credits; present multiple strategies for improved building performance; and to the extent possible, address the impact of specific rating systems and strategies. Students are then challenged to apply this information to specific locations and issues, based on the environmental/energy issues associated with the rating system categories listed above. Although the course provides a foundation for taking USGBC’s LEED Green Associate and/or LEED Accredited Professional exam, it is not an exam prep course. Students who successfully complete the course will understand a range of impacts that buildings may have on the environment and on building occupants, will have insights into contextual aspects of sustainability, and will be familiar with a range of strategies that may be used to encourage development of better buildings and communities.

Prerequisite: 48-315

48-801 Office Visits
Fall: 6 units
Each candidate will arrange with their home office a virtual ‘visit’ for members of the degree program and organize presentations of the projects, methodological challenges, recurring problems, best and worst practices within the context of their office experience. Asynchronous Course Delivery (Fall 2014) -> September 18, through December 7, 2014 Online Synchronous Course Conclusion (Fall 2014) - December 8-11, 2014

48-802 Principles of Research I
Fall: 6 units
Candidate’s current knowledge of problems, methods and outcomes based on their professional work. Overview of the eight knowledge areas as existing disciplines and their potential place in them. Asynchronous Course Delivery (Fall 2014) -> September 18, through December 7, 2014 Online Synchronous Course Conclusion (Fall 2014) - December 8-11, 2014

48-803 Areas of Practice
Fall: 6 units
Candidate presentations of area(s) of expertise summarizing the methods and problems that are prevalent; using case studies to establish a situated approach to research. Asynchronous Course Delivery (Fall 2014) -> September 18, through December 7, 2014 Online Synchronous Course Conclusion (Fall 2014) - December 8-11, 2014

48-804 International Exchange I
Fall: 12 units
Conduct workshops for collaborative research and information exchange meetings with EU cohorts visiting from the Université Toulouse III - Paul Sabatier, Doctoral Programs in Architecture. Asynchronous Course Delivery (Fall 2014) -> September 18, through December 7, 2014 Online Synchronous Course Conclusion (Fall 2014) - December 8-11, 2014

48-805 Directed Study I
Fall: 6 units
Prepare the first publishable article under the supervision of the advisor, based on the current professional practice record of the candidate. Submitted to a committee of faculty for approval. Asynchronous Course Delivery (Fall 2014) -> September 18, through December 7, 2014 Online Synchronous Course Conclusion (Fall 2014) - December 8-11, 2014

48-809 International Exchange II
Spring: 12 units
Visit Université Toulouse III - Paul Sabatier, Doctoral Programs in Architecture and participate in collaborative research and information exchange meetings with EU cohorts, based on the cohorts current knowledge base culled from their practice experience. Asynchronous Course Delivery (Spring 2015) - January 18, through May 13, 2015 – Online Synchronous Course Conclusion (Spring 2015) - May 14 through 17, 2015
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48-810 Comparative Analysis of US and EU Practices
Spring: 6 units
Practices in the building sector vary considerably in the US versus the EU. The instructor will provide a rich collection of national and international initiatives in the AEC domains and include a stimulating series of site visits to important installations in the area. Asynchronous Course Delivery (Spring 2015) - January 18, through May 13, 2015—Online Synchronous Course Conclusion (Spring 2015) - May 14 through 17, 2015