ELECTRICAL ENGINEERING AND COMPUTER SCIENCE
Course 6

Department Contact

Academic Office: EECS Undergraduate Office, ug@eecs.mit.edu

Description

Course 6 at MIT consists of electrical engineering, computer science, and artificial intelligence and decision-making, as well as combinations with other departments (Biology, Brain & Cognitive Sciences, Economics, and Urban Science and Planning).

Electrical Engineering: Electrical engineers design the most sophisticated systems ever built. From computers with billions of transistors to microgrids fed by renewable energy sources, from algorithms that predict disease to solar cells and electric vehicles, electrical engineering touches all parts of modern society. They leverage computational, theoretical, and experimental tools to develop groundbreaking sensors and energy transducers, new physical substrates for computation, and the systems that address the shared challenges facing humanity. Their research is interdisciplinary by nature, and has far-reaching effects on almost every field of human activity, including energy and climate, human health, communications and computation, finance and music.

Computer Science: Computer science deals with the theory and practice of algorithms, from idealized mathematical procedures to the computer systems deployed by major tech companies to answer billions of user requests per day. Primary subareas of this field include: theory, which uses rigorous math to test algorithms' applicability to certain problems; systems, which develops the underlying hardware and software upon which applications can be implemented; and human-computer interaction, which studies how to make computer systems more effectively meet the needs of real people. The products of all three subareas are applied across science, engineering, medicine, and the social sciences. Computer science drives interdisciplinary collaboration both across MIT and beyond, helping users address the critical societal problems of our era, including opportunity access, climate change, disease, inequality and polarization.

Artificial Intelligence and Decision-making: Artificial Intelligence and Decision-making combines intellectual traditions from across computer science and electrical engineering to develop techniques for the analysis and synthesis of systems that interact with an external world via perception, communication, and action; while also learning, making decisions and adapting to a changing environment. Research in this field explores the foundations of machine learning and decision systems (artificial intelligence, reinforcement learning, statistics, causal inference, systems and control); the building blocks of embodied intelligence (computer vision, NLP, robotics); applications to real-world autonomous systems; life sciences; and the interface between data-driven decision-making and society.

Inside Course 6

6-3	Computer Science and Engineering
6-4	Artificial Intelligence and Decision-Making
6-5	Electrical Engineering with Computing
6-7	Computer Science and Molecular Biology
6-9	Computation and Cognition (contact Course 9)
6-14	Computer Science, Economics, and Data Science
11-6	Urban Science and Planning with Computer Science (contact Course 11)

Introductory Classes

6.100A/6.100L **Introduction to Computer Science Programming in Python**
Introduction to computer science and programming for students with little or no programming experience. Students develop skills to program and use computational techniques to solve problems. Topics include the notion of computation, Python, simple algorithms and data structures, testing and debugging, and algorithmic complexity. 6.100A is a half-semester, 6-unit subject for students with some programming experience. 6.100L is a full-semester, 9-unit subject aimed at students with no programming experience.

6.100B **Introduction to Computational Thinking and Data Science**
Provides an introduction to using computation to understand real-world phenomena. Topics include plotting, stochastic programs, probability and statistics, random walks, Monte Carlo simulations, modeling data, optimization problems, and clustering.

6.1200 **Mathematics for Computer Science**
Elementary discrete mathematics for science and engineering, with a focus on mathematical tools and proof techniques useful in computer science. Topics include logical notation, sets, relations, elementary graph theory, state machines and invariants, induction and proofs by contradiction, recurrences, asymptotic notation, elementary analysis of algorithms, elementary number theory and cryptography, permutations and combinations, counting tools, and discrete probability.

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6.120A	**Discrete Mathematics and Proof for Computer Science** Subset of elementary discrete mathematics for science and engineering useful in computer science. Topics may include logical notation, sets, done relations, elementary graph theory, state machines and invariants, induction and proofs by contradiction, recurrences, asymptotic notation, elementary analysis of algorithms, elementary number theory and cryptography, permutations and combinations, counting tools.
6.3700	**Introduction to Probability** An introduction to probability theory, the modeling and analysis of probabilistic systems, and elements of statistical inference. Probabilistic models, conditional probability. Discrete and continuous random variables. Expectation and conditional expectation, and further topics about random variables. Limit Theorems. Bayesian estimation and hypothesis testing. Elements of classical statistical inference. Bernoulli and Poisson processes. Markov chains. Students taking graduate version complete additional assignments.
6.3800	**Introduction to Inference** Introduces probabilistic modeling for problems of inference and machine learning from data, emphasizing analytical and computational aspects. Distributions, marginalization, conditioning, and structure, including graphical and neural network representations. Belief propagation, decision-making, classification, estimation, and prediction. Sampling methods and analysis. Introduces asymptotic analysis and information measures. Computational laboratory component explores the concepts introduced in class in the context of contemporary applications. Students design inference algorithms, investigate their behavior on real data, and discuss experimental results.
6.2000	**Electrical Circuits: Modeling and Design of Physical Systems** Fundamentals of linear systems, and abstraction modeling of multi-physics lumped and distributed systems using lumped electrical circuits. Linear networks involving independent and dependent sources, resistors, capacitors, and inductors. Extensions to include operational amplifiers and transducers. Dynamics of first- and second-order networks; analysis and design in the time and frequency domains; signal and energy processing applications. Design exercises. Weekly laboratory with microcontroller and transducers.

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Course 6-Friendly UROP Areas

- Computer Science and Artificial Intelligence Laboratory (CSAIL)
- Research Laboratory of Electronics (RLE)
- Laboratory for Information and Decision Systems (LIDS)
- Media Lab
- Microsystems Technology Laboratories (MTL)
- Institute for Data, Systems, Society (IDSS)
- Lincoln Laboratory (LL)
- Broad Institute (BR)

Get Involved with Course 6

- EECS Undergraduate Student Advisory Group (USAGE)
- Student Information Processing Board (SIPB)
- Electric Vehicle Team
- VR/AR @ MIT
- Robotics Team
- HKN
- MIT Formula SAE Team
- Women in EECS
- MIT Solar Electric Vehicle Team
- IEEE/ACM

Skills

- **Electrical engineering**
    - Proficiency in programming and familiarity with algorithms
    - Analyze and design analog and digital systems
    - Proficiency with designing and building real systems
    - Problem-solving and troubleshooting
    - Ability to work in interdisciplinary teams
- **Computer science**
    - Proficiency in programming languages
    - Familiarity with logic and discrete mathematics
    - Problem-solving and troubleshooting
    - Ability to work in interdisciplinary teams

- **Artificial intelligence and decision-making**
  - Proficiency in programming and algorithms
  - Familiarity with probability, statistics, linear algebra
  - Problem formulation and model validation
  - Ability to work in interdisciplinary teams

Possible Future Jobs

- **Electrical engineering**
  - **Digital designer/computer architect:** Design computational hardware from transistors to general-purpose processors to special-purpose digital circuits such as hardware accelerators.
  - **Device engineer:** Employ knowledge of device physics and material properties to research, design, develop, and test new electronic, photonic, magnetic, and quantum devices.
  - **Embedded systems engineer:** Envision and create systems combining electronics, sensing and computation for embedded applications such as consumer electronics, automotive applications, or healthcare
- **Computer science**
  - **Software engineer:** Some develop applications that allow people to do specific tasks on a computer or another device. Others develop the underlying systems that run the devices or that control networks.
  - **Network systems and data communications analyst/specialist:** Plan, design, build, maintain, and test networks and other data communications systems.
  - **Information security analyst:** Plan and carry out security measures to protect an organization’s computer networks and systems. Responsibilities are continually expanding as the number of cyberattacks increases
- **Artificial intelligence and decision-making**
  - **AI engineer:** Design and implement learning and inference methods, build models using machine-learning software toolkits, train and validate models.
  - **Data scientist:** Formulate prediction problem, gather and clean data, validate resulting models, study impact of data sources and problem formulation on ethical deployment of system.
  - **Roboticist:** Design and program physical robots for flexible manufacturing, handling merchandise in warehouses, automated driving.

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Career Industry Examples

- Automation
- App development
- Circuits and systems
- Cybersecurity
- Data science
- Laser and electro-optics
- Magnetics
- Medical technologies
- Power electronics
- RF communications
- Robotics
- Telecommunications
- Ultrasonics

Sample Employers

- Amazon
- Analog Devices
- Apple
- Boeing
- Bose
- Citadel LLC
- Formlabs
- Google
- iRobot
- Lockheed Martin
- meta
- McKinsey & Company
- Microsoft
- Vecna Robotics
- Boston Dynamics