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, building carbon footprint, 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 6001a, Advanced Building Envelope Design Anna Dyson
(Required of second-year M.Arch. I students who waive ARCH 6005.) 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 6002b, Architectural Practice and Management Susana La Porta Drago, Dov Feinmesser, Joshua Kuhr, Aaron Trahan, 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

ARCH 6003b, Building Project I: Research and Design Adam Hopfner, Louis Koushouris, Carlos Zapf, Alexander Kruhly, Beka Sturges, and Ming Thompson
(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. 6 Course cr

[ARCH 6004, 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 5001, ARCH 5002, ARCH 6003. 3 Course cr

ARCH 6005a, Environmental Design Mae-Ling Lokko
(Required of second-year M.Arch. I students.) The act of building is one of the world's most powerful drivers of environmental processes, emissions and resource flows – from the extraction and processing of building materials, to the energy consumed over its lifetime and its generation of waste for eventual degradation. This has always been part of a changing, interconnected and larger ecological system. The seminar examines how the design of buildings in the 21st century are linked to ecological health, indoor environmental health and carbon life cycles. Across all three areas, students will examine key ecological theory and principles, bioclimatic design across various climate

contexts and thermal comfort standards; followed by an introduction to fundamental scientific principles governing the design and control of thermal, luminous, and acoustic environments of buildings. Material properties are explored in detail, and students are exposed to the various technologies for producing and controlling light, heat and moisture. The overarching premise of the course is that the understanding and creative application of key principles by the architect must respond to and address the larger issues surrounding energy, environmental health and well-being at multiple scales and across domains beyond the single building. The course is presented in a hybrid lecture and interactive lab format. Labs and the final design competition project will be carried out as group work. Labs in the first part of the semester will focus on the study and analysis of case study buildings in both real-world environments and digital energy simulation programs; while the remainder of the semester will broaden the application of environmental design principles in a group competition. The Environmental Design Competition is designed for students to both communicate their understanding of dynamic environmental conditions and develop multiscalar design strategies in response to an ever expanding array of energy and environmental performance standards and broader design goals. 3 Course cr

ARCH 6006a, 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 impact of the evolution of these systems on architectural form. Lectures and homework assignments will cover structural classifications, fundamental principles of mechanics, computational methods, and the behavior and case studies of truss, cable, arch, beams, columns, and simple framework systems. Homework, discussion sections, quizzes, and final examinations are required. 3 Course cr

ARCH 6007b, Structures II Sara McMonagle
(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 6006. 3 Course cr

ARCH 6008b, Systems Integration and Development in Design Martin Finio
(Required of second-year M.Arch. I students. Successful completion of the Revit component for the required Summer Visualization courses is a prerequisite for Systems Integration.) 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 reinform 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 5003, ARCH 6006, ARCH 6007, ARCH 6005. 3 Course cr

ELECTIVE COURSES

ARCH 6101a, Bad Buildings: Decarbonization Through Reuse, Retrofit and Proposition Tess McNamara

Current sustainability discourse labels many existing buildings as 'bad.' Hooked on fossil fuels, leaky, and inefficient, existing buildings are penalized for their carbon footprint by cities and policymakers to provoke energy renovations and upgrades. New 'Net Zero Carbon' buildings have been the sustainability focus of the AEC industry—all-electric, highly efficient, and technologically advanced, these ground up buildings have been heralded as climate saviors. This seminar presents the opposite as true: new 'Net Zero' buildings are a distraction, not our salvation. It is the existing 'bad' buildings, the messy fabric all around us, that do pose a carbon challenge, but also hold a profound solution to achieving a low carbon future. In pursuit of new solutions grounded in practice, this seminar follows two tracks: the technical and theoretical. The technical side covers reuse (embodied carbon) and retrofit (operational carbon) through lectures, guest speakers, and short assignments. The theoretical track covers case studies and readings on adaptive reuse and architectural proposition. The seminar culminates in student-initiated proposals for decarbonizing and reinventing an existing building in New York City. 3 Course cr

ARCH 6102a, Building Disasters: When Things Go Wrong John Jacobson

Building Disasters: When Things Go Wrong This seminar flips the traditional approach to architectural education by focusing not on celebrated successes, but on failures – spectacular, sobering, and instructive. Through detailed case studies of structural and architectural disasters, the course examines how miscalculations, human error, design flaws, mismanagement, and unforeseen conditions can lead to catastrophic outcomes. More than a technical postmortem, these failures are also considered within their broader political, cultural, environmental, and professional contexts. What went wrong? Why did it happen? What were the consequences—not just for the buildings themselves, but for the people who used, built, and designed them? The course also looks at how these failures have prompted changes in building codes, engineering standards, professional ethics, and architectural practice. By studying what did not work, students gain critical insight into what it means to build responsibly, learning to anticipate risk, question assumptions, and navigate the complex realities of the practice of architecture. Each student selects a building failure to research and presents their findings in class. Through this process, the course aims to develop more thoughtful, critical, and ethically grounded designers – aware not only of how things are built, but of how things can go wrong. 3 Course cr

ARCH 6103b, Demo: Demonstration Projects for the Viable Reuse of Aging Buildings Violette de la Selle

The design of a building implicitly accounts for its lifespan, as a structure is expected to remain in sound condition for an anticipated number of years. Yet these predictions prove irrelevant when a building falls out of use and is demolished prematurely. Today, as we strive to limit our carbon emissions and curb global warming, we come to value the material existence of a building as a distinct advantage, given that new construction materials accounts for 23 percent of process-related global carbon emissions. Contrary to the tendency to eliminate buildings prematurely, could we in fact allow them to

endure indefinitely? Using drawings as research record, the course studies a regional building in detail to develop proposals for its continued use. 3 Course cr

ARCH 6104b, Design Computation Michael Szivos
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 composing a unified, term-long project. Limited enrollment. 3 Course cr

ARCH 6105b, Exploring New Value of Design Practice Phillip Bernstein
An architectural education is a hard-won and expensive proposition, and architects have unique skills, work hard, and contribute widely to the built world. Is this contribution understood, acknowledged, or appreciated? Is the value of the architect's contribution clear to clients, the public, or in the economy? If so, why isn't architectural practice more profitable? How do we make the value of design explicit, increasing the efficacy of the profession and converting our value to a more remunerative profession? This course is a chance to reimagine and redesign the value proposition of architecture practice, explore strategies used by better compensated adjacent professions and markets, and investigate methods and models by which architects can deliver—and be paid for—the value they bring to the building industry. Using the platform of business plans—where value generation is defined through specific business parameters including profitability—we compare and contrast value generation strategies and tactics. Students form firms and propose new practice paradigms as a final project. 3 Course cr

ARCH 6106b, Introduction to Architectural Robotics Hakim Hasan
This course introduces students to robotic fabrication and assembly techniques and their evolving role in architecture and construction. Students will explore the practical implementation of robotic workflows while developing critical design and fabrication thinking. The course emphasizes design-through-making, empowering students to prototype robotic assemblies in the Yale School of Architecture's Robotics Lab. This version of the course adopts a new AI-assisted scripting approach, enabling students to generate robotic workflows without requiring prior parametric modeling experience. Instead of manual script-building, students will learn how to craft effective prompts and iteratively refine AI-generated Grasshopper scripts. This shift lowers the barrier to entry while preserving the rigor of robotic logic, tooling, and physical realization. Through lectures, lab sessions, and hands-on projects, students will explore how

automation, robotics, and artificial intelligence are reshaping the future of architectural production and leave the course with a portfolio of robotic workflows, physical artifacts, and prompt-based scripting strategies. Course 1002: Students must complete shop training before enrolling in this course. 3 Course cr

[ARCH 6107, Introduction to Robotic 3d Printing]
This course provides an introduction to the field of robotic 3D printing. Students will learn about the principles and techniques of 3D printing, as well as the role of robotics in the 3D printing process. The course will cover a range of topics, including Designing, 3D modeling, Simulating, and Postprocessing for Robotic 3D Printing. Students will also explore the use of robotics in 3D printing, including the use of robotic fabrication techniques. Course 1002: **Students must complete shop training before enrolling in this course.** 3 Course cr

[ARCH 6108, Regenerative Building Research]
As we approach "the climate tipping point" and a host of interrelated and critical planetary thresholds, the seminar seeks to examine the environmental impacts of building sector activity and the agency of architects (and the building sector more broadly) in mitigating and potentially reversing the ecological and atmospheric impacts created through the building life cycle and its flows of material and energy. What if, instead of depleting our planet's forests, peatlands, and wetlands, the making of buildings and cities could incentivize their restoration and enhance biodiversity while rebalancing socioeconomic inequity? As both the science and technical means of biospheric management evolve, concurrent innovations in bio-based and circular economic construction and associated methods of impact assessment offer the possibility for a new and powerful symbiosis between healthy ecosystems and convivial urban growth. In an era of big data, bioregional synergies can be analyzed and predicted through extrapolative methodologies using broad datasets and powerful computational models. But they must also be explored, tested, and implemented through empirical means, simultaneously, in regional ecosystems and the urban areas that would rely on them and provide critical feedback. Through a range of readings, analytical exercises, and material and assembly tests, the seminar engages advanced concepts and methods of regenerative design and construction and posits system change for global building. 3 Course cr

[ARCH 6109, Slavery, Its Legacies, and the Built Environment]
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 6110, Structuring Architecture: Form and Space]
Structures are what primarily define the form and space of architecture. Structures for buildings are composed of various structural components such as columns, walls, beams, trusses, arches, cables, slabs, shells, etc. Studies on architectural structures (in basic structures classes) are typically based on these structural components in an

attempt to deal with most major structural components in architecture. While this approach is good to understand various structural components, how to configure them to create desired forms and spaces of architecture can still be very challenging for architects. This seminar studies structures based on various overall configurations of forms and spaces of architecture. Based on certain forms and spaces, different structural design alternatives are investigated through cases studies and alternative design studies with due consideration of architectural design, structural efficiency and other related design issues. 3 Course cr

ARCH 6111a, Technology and Design of Tall Buildings Kyoung Moon
Architecture is a discipline that is actively engaged in the interests of both technology and art. In architecture, especially in modern architecture, functional and performance attributes as well as aesthetic aspects are produced through the functionalities and limitations of technology. The very products of modern technology – from form-making structures to surface-defining enclosures – are assembled to create architecture. Physical components of architecture are nothing but cold steel members, massive concrete, mass timber, aluminum panels, various kinds of glass panes, etc. However, once these elements are put together on a specific site in a certain way through the process of design and construction, they are no longer mere technological elements. They are transformed into the components of both the functional and the aesthetical. Tall buildings are, in a sense, the accumulation of the most advanced modern architectural technologies due to their extreme height. Because of their enormous scale, the impacts of their architectural aesthetic expressions are also significant in any context where they soar. This seminar investigates the dynamic interrelationship between technology and architecture in tall buildings. It reviews contemporary design practice of tall buildings through a series of lectures and case study analyses and presentations. While most representative technologies for tall buildings are studied, an emphasis is placed on more recent as well as emerging technologies, and their architectural potentials are explored. Finally, this course culminates in a tall building design project and presentation. 3 Course cr

ARCH 6112b, The Architect As: Recasting the Role of the Architect in the Development Lifecycle Antonia Devine
The course is an introduction to the real estate development lifecycle taught through the lens of the Architect. It follows the typical chronology of a multi-family residential project with each week focusing on one phase, starting from a developer's initial interest in a site to a resident moving into the fully realized building; in between, the course addresses feasibility and acquisitions, entitlements and zoning, financing, design, construction, marketing and branding, and operations and asset management. We 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, taking on new responsibilities, learning new modes of analysis—to maximize agency, impact and compensation? Finally, we 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? 3 Course cr

[ARCH 6113, The Mechanical Eye]
This course, based at the Center for Collaborative Arts and Media (CCAM), examines mechanized perception as a method of sensing the built environment, focusing on how both humans and human-like machines respond to their surroundings. From the physiological to the peripheral, students will explore these "mechanical eyes" and their ability to perceive, revealing biases and transforming our engagement with material spaces. Central to the curriculum are weekly études across various technical mediums that challenge conventional perceptions, encouraging students to rethink structure and form through themes such as inversion, cause and effect, and embodiment. The final project focuses on designing a mechanical eye for artificial or real life, creating an architectural stimulus that questions the underlying human perspectives in mechanical data. The project will serve as a critical social and cultural exploration of how mechanical perceptions can inform and revolutionize art and architecture workflows to accommodate the expanding state of human and human-like perception. 3 Course cr

[ARCH 6190, Civita di Bagnoregio]
This three-week summer program is based in Civita di Bagnoregio, an Italian hill town settled during Etruscan times and continuously inhabited for over 2,500 years. The program focuses on Civita's urban history and the preservation, architectural conservation, and stabilization challenges faced by the town and other hill towns in the region, ranging from geotechnical instability and natural erosion to changes in their social and economic infrastructure, which have exacerbated the loss of their historic fabric and the abandonment of their traditional way of life. The program includes visits to hill towns in Lazio, Tuscany, and Umbria, as well as to a material testing laboratory in Rome. Students have individual assignments and a group final project. 3 Course cr

[ARCH 6191, Soil Sisters Senegal]
NA 3 Course cr

[ARCH 6999, Independent Coursework]
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 the 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.