

Master of Science (M.S.) in Architecture (9-month)

Program Description

The Master of Science in Architecture degree program is intended primarily for practitioners in the building industry who are interested in gaining state-of-the-art knowledge and skills in computation and building performance. Applicants to the program are expected to have a prior degree related to the building sector, including architecture, engineering, planning, or management. The program is designed to be completed in nine months allowing those who are already established in the industry to take a leave and return with relatively little discontinuity in their professional careers.

Curriculum

	Fall	Spring
General 21 units	48-711 Research Models and Methods in Architecture (9) 48-722 Building Performance Modeling (12)	
Core 9 units	SKILLS course 48-725 Building Economics (9) OR 48-726 Acoustics and Lighting (9) OR 48-767 Software Requirement Modeling (6) AND 48-768 Software Requirement Application (6)	
Core Selectives 18 units		SELECTIVES (18) From courses accepted as fulfilling a core requirement in Computational Design, Building Performance and Diagnostics, Sustainable Design, or AEC Management*
Computing / Alternatives 18 units	Recommended computing course – one of the following: ** 15-100 Introductory/Intermediate Programming (10) 15-111 Intermediate/Advanced Programming (10) (Fall or Spring)	
Electives 18 units	ELECTIVES (18) (Fall or Spring)	

* Some core courses are offered in the Fall semester and students wishing to elect those courses as one of their selective requirements will need to modify their schedule, for example, by taking their computing or alternative in the Spring semester.

** Students may petition to substitute the computing course by an elective, subject to approval by the Graduate Program Committee.

Degree Requirement

In addition to the standard requirements for all graduate students in the School of Architecture, students in this program must satisfy the following:

- Students must complete a minimum of 75 units of course work for graduation.
- The minimum full-time residency requirement is two academic semesters. Full-time status requires a minimum of 36 units per semester during the residency period.
- Students must start the sequence of courses in the Fall semester.

Transferring to other Master programs

Students in the MSA program who wish to apply for a transfer to any of the other Master programs in the School of Architecture should ensure that their selectives are taken from the core courses for the intended concentration area. Refer to the specific program description and curriculum for details.

All course numbers/titles and their schedules may be subject to change. Please refer to the School of Architecture Graduate Programs Website [www.arc.cmu.edu] for the latest information.

Master of Science (M.S.) in Architecture-Engineering-Construction Management (9-month or 16-month)

**Program
Description**

The Master of Science degree program in Architecture-Engineering-Construction Management is offered jointly with the Department of Civil and Environmental Engineering.

The program aims to prepare building delivery professionals – civil engineers, construction planners, facility managers, developers, architects, planners, landscape architects, interior designers, and other building consultants – for careers in decision making that can have a positive impact on economic, environmental, and ethical concerns through the management of design, construction, maintenance, and use of facilities.

The program is intended for professionals who are prepared to take a year off from their employment or for recent graduates who are looking to diversify their qualifications prior to entering the job market. The program is structured to fit either a 9-month (two semesters) or a 16-month (three semesters + summer) time frame for those with or without prior professional experience respectively.

**Curriculum
9-month**

	Fall	Spring
Quantitative Methods 24 units	12-704 Probability and Estimation Methods for Engineering Systems (12)	48-759 Value Based Design in AEC (12)
Micro-Economics 24 units	12-706 Civil Systems Investment Planning and Pricing (12) 48-725 Design Economics or equivalent (12)	
Management 24 units	12-711 Advanced Project Management for Construction (12)	48-781 Knowledge Management in Architecture and Planning (12)
Project/Elective 24 units		48-766 AEC Synthesis (12)* Or Elective Elective (var.)

* The project course deals with synthesis in solving AEC problems using the tools, theories, and methods studied in the program courses. Sponsors from government agencies, NGOs, or the private sector will be invited to underwrite real or realistic facility or design management problems. Students and faculty work in teams to formulate and resolve problem defined by these entities, which will serve as "clients." At the end of the semester, student groups will present their work to the clients and develop a self-evaluation of their work.

**Curriculum
16-month**

	Fall	Spring	Summer	Fall
Quantitative Methods 24 units	12-704 Probability and Estimation Methods for Engineering Systems (12)	48-759 Value Based Design in AEC (12)		
Micro-Economics 24 units	12-706 Civil Systems Investment Planning and Pricing (12) 48-725 Design Economics or equivalent (12)			
Management 24 units	12-711 Advanced Project Management for Construction (12)	48-781 Knowledge Management in Architecture and Planning (12)		
Project/Elective 24 units		Elective (var.)		48-765 AEC Synthesis (var. 12-24)* or Elective
Internship			Internship	

* The project course deals with synthesis in solving AEC problems using the tools, theories, and methods studied in the program courses. Sponsors from government agencies, NGOs, or the private sector will be invited to underwrite real or realistic facility or design management problems. Students and faculty work in teams to formulate and resolve problem defined by these entities, which will serve as "clients." At the end of the semester, student groups will present their work to the clients and develop a self-evaluation of their work. The Fall and Spring semester courses taken successively provide a sequence.

**Degree
Requirement**

In addition to the standard requirements for all graduate students in the School of Architecture, students in this program must satisfy the following:

- Students must complete a minimum of 96 units of course work for graduation.
- The residency requirement (9- or 16-month) is determined at admission based on the previous experience and preparation of the candidate. The minimum full-time residency requirement for either time frame is two academic semesters. Full-time status requires a minimum of 36 units per semester during the residency period.
- Students must start the sequence of courses in the Fall or Spring semester.

All course numbers/titles and their schedules may be subject to change. Please refer to the School of Architecture Graduate Programs Website [www.arc.cmu.edu] for the latest information.

Master of Science (M.S.) in Building Performance and Diagnostics (2-year)

Program Description

The Master of Science degree program in Building Performance and Diagnostics is intended for practitioners, researchers, and educators in architecture and the building industry who wish to be leaders in advanced building technologies and their performance. The program covers, in depth, knowledge about the state-of-the-art in building systems integration and total building performance. The program culminates with a project in which students must apply the knowledge they have acquired to realistic problems, using the appropriate analytic and modeling skills. The program is open to graduates with a prior bachelor's degree and who have some connection with the building sector through architecture, engineering, planning, or management. Graduates of this program from Carnegie Mellon University have found outstanding careers in practice, industry, and education.

Curriculum

Year 1	Fall	Spring
General 9 units	48-711 Research Models and Methods in Architecture (9)	
Core 21 units	48-722 Building Performance Modeling (12)	48-723 Performance of Advanced Building Systems (9)
Core Selectives 18 units	SELECTIVES (18)* (Fall or Spring)	
Computing/ Alternatives 18 units	Recommended computing course:** (Fall or Spring) 15-100 Introductory /Intermediate Programming (10) 15-200 Advanced Programming (9)	
Open Selections 9 units	OPEN Selections (9)*** (Fall or Spring)	

* Selectives are courses that are accepted as fulfilling the requirement of showing proficiency in aspects of Building Performance and Diagnostics.

** Computing is not required for MS (BPD) students – recommended for those intending to do a PhD in performance simulation. Students may substitute with a selective or elective, subject to approval by the Graduate Program Committee.

*** Open selections enable students to take necessary prerequisites without extending the duration of their program. Students otherwise take elective(s) subject to approved by the Graduate Program Committee.

Year 2	Fall	Spring
Core 24 units	90-711 Empirical Methods for Public Policy and Management (12) +	90-722 Management Science I: Optimization and Multi-criteria Methods (6) +
	90-772 Operations Research for the Public Sector (6) +	90-760 Management Science II: Decision Risk Modeling (6) +
		48-721 Building Controls and Diagnostics (12)
Electives 15 units	ELECTIVES (15)* (Fall or Spring)	
Project 36 units	48-702 Master's project (18)+	48-703 Master's project (var. 18-36)+

+ Select 90-711 or any combination of 90-772, 90-722 and 90-760 for a total of 12 units.

++ Master's projects provide students with the opportunity to conduct research under the direction of the School's faculty. Normally, the project is undertaken in the Spring semester. However, with the approval of their faculty advisor, students may elect to spread the project over two semesters (18 units per semester) and take an appropriate number of required or elective courses to maintain full-time status.

Core Selectives These are among the concentration courses accepted by the program as fulfilling the requirement of students showing proficiency in core aspects of Building Performance and Diagnostics. The following courses are presently accepted as fulfilling this requirement:

- 12-651 Air Quality Engineering (9)
- 12-726 Mathematical Modeling of Environmental Quality Systems (12)
- 48-752 Zero Energy House (9)
- 48-725 Building Economics (9)
- 48-726 Acoustics and Lighting (9)
- 48-729 Special Topics in BPD (variable units)
- 48-737 Productivity, Health and Quality of Buildings (9)
- 48-795 LEED™ Buildings and Green design Concepts (9)
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Student may also elect to take other courses as concentration selectives, not listed above but offered elsewhere in the university and related to the interest area of Building Performance and Diagnostics (for example, courses in energy and environmental policy/systems, green design, etc.), subject to approval by the Graduate Program Committee.

Owing to periodic changes to the curricular offerings, students may, under the advice and of their faculty program coordinator, and approval of the Graduate Program Committee, elect alternative courses to fit within this category.

Open Selections

Open selections enable students to take necessary prerequisite courses, which may be required for certain concentration selectives, without extending the duration of their program.

The following physics course is recommended for students wishing to pursue an interest in the area of energy and environmental policy:

24-721 Thermodynamics

Students who wish to pursue a PhD in the Building Performance and Diagnostics in performance simulation are encouraged to take 15-211 Fundamental Data Structures and Algorithms for which the following course is a mathematical prerequisite:

21-127 Concepts of Mathematics

There may be other more suitable prerequisites that meet the student's specific interest. Those courses can be elected, after consultation with the Faculty Program Coordinator.

Student must submit all petitions for course substitution or election in writing through the Faculty Program Coordinator to the Graduate Program Committee for approval.

Degree Requirement

In addition to the standard requirements for all graduate students in the School of Architecture, students in this program must satisfy the following:

- Students must complete a minimum of 150 units of course work for graduation.
- The minimum residency requirement is 3 academic semesters. Full-time status (minimum 36 units per semester) is required during the residency period.
- Students must start the sequence of courses in the Fall semester.

Information for MSA Students

Students who have completed the Fall and Spring semester requirements of the MSA degree can apply for a transfer to the 2-year MS (BPD) Program. With the approval of the Graduate Program Committee, the student may enroll in the second year of the Program, subject to conformance to the Program requirements.

All course numbers/titles and their schedules may be subject to change. Please refer to the School of Architecture Graduate Programs Website [www.arc.cmu.edu] for the latest information.

Master of Science (M.S.) in Computational Design (2-year)

Program Description

The Master of Science degree program in Computational Design is intended primarily for practitioners in the building industry who wish to broaden their knowledge about the state-of-the-art in computer approaches and applications to architectural and building sciences, and for individuals who wish to pursue research careers in these areas. The program covers, in depth, a range of computational design issues and culminates with a project where students apply acquired knowledge to realistic problems. The program is open to graduates with a prior bachelor's degree and who have some connection or interest in design through architecture, engineering, computer science, planning, management, or computer-aided design.

Curriculum

Year 1	Fall	Spring
General 9 units	48-711 Research Models and Methods in Architecture (9)	
Computing 24 units	48-756 Application in CAD (12)	48-770 Computation I: Introduction to Programming and Databases (12)
Project 24 units	MS(CD) Project Course I (12)	MS(CD) Project Course II (12)
Elective 12 units	Elective (6)	Elective (6)

* Selectives are courses that are accepted as fulfilling the requirement of showing proficiency in core aspects of Computational Design. Most selectives expect some programming skill as a prerequisite. Students without prerequisites should use the elective slot to take such courses without extending the duration of the program, e.g., 21-127 Concepts of Mathematics, is a prerequisite for 15-211, required for all MS (Computational Design) students.

Year 2	Fall	Spring
Concentration Selectives 18 units	Concentration Selectives (9)	Concentration Selectives (9)
Computing 24 units	15-211 Fundamentals of Data Structure and Algorithms (12)	15-212 Principles of Programming (12)
Project 24 units	MS(CD) Project Course III (12)	MS(CD) Project Course IV (12)
Electives 12 units	Electives (6)	Electives (6)

+ Completion of one or more of 15-212, 15-213 or 17-652 is required for candidacy in the PhD program in Computational Design.

**Concentration
Selectives**

These concentration courses, subject to approval by the Graduate Program Committee, are accepted by the program as fulfilling the requirement of students showing proficiency in some aspects of Computational Design. These courses may be offered by the School of Architecture, School of Computer Science, Department of Civil and Environmental Engineering, Department of Mechanical Engineering, Human Computer Interaction Institute, Robotics, etc.

Approved courses may vary from year to year. Owing to periodic changes to the curricular offerings, students may, under the advice and of their Faculty Program Coordinator, and approval of the Graduate Program Committee, elect alternative courses to fit within this category.

Student must submit all petitions for course substitution or election in writing through the Faculty Program Coordinator to the Graduate Program Committee for approval.

Master of Science (M.S.) in Sustainable Design (12-month)

Program Description

The Master of Science in Sustainable Design degree program provides an integrated education that strives to prepare its graduates for careers that will reshape the built environment in a sustainable fashion. This challenging program is intended for recent graduates and practicing professionals with degrees related to the built environment including architecture, landscape architecture, ecology, engineering, construction, interior architecture/design, facilities management and others.

Curriculum

	Fall	Spring	Summer
General 9 units	48-711 Research Models and Methods in Architecture (9)		
Core 48 units	48-722 Building Performance Modeling (12) 48-737 Productivity, Health and the Quality of Buildings (9) 48-752 Zero Energy House (9)	48-723 Performance of Advanced Building Systems (9) 48-795 LEED Buildings and Green Design Concepts (9)	
Core Selectives 27 units	1 Selective(9)	2 Selectives (18)	
Project 36 units		48-731 SD Synthesis PREP (12)	48-769 SD Synthesis (24)

Selective Categories

Students in the program must take one selective from each category. Courses listed under each category are only indicative. There may be other courses offered in other academic departments in the university which are acceptable for fulfilling this requirement. Seek approval from the Faculty Program Coordinator.

CATEGORY 1 ENVIRONMENTAL ECONOMICS TOOLS AND CALCULATIONS	CATEGORY 2 ENVIRONMENTAL LAW AND POLICY	CATEGORY 3 SUSTAINABLE DESIGN AND DEVELOPMENT
12-712 Environmental Sustainability in Engineering (6) 12-715 Sustainable Case Studies (6) 48-569 GIS and CAFM (9) 48-721 Building Controls and Diagnostic (12) 73-248 Environmental Economics (9) 73-358 Economics of the Environment and Natural Resources (9) 90-779 Transportation Planning and Financing: Land use Impact (6)	90-702 International Environmental Law and Policy (12) 79-365 Climate Change, Energy Policy and Environmental Protection (9) 19-448 Science, Technology and Ethics (9)	90-707 The Business of Brownfields (12) 90-789 Sustainable Community Development (12) CEE1210 Engineering and Sustainable Development (University of Pittsburgh; 3 credit hours) (9)

Degree Requirement

In addition to the standard requirements for all graduate students in the School of Architecture, students in this program must satisfy the following:

Students must complete a minimum of 120 units of course work for graduation with a minimum residency requirement of 2 academic semesters. Full-time status (minimum 36 units per semester) is required during the residency period.

All course numbers/titles and their schedules may be subject to change. Please refer to the School of Architecture Graduate Programs Website [www.arc.cmu.edu] for the latest information.

Master of Urban Design (12 month)

Program Description

The Master in Urban Design (MUD) is a 12-month degree program to develop physical design expertise critical to establishing new directions in sustainable community design and policy. Through a partnership with the Master of Public Policy and Management in Carnegie Mellon's Heinz School of Public Policy, the MUD prepares students to collaborate effectively in multidisciplinary teams to address the challenges and opportunities to revitalize neighborhoods, cities and regions.

Ensuring sustainability and quality of life in urban and regional design must be built on both multi-disciplinary expertise and participatory processes. Physical decisions about land-use, zoning, transportation and other infrastructures, mixed use development, and neighborhood design is brought together with urban geography, economics and policy in the Carnegie Mellon MUD degree. The center piece of the curriculum is the Urban Lab, a two term neighborhood analysis and design studio in which students from different disciplines work with architects, urban designers, the neighborhoods, and political and economic decision-makers, to address the complex and multidimensional nature of sustainable cities and regions.

Curriculum

	Fall 51units	Spring 51 units	Summer 36 units
Urban Lab 36 units	48-705 Urban Lab (18)	48-706 Urban Lab (18)	
Core 48 units	90-784 Geographical Information Systems (12) 90-743 Urban and Regional Economic Development (12)* OR 90-711 Empirical Methods (12)* OR 90-710 Applied Economic Analysis for Public Policy and Management (12)*	48-453 Urban Design Theory (9) 90-789 Sustainable Community Development (12) 48-707 Urban Design Thesis Prep (3)	
Elective 18 units	Elective (9-12)** Examples: 48-576 Mapping Urbanism (9) 90-765 Cities, Tech, Environment (12) Student proposed elective (9- 12)	Elective (9-12) Examples: 48-725 Real Estate Design & Dev (9) 90-765 Cities, Tech, Environment (12) Student proposed elective (9-12)	
Project 36 units			48-708 Urban Design Thesis (24)

Degree Requirement In addition to the standard requirements for all graduate students in the School of Architecture, students in this program must satisfy the following:

- Students must complete a minimum of 126 units of course work for graduation.
- The minimum residency requirement is two academic semesters. Full-time status (minimum 36 units per semester) is required during the residency period.
- Students must start the sequence of courses in the Fall semester.

All course numbers/titles and their schedules may be subject to change. Please refer to the School of Architecture Graduate Programs Website [www.arc.cmu.edu] for the latest information.

Collaborative degree with Oxford University MSc in Nature, Society and Environmental Policy program at Oxford University

Admission to Carnegie Mellon University's MUD program also carries the opportunity to apply for admission to the MSc in Nature, Society and Environmental Policy program at Oxford University, and achieve two overlapping Master degrees. The MSc is a three-term (12 month) program that aims to provide students with a broad perspective on society and the environment in the context of current debates on policy, regulation, social change, globalization, and environmental sustainability.

Students showing outstanding academic performance in the MUD program at Carnegie Mellon University can, if they wish, be recommended by their academic advisor for the MSc Program at Oxford University. Students are responsible for submitting the required application documentation to Oxford according to their deadlines. Students who are admitted to the MSc program by Oxford University will be able to waive the 24-unit summer thesis requirement at CMU, replaced by successful completion of the final thesis requirement for Oxford's MSc. Completed in residence in the final semester at Oxford, this thesis is expected to fulfill Oxford's academic requirements as well as address issues relevant in the context of the studio work developed in Pittsburgh. It is the responsibility of the student to make sure that the advisors in Oxford and Carnegie Mellon are aware of the topic selection and approve it as viable work to satisfy requirements in both institutions.

Successful completion of the Oxford program is a graduation requirement for students pursuing the double degree with the CMU thesis project replaced by the Oxford thesis. Academic transcripts or equivalent proof of completion and a copy of the thesis developed in Oxford should be submitted to Carnegie Mellon by August after completion of the Oxford degree. Because these are requirements for graduation in Carnegie Mellon, only after these documents are submitted can the student be certified for graduation with their MUD degree at CMU. If a student pursuing the double degree for any circumstance fails to complete the program in Oxford, she/he can always enroll in the summer thesis course at Carnegie Mellon to complete the MUD requirements for the award of the MUD degree.