

# TECHNOLOGY AND PRACTICE

Mae-ling Lokko and Kyoung Sun Moon, Study Area Coordinators

This study area explores fundamental theories and methods of building technologies and the relationships among these technologies, architectural design, and the larger natural environment. Courses examine materials, construction, structural systems, and the environmental technologies that provide healthy, productive, sustainable, and comfortable environments. This area also covers professional practice and examines the relationship between methods of construction, procurement, and management. Advanced courses investigate specific technical systems in greater detail, survey emerging methods and technologies, and explore the relationship between building technologies and architectural design in current practice and writings.

For the M.Arch. I program, requirements in this study area include six courses that survey common technical systems used in buildings and integrate the consideration of these technical systems into architectural design through a series of projects of increasing complexity. In addition, there is a required course on architectural practice. Students in the M.Arch. I program are also required to complete one elective seminar in this study area.

## REQUIRED COURSES

### **ARCH 2011a, Structures I** Kyoung Moon

(Required of first-year M.Arch. I students.) An introduction to the analysis and design of building structural systems and the evolution and impact of these systems on architectural form. Lectures and homework assignments cover structural classifications, fundamental principles of mechanics, computational methods, and the behavior and case studies of truss, cable, arch, and simple framework systems. Discussion sections explore the applications of structural theory to the design of wood and steel systems for gravity loads through laboratory and computational exercises and design projects. Homework, design projects, and midterm and final examinations are required.

3 Course cr

### **[ ARCH 2012, Structures II ]**

(Required of first-year M.Arch. I students.) This course is a continuation of introductory analysis and design of building structural systems. The course introduces materials and design methods of timber, steel, and reinforced concrete. Structural behavior, ductility concepts, movement, and failure modes are emphasized. Geometric properties of structural shapes, resistances to stresses, serviceability, column analysis, stability, seismic, wind load, and lateral force resisting systems are presented.

Homework involves calculations, descriptive analysis, and the building and testing of structural models. Midterm and final examinations are required. Prerequisite: ARCH

2011. 3 Course cr

### **[ ARCH 2016, Building Project I: Research and Design ]**

(Required of first-year M.Arch. I students.) This course explores the conception and construction of dwelling space in the city. Through a term-long process of collaborative research, analysis, design, and technical documentation, student teams examine the specific relationship of the human body to its environment, the elemental concerns of

inhabitation, and the physical, spatial, and technical formation of building. A series of iterative analytical exercises, conducted at a range of scales using various analytical tools and design media, address the building site, its enclosure, apertures, interior surfaces, and its fixtures and fittings, and their roles in mediating our experience of private and social space, of weather, and of climate. This collaborative process begins at the start of the term with the formation of design teams and the introduction of our Building Project partners: our clients at Columbus House of New Haven, a New Haven-based shelter and permanent supportive housing provider for the homeless, and the New Haven city officials who administer the city's zoning, building, and life-safety laws and regulations under the auspices of New Haven's Livable City Initiative. Over the course of the term and in conjunction with a series of lectures, field trips, and workshops, each student team develops and documents a distinct and technically detailed design proposal for a two-family house, one of which is selected at the end of the term. This work sets the stage for the second phase of the course and the subsequent work of the summer: the construction of the Jim Vlock Building Project house in New Haven's Hill neighborhood. 3 Course cr

**[ ARCH 2017, Building Project II ]**

(Required of first-year M.Arch. I students, early summer.) This course examines the materialization of a building, whereby students are required to physically participate in the construction of a structure that they have designed. By engaging in the act of making, students are exposed to the material, procedural, and technical demands that shape architecture. Construction documents are generated and subsequently put to the test in the field. Students engage in collaboration with each other, and with a client, as they reconcile budgetary, scheduling, and labor constraints, and negotiate myriad regulatory, political, and community agencies. The course seeks to demonstrate the multiplicity of forces that come to influence the execution of an architectural intention, all the while fostering an architecture of social responsibility, providing structures for an underserved and marginalized segment of the community. For more information, see the section on the Building Project online at <http://architecture.yale.edu/academics/building-project>. Prerequisites: ARCH 1011, ARCH 1012. 3 Course cr

**ARCH 2018a, Advanced Building Envelope Design** Anna Dyson

(Required of second-year M.Arch. I students who waive ARCH 2021.) This course is geared toward graduate students in Architecture who already have an advanced background in bioclimatic analysis and design and who wish to pursue an area of design research in conjunction with their studio projects. The core content of the course is a hybrid lecture/seminar format that focuses on an overview of emerging critical theory and technology in the areas of environmental and energy systems. The deliverable is a design research project that runs in parallel to design studio and considers an aspect of the studio project that gets pushed in a highly developed and experimental direction toward new methods of metabolizing energy, water, air, or living systems through the building envelope. We reconsider fundamentally novel ways of redirecting energy and water flows toward the fulfillment of various social mandates to transform the relationship between the built environment and extended ecosystems. 3 Course cr

**ARCH 2021a, Environmental Design** Mae-Ling Lokko

(Required of second-year M.Arch. I students.) This course examines the fundamental scientific principles governing the thermal, luminous, and acoustic environments

of buildings, and introduces students to the methods and technologies for creating and controlling the interior environment. Beginning with an overview of the laws of thermodynamics and the principles of heat transfer, the course investigates the application of these principles in the determination of building behavior, and explores the design variables, including climate, for mitigating that behavior. The basic characteristics of HVAC systems are discussed, as are alternative systems such as natural ventilation. The second half of the term draws on the basic laws of physics for optics and sound and examines the application of these laws in creating the visual and auditory environments of a building. Material properties are explored in detail, and students are exposed to the various technologies for producing and controlling light, from daylighting to fiber optics. The overarching premise of the course is that the understanding and application of the physical principles by the architect must respond to and address the larger issues surrounding energy and the environment at multiple scales and in domains beyond a single building. The course is presented in a lecture format. Homework, computational labs, design projects, short quizzes, and a final exam are required. 3 Course cr

**[ ARCH 2022, Systems Integration and Development in Design ]**

(Required of second-year M.Arch. I students.) This course is an integrated workshop and lecture series in which students learn to develop the technical systems of preliminary design proposals from earlier studio work. The careful advancement of structural form and detail, environmental systems, egress and accessibility, and envelope design, as well as an understanding of the constructive processes from which a building emerges, are all approached systematically, as elements of design used not only to achieve technical and performance goals but also to reinforce and reinforce the conceptual origins of the work. The workshop is complemented by a series of lectures from leading structural, environmental, and envelope consultants. Detailed technical drawings and analyses, along with the sustained use of BIM software, are required. Prerequisites: ARCH 1021, ARCH 2011, ARCH 2012, ARCH 2021. 3 Course cr

**ARCH 2031a, Architectural Practice and Management** Susana La Porta Drago, Melinda Agron, Dov Feinmesser, Heather Kim, Angel Campos, and Cristian Oncescu

(Required of third-year M.Arch. I students. No waivers allowed. Available as an elective for M.Arch. II students who obtain permission of the instructor.) The process by which an architectural design becomes a building requires the architect to control many variables beyond the purely aesthetic, and understanding how to control that process is key to successful practice. This course provides an understanding of the fundamentals of the structure and organization of the profession and the mechanisms and systems within which it works as well as the organization, management, and execution of architectural projects. Lectures explore the role and function of the architect, the legal environment, models of practice and office operations, fees and compensation, project delivery models and technology, and project management in the context of the evolution of architectural practice in the delivery of buildings. 3 Course cr

**ELECTIVE COURSES**

**[ ARCH 2211, Technology and Design of Tall Buildings ]**

This seminar investigates the dynamic interrelationship between technology and architecture in tall buildings. Among the various technologies involved, emphasis is

placed on structural and facade systems, recognizing the significance of these systems, the separation of which in terms of their function led to modern architecture and allowed the emergence of tall buildings. This seminar reviews contemporary design practice of tall buildings through a series of lectures and case study analyses. While most representative technologies for tall buildings are studied, particular emphasis is placed on more recent trends such as diagrid structures and double-skin facades. Further, this seminar investigates emerging technologies for tall buildings and explores their architectural potentials. Finally, this course culminates in a tall building design project and presentation. Limited enrollment. 3 Course cr

**ARCH 2222a, The Mechanical Eye** Dana Karwas

This course examines the human relationship to mechanized perception in art and architecture. Mechanical eyes, such as satellites, rovers, computer vision, and autonomous sensing devices, give us unprecedented access to nonhuman and superhuman views into known and unknown environments. But the technology of automatic observation alienates human observers and fools them into thinking that this is an unemotional, inhuman point of view due to its existence in a numeric or digital domain. The observer is looking at seemingly trustworthy data that has been “flattened” or distilled from the real world. But this face-value acceptance should be rejected; interpreters of this device data should interrogate the motives, biases, or perspectives informing the “artist” in this case (that is, the developer/programmer/engineer who created the devices). Despite the displacement of direct human observation, mechanical eyes present in remote sensing, LiDAR scanning, trail-cams, metagenomic sequencing, urban informatics, and hyperspectral imaging have become fundamental to spatial analysis. But as these become standard practice, observers should also be trained in cracking open the data to understand the human perspective that originally informed it. In this class, students investigate the impact of the mechanical eye on cultural and aesthetic inquiry into a specific site. They conceptually consider their role as interpreter for the machine and create a series of site analysis experiments across a range of mediums. The experiments are based on themes of inversion, mirroring, portraiture, memory, calibration, and foregrounding to “unflatten” data into structure and form. Limited enrollment. 3 Course cr

**[ ARCH 2226, Design Computation ]**

The capabilities and limitations of architects’ tools influence directly the spaces architects design. Computational machines, tools once considered only more efficient versions of paper-based media, have a demonstrated potential beyond mere imitation. This potential is revealed through design computation, the creative application of the processes and reasoning underlying all digital technology, from email to artificial intelligence. Just as geometry is fundamental to drawing, computation affords a fundamental understanding of how data works, which is essential to advance the development of BIM, performative design, and other emerging methodologies. This seminar introduces design computation as a means to enable architects to operate exempt from limitations of generalized commercial software; to devise problem-specific tools, techniques, and workflows; to control the growing complexities of contemporary architectural design; and to explore forms generated only by computation itself. Topics include data manipulation and translation, algorithms, information visualization, computational geometry, human-computer interaction, custom tooling, generative form-finding, emergent behavior, simulation, and system modeling. Using Processing,

students develop computational toolsets and models through short, directed assignments ultimately comprising a unified, term-long project. Limited enrollment.  
3 Course cr

**[ ARCH 2230, Exploring New Values in Design Practice ]**

How do we make design a more profitable practice? Design business has traditionally positioned building as a commodity in the delivery supply chain, valued by clients like other products and services purchased at lowest first cost. Despite the fact that the building sector in its entirety operates in large capital pools where significant value is created, intense market competition, sole focus on differentiation by design quality, and lack of innovation in project delivery and business models have resulted in a profession that is grossly underpaid and marginally profitable. The profession must explore new techniques for correlating the real value of an architect's services to clients and thereby break the downward pressure on design compensation. This seminar redesigns the value proposition of architecture practice, explores strategies used by better-compensated adjacent professions and markets, and investigates methods by which architects can deliver—and be paid for—the value they bring to the building industry. Prerequisite: ARCH 2031 or equivalent strongly recommended. Limited enrollment. 3 Course cr

**[ ARCH 2238, The Mechanical Artifact ]**

The Mechanical Artifact: Ultra Space is a course designed to engage students to our unfolding sci-fi space future. In this course, students will work in teams to design, build, test, and deploy a space artifact of their own, to be included in a project slot on a parabolic research flight. One student from the course will also be selected as a flier on the zero-G flight. The final project will serve as a mechanism, device, lesson, story, or experience for creatively designing for the zero-G environment. It will be a practical exercise to design for space, while at the same time engaging thoughtfully about our role in it. Limited Enrollment. 3 Course cr

**[ ARCH 2240, The Architect As: Recasting the Role of the Architect in the Development Lifecycle ]**

An introduction to the real estate development lifecycle through the lens of the Architect. The course follows the typical chronology of a multi-family residential project starting from a developer's initial interest in a site, to a resident inhabiting the completed building; in between, it addresses feasibility, acquisitions, zoning, financing, design, construction, marketing and branding, and operations. We will employ this linear framework first to understand the underlying components of each phase, and second to evaluate: what is the role of the Architect - past versus present, real versus perceived? Where the Architect's role has been eroded or altered over time, how can they rebuild it - leveraging their multifaceted skillset or learning new modes of analysis - to maximize agency and impact? Finally, we will ask broader questions that cut across the development lifecycle: what does an enhanced Architect mean for the other players along the value chain? What does it mean for the ability of the Architect to impact development strategy, or to frame development as a series of design challenges? How does the dynamic between form and finance, design and development change? And, what does the rebuilt Architect mean for the final product - the realized building - and the built environment? The seminar examines traditional and hybrid design practices through readings, assignments, and guest lectures. As a final project, students submit a

design-driven development proposal for a site in New Haven, employing the disruptive practices learned over the semester. 3 Course cr

**[ ARCH 2241, Building Disasters: When Things Go Wrong ]**

This seminar explores accidents, failures, and catastrophes, large and small, in buildings and—whether caused by bad luck, bad design, bad management, or miscalculation—how such incidents have impacted users, owners, and designers. Limited enrollment. 3 Course cr

**ARCH 2242a, Slavery, Its Legacies, and the Built Environment** Phillip Bernstein, Luis C.deBaca, and Jordan Carver

This collaboration of the Law School and School of Architecture is taught in conjunction with the University of Michigan Law School's Problem Solving Initiative. The course examines the legal and social impact of modern and historic forms of slavery and involuntary servitude. Drawing from the disciplines of law, history, land use, architecture, and others, student teams assemble a final portfolio that will inform a spring 2022 School of Architecture studio course that will design a national slavery memorial on the Washington, D.C., waterfront. This course satisfies the ABA Experiential Learning requirement. 3 Course cr

**ARCH 2245a, Alternative Development Workshop** Nicholas McDermott  
3 Course cr

**ARCH 2246a, Introduction to Architectural Robotics** Hakim Hasan  
3 Course cr

**[ ARCH 2247, Soil Sisters ]**

This course aims to investigate a new paradigm for connecting agricultural waste to large-scale regional material supply chains, in which improving soil nutrition and soil resiliency underpin the design goal of providing cross-sectoral environmental performance through the provision of new biomaterial construction systems.  
3 Course cr

**[ ARCH 2248, Civita di Bagnoregio ]**  
3 Course cr

**ARCH 2249a, Bad Buildings:Decarbonization Through Reuse, Retrofit and Proposition** Tess McNamara  
3 Course cr

**[ ARCH 2255, Ghana ]**  
3 Course cr

**[ ARCH 2299, Independent Course Work ]**

Program to be determined with a faculty adviser of the student's choice and submitted, with the endorsement of the study area coordinators, to the Rules Committee for confirmation of the student's eligibility under the rules. (See the School's *Academic Rules and Regulations*.) 3 Course cr

## Electives outside of School of Architecture

Courses offered elsewhere in the University may be taken for credit with permission of the instructor. Unless otherwise indicated, at the School of Architecture full-term courses are typically assigned 3 credits; half-term courses are assigned 1.5 credits.