Computer Science

Subject: Computer Science

Computer Science 1

Great Ideas in Computer Science (119953)

Henry Leitner

2017 Spring (4 Credits) **Schedule:** TR 1000 AM - 1129 AM

Instructor Permissions: None **Enrollment Cap:** n/a

An introduction to the most important discoveries and intellectual paradigms in computer science, designed for students with little or no previous background. Explores problem-solving using high and low-level programming languages; presents an integrated view of computer systems, from switching circuits up through compilers and GUI design. Examines theoretical and practical limitations related to unsolvable and intractable computational problems, and the social and ethical dilemmas presented by such issues as software unreliability and invasions of privacy.

Course Notes: **May not be taken for credit after completing Computer Science 50. This course, when taken for a letter grade, meets the General Education requirement for Empirical and Mathematical Reasoning.**

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Primarily for Undergraduate Students
FAS: General Education	Empirical and Mathematical Reasoning
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science

Computer Science 20

Discrete Mathematics for Computer Science (128073)

Harry Lewis

2017 Spring (4 Credits) **Schedule:** MWF 1000 AM - 1059 AM

Instructor Permissions: None **Enrollment Cap:** n/a

Widely applicable mathematical tools for computer science, including topics from logic, set theory, combinatorics, number theory, probability theory, and graph theory. Practice in reasoning formally and proving theorems.

Course Notes: **Covers material used in Computer Science 121 and Computer Science 124. Ordinarily, not to be taken after those courses or after courses such as Applied Mathematics 106, Applied Mathematics 107, Mathematics 101, and Mathematics 153. This course, when taken for a letter grade, meets the General Education requirement for Empirical and Mathematical Reasoning.**

Additional Course Attributes:

Attribute	Value(s)
FAS: General Education	Empirical and Mathematical Reasoning

FAS: Final Assessment Category	Three-hour Exam
FAS Divisional Distribution	Science & Engineering & Applied Science
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Core Curriculum	Quantitative Reasoning
FAS: Course Level	Primarily for Undergraduate Students

Computer Science 50

Introduction to Computer Science I (152514)

David J. Malan

2016 Fall (4 Credits) **Schedule:** MW 0100 PM - 0229 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Introduction to the intellectual enterprises of computer science and the art of programming. This course teaches students how to think algorithmically and solve problems efficiently. Topics include abstraction, algorithms, data structures, encapsulation, resource management, security, software engineering, and web development. Languages include C, Python, SQL, and JavaScript plus CSS and HTML. Problem sets inspired by real-world domains of biology, cryptography, finance, forensics, and gaming. Designed for concentrators and non-concentrators alike, with or without prior programming experience. 73% of CS50 students have never taken CS before.

Class Notes: **CS50 officially meets on Mondays and Wednesdays, from 1pm until 2:30pm in Sanders Theatre, but students are only expected to attend in person the course's first lecture on Wednesday 8/31 and last lecture on Monday 11/21. Students with conflicts can watch those lectures online. Sections to be arranged. Students may simultaneously enroll in CS50 and another course that meets at the same time. To do so, students should enroll in the other course via my.harvard.edu, and then email enrollment@fas.harvard.edu to have CS50 manually added to their crimson carts as well. Undergraduates, GSAS students, and cross-registered students may take CS50 either Satisfactory/Unsatisfactory (SAT/UNS) or for a letter grade. When taken for a letter grade, CS50 meets the General Education requirement for undergraduates for Empirical and Mathematical Reasoning. See cs50.harvard.edu for FAQs.**

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Primarily for Undergraduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Core Curriculum	Quantitative Reasoning
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: General Education	Empirical and Mathematical Reasoning

Computer Science 51

Introduction to Computer Science II (112960)

Stuart Shieber

2017 Spring (4 Credits) **Schedule:** T 0100 PM - 0229 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Abstraction and design in computation. Topics include functional and object-oriented styles of programming, software engineering in the small, and models of computation. Our main goal is to understand how to design large programs to make them readable, maintainable, elegant, and efficient.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: Course Level	Primarily for Undergraduate Students

Computer Science 61

Systems Programming and Machine Organization (123623)

Margo Seltzer

Eddie Kohler

2016 Fall (4 Credits) **Schedule:** TR 0230 PM - 0359 PM
TR 0230 PM - 0359 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Fundamentals of computer systems programming, machine organization, and performance tuning. This course provides a solid background in systems programming and a deep understanding of low-level machine organization and design. Topics include C and assembly language programming, program optimization, memory hierarchy and caching, virtual memory and dynamic memory management, concurrency, threads, and synchronization.

Recommended Prep: **CS50 or some experience programming in C.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Undergraduate Students
FAS: Final Assessment Category	Three-hour Exam
FAS Divisional Distribution	Science & Engineering & Applied Science

Computer Science 90NAR

The Internet: Governance and Power (203579)

Virgilio Almeida

2016 Fall (4 Credits) **Schedule:** TR 1130 AM - 1259 PM

Instructor Permissions: None **Enrollment Cap:** n/a

In this course, we study cyberspace governance. Cyberspace is a unique combination of physical and virtual properties. In this course, we view cyberspace as a structure consisting of three layers: the physical layer represented by the global communication infrastructure and two virtual layers, composed by the Internet layer and the social and economic layer. Our focus concentrates on the top two layers. The principles, norms, rules, and procedures that shape the cyberspace are studied in this course through quantitative analysis of data collected from different sources in the digital world. Data-oriented analysis of problems and policies in cyberspace will be illustrated by examining several case studies in the major internet platforms. The case studies will help students to understand the role of social algorithms,

programs that rank and classify people and information and services that provide customized experiences. Ultimately, students learn how to use quantitative methods to understand different issues related to digital governance.

Course Notes: **This course does not count for concentration credit for SEAS undergraduate concentrators.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Undergraduate Students
FAS Divisional Distribution	Science & Engineering & Applied Science

Computer Science 90NBR

Contemporary Issues in Intelligence Gathering (203578)

Jonathan Zittrain

2017 Spring (4 Credits) **Schedule:** M 0500 PM - 0659 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

The digital environment offers greatly expanded opportunities for intelligence gathering. This seminar will explore some of the most difficult problems arising in managing the collection and use of intelligence for national security, including compliance with the law; avoidance of, and remedies for, over collection; and protection of privacy and other fundamental values.

We will discuss how an intelligence community's activities can be meaningfully communicated to the public while respecting its sources and methods; how agencies might internally reconcile their various missions to protect the public and protect public values; and what a set of authorities and limitations for intelligence collection might look like if a clean slate were available on which to develop them. Please visit http://brk.mn/CIIG17 to access the application and read more about the course.

Course Notes: **This course is jointly listed with HLS. This course does not count for concentration credit in Computer Science.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Undergraduate Students
FAS Divisional Distribution	Science & Engineering & Applied Science

Computer Science 91R

Supervised Reading and Research (113257)

Harry Lewis

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Supervised individual study of advanced topics in computer science. A student wishing to enroll in Computer Science 91r must be accepted by a faculty member who will supervise the course work. A form available from the Student Affairs Office, Pierce Hall 110, must be filled out and signed by the student and faculty supervisor. Students writing theses may enroll in this course while conducting thesis research and

writing.

Course Notes: **At most two terms of Computer Science 91r may be taken for academic credit. May not be taken Pass/Fail. Students wishing more information about the range of suitable projects or faculty supervisors should consult the Director of Undergraduate Studies.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Undergraduate Students
FAS Divisional Distribution	Science & Engineering & Applied Science

Computer Science 91R

Supervised Reading and Research (113257)

Harry Lewis

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Supervised individual study of advanced topics in computer science. A student wishing to enroll in Computer Science 91r must be accepted by a faculty member who will supervise the course work. A form available from the Student Affairs Office, Pierce Hall 110, must be filled out and signed by the student and faculty supervisor. Students writing theses may enroll in this course while conducting thesis research and writing.

Course Notes: **At most two terms of Computer Science 91r may be taken for academic credit. May not be taken Pass/Fail. Students wishing more information about the range of suitable projects or faculty supervisors should consult the Director of Undergraduate Studies.**

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	Science & Engineering & Applied Science
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Undergraduate Students

Computer Science 105

Privacy and Technology (125407)

James Waldo

2016 Fall (4 Credits) **Schedule:** TR 0100 PM - 0229 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

What is privacy, and how is it affected by recent developments in technology? This course critically examines popular concepts of privacy and uses a rigorous analysis of technologies to understand the policy and ethical issues at play. Case studies: database anonymity, research ethics, wiretapping, surveillance, and others. Course relies on some technical material, but is open and accessible to all students, especially those with interest in economics, engineering, political science, computer science, sociology, biology, law, government, philosophy.

Course Notes: **This course, when taken for a letter grade, meets the General Education requirement for Culture and Belief.**

Additional Course Attributes:

Attribute	Value(s)
FAS: Core Curriculum	Social Analysis
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: Course Level	For Undergraduate and Graduate Students
FAS: General Education	Culture and Belief

Computer Science 108

Intelligent Systems: Design and Ethical Challenges (160419)

Barbara Grosz

2016 Fall (4 Credits) **Schedule:** TR 1130 AM - 1259 PM

Instructor Permissions: Instructor **Enrollment Cap:** 30

For centuries, people have imagined smart machines in fictional stories. Computer systems now communicate in speech and text, learn, negotiate, and work in teams (with people and other systems). These intelligent-systems capabilities raise questions about the impact of such systems on people and societies. This course introduces the basic techniques of AI in the context of (science) fiction imaginings and ethical challenges. It examines the roles of design and of policy in reducing potential negative consequences. The course presumes a basic programming ability, but is accessible to concentrators in the humanities and social sciences as well as science and engineering.

Recommended Prep: **CS50 or equivalent.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students
FAS Divisional Distribution	Science & Engineering & Applied Science

Computer Science 109A

Data Science 1: Introduction to Data Science (109899)

Pavlos Protopapas

Kevin A. Rader

2016 Fall (4 Credits) **Schedule:** MW 0100 PM - 0229 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Data Science 1 is the first half of a one-year introduction to data science. The course will focus on the analysis of messy, real life data to perform predictions using statistical and machine learning methods. Material covered will integrate the five key facets of an investigation using data: (1) data collection - data wrangling, cleaning, and sampling to get a suitable data set; (2) data management - accessing data quickly and reliably; (3) exploratory data analysis – generating hypotheses and building intuition; (4) prediction or statistical learning; and (5) communication – summarizing results through visualization, stories, and interpretable summaries. Part one of a two part series. The curriculum for this course builds throughout the academic year. Students are strongly encouraged to enroll in both the fall and spring course within the

same academic year.

Course Notes: **Only one of CS 109a, AC 209a, or Stat 121a can be taken for credit. Students who have previously taken CS 109, AC 209, or Stat 121 cannot take CS 109a, AC 209a, or Stat 121a for credit.**

Recommended Prep: **Programming knowledge at the level of CS 50 or above, and statistics knowledge at the level of Stat 100 or above (Stat 110 recommended).**

Requirements: **Not to be taken in addition to Applied Computation 209, or Applied Computation 209A, or Statistics 121, or Statistics 121A.**

Additional Course Attributes:

Attribute	Value(s)
GSD: MDS/MDE Rec. Elec.	MDE recommended elective
FAS Divisional Distribution	Science & Engineering & Applied Science
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 109B

Data Science 2: Advanced Topics in Data Science (203546)

Hanspeter Pfister

Mark Glickman

Verena Kaynig-Fittkau

2017 Spring (4 Credits) **Schedule:** MW 0100 PM - 0229 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Data Science 2 is the second half of a one-year introduction to data science. Building upon the material in Data Science 1, the course introduces advanced methods for data wrangling, data visualization, and statistical modeling and prediction. Topics include big data and database management, interactive visualizations, nonlinear statistical models, and deep learning. Part two of a two part series. The curriculum for this course builds throughout the academic year. Students are strongly encouraged to enroll in both the fall and spring course within the same academic year.

Course Notes: **Can only be taken after successful completion of CS 109a, AC 209a, Stat 121a, or equivalent. Students who have previously taken CS 109, AC 209, or Stat 121 cannot take CS 109b, AC 209b, or Stat 121b for credit.**

Recommended Prep: **CS 109a, AC 209a, or Stat 121a required.**

Requirements: **Requisite: (Must take CS 109A OR APCOMP 209A OR STAT 121A before taking CS 109B) AND (Not to be taken in addition to CS 109, OR APCOMP 209, OR APCOMP 209B, OR STAT 121, OR STAT 121B.)**

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Primarily for Undergraduate Students
Full Year Course	Divisible Course
FAS Divisional Distribution	Science & Engineering & Applied Science
GSD: MDS/MDE Rec. Elec.	MDE recommended elective

All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 121

Introduction to the Theory of Computation (119064)

Harry Lewis

2016 Fall (4 Credits) **Schedule:** TR 1000 AM - 1129 AM

Instructor Permissions: None **Enrollment Cap:** n/a

General introduction to the theory of computation, teaching how to reason precisely about computation and prove mathematical theorems about its capabilities and limitations. Finite automata, Turing machines, formal languages, computability, uncomputability, computational complexity, and the P vs. NP question.

Course Notes: **Students may not receive credit for both CS 121 and CS 125.**

Recommended Prep: **Experience in formal mathematics at the level of Computer Science 20.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students
FAS: Final Assessment Category	Three-hour Exam
FAS Divisional Distribution	Science & Engineering & Applied Science

Computer Science 124

Data Structures and Algorithms (115384)

Michael Mitzenmacher

2017 Spring (4 Credits) **Schedule:** TR 1130 AM - 1259 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Design and analysis of efficient algorithms and data structures. Algorithm design methods, graph algorithms, approximation algorithms, and randomized algorithms are covered.

Course Notes: **Starting in the spring of 2013, Computer Science 124 will assume background from Computer Science 20. Students will not receive credit for both CS 124 and CS 125.**

Recommended Prep: **Computer Science 50 or equivalent; Computer Science 51 is helpful. Some exposure to discrete applied mathematics, such as Applied Mathematics 106 or 107 or Computer Science 121 or Statistics 110, is also helpful.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Final Assessment Category	Three-hour Exam
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 125

Algorithms and Complexity (156210)

Jelani Nelson

2016 Fall (4 Credits) **Schedule:** TR 1000 AM - 1129 AM

Instructor Permissions: None **Enrollment Cap:** n/a

An accelerated introduction to theoretical computer science for students with strong mathematical preparation, to be taken in place of both Computer Science 121 and 124. Algorithm design methods, including graph algorithms, approximation algorithms, and randomized algorithms. Models of computation, computability theory, and computational complexity, including the P vs. NP question.

Course Notes: **Students may not receive credit for both CS 125 and either CS 121 or CS 124.**

Recommended Prep: **Comfort with reading and writing mathematical proofs, at the level of Math 25 or 55 (which may be taken concurrently).**

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	Science & Engineering & Applied Science
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students
FAS: Final Assessment Category	Three-hour Exam

Computer Science 134

Networks (160409)

Yaron Singer

2017 Spring (4 Credits) **Schedule:** MW 0230 PM - 0359 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Networks—of social relationships, economic interdependencies, and digital interactions—are critical in shaping our lives. This course introduces models and algorithms that help us understand networks. Fundamental concepts from applied mathematics, microeconomics, and computer science will be presented through the lens of network science, in order to equip students to usefully analyze the "big data" generated by online networks. Applications discussed include the viral spread of ideas, maximizing influence, and the contagion of economic downturns. Concepts and tools covered include game theory, graph theory, data mining, and machine learning.

Course Notes: **Computer Science 134 is also offered as Economics 1034. Students may not take both for credit.**

Recommended Prep: **Linear Algebra, Calculus, probability (either their courses or their equivalents): AM 21a, AM 21b, Statistics 110.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 141

Computing Hardware (113856)

David Brooks

2016 Fall (4 Credits) **Schedule:** MW 0100 PM - 0229 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Introduction to the design, structure, and operation of digital computers; logic circuits and digital electronics; computer arithmetic; computer architecture; and machine language programming. Consideration of the design interactions between hardware and software systems.

Recommended Prep: **Programming experience required.**

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	For Undergraduate and Graduate Students
FAS Divisional Distribution	Science & Engineering & Applied Science
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 143

Computer Networks (118418)

H. Kung

2016 Fall (4 Credits) **Schedule:** MW 0230 PM - 0359 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Networking has enabled the emergence of mobile and cloud computing, creating one of the most important technological paradigm shifts in computing of the past decade. The next major paradigm shift in computer networking will be the emergence of 5G wireless mobile networks, which will begin to replace the current 4G networks as early as 2019/2020. These further advancements in wireless networking are expected to transform the technological landscape over the next decade by enabling an endless possibility of new applications, including the Internet of Things and wireless virtual reality, through the emergence of wireless networks with gigabit speeds. In order to play a role in this era of new network-powered advancements, students must have a thorough understanding of emerging networking topics, especially in the wireless domain. Rather than teaching the basic networking protocols, which have become very mature and can be treated as a black box, in CS 143, we will teach the new issues and topics of interest, which will power important emerging applications. This focus on upcoming wireless advancements and mobile applications is the motivation for CS 143 this semester. The class will be organized into the following nine modules: A View of the Future: 5G—A World with Gigabit Wireless Networking; Basic Networking Concepts; Fundamental Radio Propagation Physics; Basic Wireless Networking Concepts: Wi-Fi, MAC protocols; New Fundamentals of Mobile Networking: 5G Millimeter Wave, Ultra Dense Networks (UDNs); Advanced Topics in 5G: Beam Forming, MIMO; 5G System Infrastructure: Network Function Virtualization and Software Defined Networking; 5G Applications: The Internet of Things and Massive Machine Type Communications; and Machine Learning Assisted Networking. Students in the course will read and discuss the latest wireless networking literature, gain hands-on experience through a programming assignment, and have the opportunity to present the concepts learned in the course through writing a final position paper on emerging wireless networking technologies.

Recommended Prep: **CS50 (or programming experience) and strong interest in the subject matter. Lab sessions will be provided to give extra support.**

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: Course Level	For Undergraduate and Graduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 146

Computer Architecture (113270)

David Brooks

Aamer Jaleel

2017 Spring (4 Credits) **Schedule:** TR 0100 PM - 0229 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Review of the fundamental structures in modern processor design. Topics include computer organization, memory system design, pipelining, and other techniques to exploit parallelism. Emphasis on a quantitative evaluation of design alternatives and an understanding of timing issues.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 152

Programming Languages (119629)

Riccardo Pucella

2017 Spring (4 Credits) **Schedule:** TR 0900 AM - 1029 AM

Instructor Permissions: None **Enrollment Cap:** n/a

Comprehensive introduction to the principal features and overall design of both traditional and modern programming languages, including syntax, formal semantics, abstraction mechanisms, modularity, type systems, naming, polymorphism, closures, continuations, and concurrency. Provides the intellectual tools needed to design, evaluate, choose, and use programming languages.

Recommended Prep: **Computer Science 51; Computer Science 121 is recommended. Students must have good programming skills, be very comfortable with recursion, proofs, basic mathematical ideas and notations, including sets, relations, functions, and induction.**

Additional Course Attributes:

Attribute	Value(s)
FAS: Final Assessment Category	Three-hour Exam
FAS Divisional Distribution	Science & Engineering & Applied Science
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 161

Operating Systems (113847)

James Mickens

2017 Spring (4 Credits) **Schedule:** TR 0100 PM - 0229 PM

Instructor Permissions: None **Enrollment Cap:** n/a

This course focuses on the design and implementation of modern operating systems. The course discusses threads, processes, virtual memory, schedulers, and the other fundamental primitives that an OS uses to represent active computations. An exploration of the system call interface explains how applications interact with hardware and other programs which are concurrently executing. Case studies of popular file systems reveal how an OS makes IO efficient and robust in the midst of crashes and unexpected reboots. Students also learn how virtualization allows a physical machine to partition its resources across multiple virtual machines. Class topics are reinforced through a series of intensive programming assignments which use a real operating system.

Recommended Prep: **Computer Science 61.**

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	For Undergraduate and Graduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science

Computer Science 164

Software Engineering (119247)

David J. Malan

2017 Spring (4 Credits) **Schedule:** R -

Instructor Permissions: Instructor **Enrollment Cap:** 24

An introduction to principles of software engineering and best practices. Students work in teams on the design, implementation, and deployment of a term-long project that solves a problem on campus. Structured as supervised independent study with weekly milestones and weekly meetings for design discussions and code reviews with an advisor.

Class Notes: **Students will work on projects in teams of four. Each team will meet weekly with its assigned advisor for two hours on Thursday afternoons or evenings; times to be arranged. Enrollment limited. Apply at cs164.github.io. Optional info session on Monday 1/23 at 2:30pm in Pierce 301. Course does not meet on Thursday 1/26; weekly team meetings start on Thursday 2/2.**

Recommended Prep: **Any six CS courses numbered 50 or higher (or, with permission, multiple years of programming experience).**

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	Science & Engineering & Applied Science
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 165

Data Systems (119249)

Stratos Idreos

2016 Fall (4 Credits) **Schedule:** MW 0400 PM - 0529 PM

Instructor Permissions: None **Enrollment Cap:** n/a

We are in the big data era and data systems sit in the critical path of everything we do. We are going through major transformations in businesses, sciences, as well as everyday life - collecting and analyzing data changes everything and data systems provide the means to store and analyze a massive amount of data. This course is a comprehensive introduction to modern data systems. The primary focus of the course is on the modern trends that are shaping the data management industry right now: column-store and hybrid systems, shared nothing architectures, cache conscious algorithms, hardware/software co-design, main-memory systems, adaptive indexing, stream processing, scientific data management, and key-value stores. We also study the history of data systems, traditional and seminal concepts and ideas such as the relational model, row-store database systems, optimization, indexing, concurrency control, recovery and SQL. In this way, we discuss both how and why data systems evolved over the years, as well as how these concepts apply today and how data systems might evolve in the future. We focus on understanding concepts and trends rather than specific techniques that will soon be outdated - as such the class relies largely on recent research material and on a semi-flipped class model with a lot of hands-on interaction in each class.

Recommended Prep: **Computer Science 51 and Computer Science 61.**

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	For Undergraduate and Graduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science

Computer Science 171

Visualization (124364)

Hanspeter Pfister

2016 Fall (4 Credits) **Schedule:** TR 0230 PM - 0359 PM

Instructor Permissions: Instructor **Enrollment Cap:** 60

An introduction to key design principles and techniques for visualizing data. Covers design practices, data and image models, visual perception, interaction principles, visualization tools, and applications. Introduces programming of web-based interactive visualizations.

Course Notes: **This course, when taken for a letter grade, meets the General Education requirement for Empirical and Mathematical Reasoning.**

Recommended Prep: **Students are expected to have basic programming experience (e.g., Computer Science 50).**

Additional Course Attributes:

Attribute	Value(s)
FAS: Core Curriculum	Quantitative Reasoning
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: General Education	Empirical and Mathematical Reasoning

All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 175

Computer Graphics (113410)

Steven Gortler

2016 Fall (4 Credits) **Schedule:** MW 0230 PM - 0359 PM

Instructor Permissions: None **Enrollment Cap:** n/a

This course covers the fundamentals of 3D computer graphics using a modern shader-based version of OpenGL. Main topics include: geometric coordinate systems and transformations, keyframe animation and interpolation, camera simulation, triangle rasterization, material simulation, texture mapping, image sampling and color theory. The course also touches on ray tracing, geometric modeling and simulation-based animation.

Recommended Prep: **Computer Science 51 or 61, Applied Mathematics 21b or Mathematics 21b.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 179

Design of Useful and Usable Interactive Systems (123971)

Ofra Amir

2017 Spring (4 Credits) **Schedule:** TR 0230 PM - 0359 PM

Instructor Permissions: Instructor **Enrollment Cap:** 60

The course covers skills and techniques necessary to design innovative interactive products that are useful, usable and that address important needs of people other than yourself. You will learn how to uncover needs that your customers cannot even articulate. You will also learn a range of design principles, effective creativity-related practices, and techniques for rapidly creating and evaluating product prototypes. You will also have several opportunities to formally communicate your design ideas to a variety of audiences. You will complete two large team-based design projects.

Recommended Prep: **CS 50 or web programming experience.**

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	For Undergraduate and Graduate Students
FAS Divisional Distribution	Science & Engineering & Applied Science
All: Cross Reg Availability	Available for Harvard Cross Registration
GSD: MDS/MDE Rec. Elec.	MDE recommended elective

Computer Science 181

Machine Learning (148156)

Alexander Rush

David Parkes

2017 Spring (4 Credits) **Schedule:** TR 1000 AM - 1129 AM

Instructor Permissions: None **Enrollment Cap:** n/a

Introduction to machine learning, providing a probabilistic view on artificial intelligence and reasoning under uncertainty. Topics include: supervised learning, ensemble methods and boosting, neural networks, support vector machines, kernel methods, clustering and unsupervised learning, maximum likelihood, graphical models, hidden Markov models, inference methods, and computational learning theory. Students should feel comfortable with multivariate calculus, linear algebra, probability theory, and complexity theory. Students will be required to produce non-trivial programs in Python.

Recommended Prep: **Computer Science 51, Statistics 110, Math 21a and 21b (or equivalent).**

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	For Undergraduate and Graduate Students
GSD: MDS/MDE Rec. Elec.	MDE recommended elective
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science

Computer Science 182

Artificial Intelligence (110661)

Scott Kuindersma

2016 Fall (4 Credits) **Schedule:** TR 0100 PM - 0229 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Introduction to AI focused on problems in reasoning about action and rational decision making, covering search, knowledge representation and planning. Search: heuristics, informed search and optimization; constraint satisfaction; game playing. Knowledge representation: logics, efficient logical inference, reasoning about categories. Planning: action representations and planning algorithms, hierarchical task networks, sequential decision making. Applications to multi-agent systems, robotics and natural-language processing. Discussion of relevant work in philosophy, economics, and decision theory.

Course Notes: **Formerly Intelligent Machines: Reasoning, Actions, and Plans**

Recommended Prep: **Computer Science 51; Computer Science 121 (may be taken concurrently).**

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	For Undergraduate and Graduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science

Computer Science 205

Computing Foundations for Computational Science (128104)

Manjunathaiah Muniyappa

2017 Spring (4 Credits) **Schedule:** TR 0230 PM - 0359 PM

Instructor Permissions: None **Enrollment Cap:** n/a

An applications course highlighting the use of computers in solving scientific problems. Students will be exposed to fundamental computer science concepts such as computer architectures, data structures, algorithms, and parallel computing. Fundamentals of scientific computing including abstract thinking, algorithmic development, and assessment of computational approaches. Students will learn to use open source tools and libraries and apply them to data analysis, modeling, and visualization of real scientific problems. Emphasizes parallel programming and "parallel thinking."

Recommended Prep: **Students are expected to have programming experience (e.g., CS50/51, fluent in Python, C/C++, or similar). Course will be taught primarily in Python and C.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 207

Systems Development for Computational Science (128105)

Rahul Dave

2016 Fall (4 Credits) **Schedule:** MW 0230 PM - 0359 PM

Instructor Permissions: None **Enrollment Cap:** n/a

This is a project-based course emphasizing designing, building, testing, maintaining and modifying software for scientific computing. Students will work in groups on a number of projects, ranging from small data-transformation utilities to large-scale systems. Students will learn to use a variety of tools and languages, as well as various techniques for organizing teams. Most important, students will learn to fit tools and approaches to the problem being solved.

Recommended Prep: **Students are expected to have basic programming experience (Computer Science 50).**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: Course Level	Primarily for Graduate Students

Computer Science 222

Algorithms at the Ends of the Wire (111994)

Michael Mitzenmacher

2016 Fall (4 Credits) **Schedule:** TR 1130 AM - 1259 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Covers topics related to algorithms for big data, especially related to networks. Themes include compression, cryptography, coding, and information retrieval related to the World Wide Web. Requires a major final project.

Recommended Prep: **Computer Science 124.**

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: Course Level	Primarily for Graduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 224

Advanced Algorithms (156211)

Jelani Nelson

2017 Spring (4 Credits) **Schedule:** TR 0230 PM - 0359 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Advanced algorithm design, including but not limited to amortization, randomization, online algorithms, graph algorithms, approximation algorithms, linear programming, and data structures.

Recommended Prep: **CS 124 and probability.**

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: Course Level	Primarily for Graduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 225

Pseudorandomness (115692)

Salil Vadhan

2016 Fall (4 Credits) **Schedule:** TR 0100 PM - 0229 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Efficiently generating objects that ``look random'' despite being constructed using little or no randomness. Connections and applications to computational complexity, cryptography, and combinatorics. Pseudorandom generators, randomness extractors, expander graphs, error-correcting codes, hash functions.

Recommended Prep: **Exposure to randomized algorithms (as in Computer Science 124 or 125), computational complexity (as in Computer Science 121 or 125), and algebra (as in Applied Mathematics 106 or Mathematics 123).**

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	Science & Engineering & Applied Science

All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 227R

Topics in Cryptography and Privacy (114490)

Cynthia Dwork

2017 Spring (4 Credits) **Schedule:** TR 1000 AM - 1129 AM

Instructor Permissions: None **Enrollment Cap:** n/a

Topics in cryptography and data privacy drawn from the theoretical computer science research literature. Focus for 2016-2017: Differential Privacy -- a mathematical framework for privacy-preserving analysis of datasets, which enables aggregate computations while preventing the leakage of individual-level information -- and statistical validity in adaptive (exploratory) data analysis.

Recommended Prep: **Computer Science 124, 125, or 127.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: Course Level	Primarily for Graduate Students

Computer Science 229R

Topics in Theoretical Computer Science: Coding Theory (120237)

Madhu Sudan

2017 Spring (4 Credits) **Schedule:** TR 1130 AM - 1259 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Introduces essential elements the theory of error-correcting codes. Focuses on the basic results in the area, taught from first principles. Special focus will be given on results of asymptotic or algorithmic significance. Principal topics include

- **Construction and existence results for error-correcting codes;**
- **Limitations on the combinatorial performance of error-correcting codes;**
- **Decoding algorithms**
- **Applications to other areas of mathematics and computer science.**

Lecture notes for this course from previous offerings give further details on the material covered. These may be found at http://people.csail.mit.edu/madhu/ST13/

Recommended Prep: **Computer Science 121 and 124 or equivalents.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students
FAS Divisional Distribution	Science & Engineering & Applied Science

Computer Science 229R

Proofs, Beliefs and Algorithms through the lens of Sum of Squares (120237)

Boaz Barak

2016 Fall (4 Credits) **Schedule:** F 1000 AM - 1259 PM

Instructor Permissions: None **Enrollment Cap:** n/a

In this graduate seminar we will cover recent research on the use of mathematical programming for problems arising from optimization, machine learning, computational complexity and more, with a particular focus on the Parrilo-Lasserre "Sum of Squares" semidefinite programming hierarchy. We will discuss both lower and upper bounds, as well as how such mathematical programs give rise to a general theory of computational difficulty, computation vs. sample size tradeoffs, and computational analogs of Bayesian probabilities.

More concretely, we will touch some of the following topics:

*** Upper and lower bounds for various average case problems, including random constraint satisfaction, planted clique, and problems arising from machine learning.**
*** Speeding up Sum of Squares algorithms.**
*** Relation to Khot's Unique Games Conjecture (UGC) and the SOS approach to refuting the UGC.**
*** Can SoS be optimal algorithm in some settings? What are the candidate algorithms who could do better? In what settings might *linear* programming already be optimal? What kind of implication could such optimality entail?**
*** Semidefinite extension complexity, relations to communication complexity.**
*** Relation to statistical physics, and algorithms such as belief propagation and survey propagation.**
*** Relation to quantum information theory, quantum entanglement, and the log rank conjecture.**
*** Reducing asymptotic SoS questions to finite size via symmetry and relation to Razborov's flag algebras and Turan problems.**

However, this is a fast moving research area and our plans may change as new results, as well as new understandings of old results, come to light. The course will not require much mathematical background beyond so called "mathematical maturity". However, some familiarity with notions such as convexity, linear programming duality, separation oracles, eigenvalues/eigenvectors and positive semidefiniteness, could be helpful.

Course Notes: **The course location will alternate between Harvard and MIT.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: Course Level	Primarily for Graduate Students

Computer Science 246

Advanced Computer Architecture (127937)

David Brooks

Aamer Jaleel

2017 Spring (4 Credits) **Schedule:** TR 0100 PM - 0229 PM

Instructor Permissions: None **Enrollment Cap:** n/a

The contents and course requirements are similar to those of Computer Science 146, with the exception that students enrolled in Computer Science 246 are expected to undertake a substantial course project.

Recommended Prep: **Computer Science 141.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students
FAS Divisional Distribution	Science & Engineering & Applied Science

Computer Science 252R

Advanced Topics in Programming Languages (114807)

Christos Dimoulas

2016 Fall (4 Credits) **Schedule:** MW 1130 AM - 1259 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Seminar course exploring recent research in programming languages. Topics vary from year to year. Students read and present research papers, undertake a research project.

Recommended Prep: **Computer Science 152 or permission of the instructor.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: Course Level	Primarily for Graduate Students

Computer Science 260R

Projects and Close Readings in Software Systems (110276)

Eddie Kohler

2017 Spring (4 Credits) **Schedule:** MW 0100 PM - 0229 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Modern software systems construction and analysis. Distributed systems; operating systems; networks; data centers; big data; emerging systems deployments. Close, careful reading of research papers and code, coupled with programming projects. Readability and programmability. Topic focus will change each offering. May be repeated for credit with instructor permission.

Recommended Prep: **Programming experience and instructor permission.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: Course Level	Primarily for Graduate Students

Computer Science 261

Research Topics in Operating Systems (143667)

Margo Seltzer

2016 Fall (4 Credits) **Schedule:** TR 1000 AM - 1129 AM

Instructor Permissions: None **Enrollment Cap:** n/a

An introduction to operating systems research. Paper-based seminar course that introduces students to the state of the art in systems research through historical and quantitative lenses. Students will read and discuss research papers and complete a final research project.

Recommended Prep: **Computer Science 161, or equivalent.**

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Primarily for Graduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science

Computer Science 263

Systems Security (160579)

James Mickens

2016 Fall (4 Credits) **Schedule:** TR 0100 PM - 0229 PM

Instructor Permissions: None **Enrollment Cap:** n/a

This course explores practical attacks on modern computer systems, explaining how those attacks can be mitigated using careful system design and the judicious application of cryptography. The course discusses topics like buffer overflows, web security, information flow control, and anonymous communication mechanisms such as Tor. The course includes several small projects which give students hands-on experience with various offensive and defensive techniques; the final, larger project is open-ended and driven by student interests.

Recommended Prep: **Computer Science 161 (Operating Systems)**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students
FAS Divisional Distribution	Science & Engineering & Applied Science

Computer Science 265

Big Data Systems (113660)

Stratos Idreos

2017 Spring (4 Credits) **Schedule:** WF 0400 PM - 0529 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Big data is everywhere. A fundamental goal across numerous modern businesses and sciences is to be able to exploit as many machines as possible, to consume as much information as possible and as fast as possible. The big challenge is "how to turn data into useful knowledge". This is far from a simple task and a moving target as both the underlying hardware and our ability to collect data evolve. In this class, we will

discuss how to design data systems and algorithms that can "scale up" and "scale out". Scale up refers to the ability to use a single machine to all its potential, i.e., to exploit properly the memory hierarchy and the multiple CPU and GPU cores. Scale out refers to the ability to use more than 1 machines (typically 100s or 1000s) effectively. This is a research oriented class. Every week we will read two modern research papers; one from the scale up area and one from the scale out area. We will use examples from several areas, including relational systems and distributed databases, graph processing systems (i.e., for social networks), key value stores, noSQL and newSQL systems as well as mobile computing. Each student will work on a semester long data systems research project (in groups of 2-4 students) which can be in any of the above areas and will be based on an open research problem.

Recommended Prep: **CS 165 or permission of instructor.**

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Primarily for Graduate Students
FAS Divisional Distribution	Science & Engineering & Applied Science
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 280R

Advanced Topics in Artificial Intelligence (109283)

Barbara Grosz

2017 Spring (4 Credits) **Schedule:** TR 0100 PM - 0229 PM

Instructor Permissions: Instructor **Enrollment Cap:** 20

Seminar course exploring research directions in artificial intelligence (AI), typically combining two or more of such areas as multi-agent systems, natural-language processing, machine learning, reasoning under uncertainty, representation systems. Topic for Spring 2017: Multi-agent systems: collaboration, coordination and loosely-coupled teamwork.

Recommended Prep: **Computer Science 181 or 182, or equivalent; or permission of instructor.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: Course Level	Primarily for Graduate Students

Computer Science 282R

Topics in Machine Learning (156936)

Finale Doshi-Velez

Pierre Jacob

2017 Spring (4 Credits) **Schedule:** MW 0930 AM - 1059 AM

Instructor Permissions: None **Enrollment Cap:** n/a

The Ultimate Inference Bake-off... with Bayesian Nonparametrics!

This course is fundamentally about gaining a deep understanding of state-of-the-art inference techniques

for probabilistic models, with the goal of also thinking of ways to address their shortcomings. Since probabilistic models are obviously a very large area, we'll focus on Bayesian Nonparametric models. After a brief overview of Bayesian Nonparametric models we'll begin our ultimate inference bake-off: starting with the tried-and-true techniques and going to the current state-of-the-art. Along the way, we'll learn what works when, and where the gaps are. Students will complete several programming assignments, lead discussion on papers, and complete a substantial final project.

Course Notes: **Computer Science 282r is also offered as Statistics 317. Students may not take both for credit.**

Recommended Prep: **Students will be expected to be comfortable with distributions and inference at the level of something like CS281. Practically: Can you derive and implement Bayesian linear regression for a modestly-sized data set? A Gibbs sampler for a mixture model? An importance sampler for a given distribution?**

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	Science & Engineering & Applied Science
FAS: Course Level	Primarily for Graduate Students
GSD: MDS/MDE Rec. Elec.	MDE recommended elective
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 290HFA

Computer Science Research Seminar (204012)

David Brooks

2016 Fall (2 Credits) **Schedule:** M 0400 PM - 0459 PM
R 0400 PM - 0529 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

This course introduces first year Computer Science PhD students to the CS colloquium series. Required for G1 PhDs in CS.

Course Notes: **Limited to CS PhD G1 students only. Instructor permission required.**

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students
Full Year Course	Indivisible Course

Computer Science 290HFB

Computer Science Research Seminar (204013)

David Brooks

2017 Spring (2 Credits) **Schedule:** M 0400 PM - 0459 PM
R 0400 PM - 0529 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

This course introduces first year Computer Science PhD students to the CS colloquium series. Required for G1 PhDs in CS.

Course Notes: **Limited to CS PhD G1 students only. Instructor permission required.**

Additional Course Attributes:

Attribute	Value(s)
Full Year Course	Indivisible Course
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students
Course Search Attributes	Display Only in Course Search

Computer Science 299R

Special Topics in Computer Science (114035)

David Parkes

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Supervision of experimental or theoretical research on acceptable computer science problems and supervision of reading on topics not covered by regular courses of instruction.

Course Notes: **Open to graduate students and AB/SM candidates only. Students must arrange such work with a member of the School of Engineering and Applied Sciences. This course is graded and is ordinarily taken with the approval of the Committee on Higher Degrees. Applicants must file a project sheet before study cards are filed. Project sheets may be obtained from the Academic Office, Pierce Hall 110.**

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students
FAS Divisional Distribution	None

Computer Science 299R

Special Topics in Computer Science (114035)

David Parkes

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Supervision of experimental or theoretical research on acceptable computer science problems and supervision of reading on topics not covered by regular courses of instruction.

Course Notes: **Open to graduate students and AB/SM candidates only. Students must arrange such work with a member of the School of Engineering and Applied Sciences. This course is graded and is ordinarily taken with the approval of the Committee on Higher Degrees. Applicants must file**

a project sheet before study cards are filed. Project sheets may be obtained from the Academic Office, Pierce Hall 110.

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Primarily for Graduate Students
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 304

Statistical Machine Learning (108374)

Ryan Adams

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None

Computer Science 304

Statistical Machine Learning (108374)

Ryan Adams

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 306

Readable, Extensible, High-Performance Software Systems (109278)

Eddie Kohler

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course

Computer Science 306

Readable, Extensible, High-Performance Software Systems (109278)

Eddie Kohler

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course

Computer Science 308

Biologically-Inspired Multi-Agent Systems, Distributed Systems, and Computational Biology (119252)

Radhika Nagpal

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None

Computer Science 308

Biologically-Inspired Multi-Agent Systems, Distributed Systems, and Computational Biology (119252)

Radhika Nagpal

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course

Computer Science 310

Computational Mechanism Design, Electronic Marketplaces, and Multi-Agent Systems (116301)

David Parkes

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None

Computer Science 310

Computational Mechanism Design, Electronic Marketplaces, and Multi-Agent Systems (116301)

David Parkes

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 312

Collaborative Systems, AI Planning, and Natural Language Processing (143299)

Barbara Grosz

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None

Computer Science 312

Collaborative Systems, AI Planning, and Natural Language Processing (143299)

Barbara Grosz

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 314

Visual Computing (124155)

Hanspeter Pfister

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 314

Visual Computing (124155)

Hanspeter Pfister

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 316

Social Computing: Computation and Economics (125388)

Yiling Chen

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None

Computer Science 316

Social Computing: Computation and Economics (125388)

Yiling Chen

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None

Computer Science 320

Data Systems Design (156744)

Stratos Idreos

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 320

Data Systems Design (156744)

Stratos Idreos

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 322

Databases, Operating System, and Software Design (113643)

Margo Seltzer

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 322

Databases, Operating System, and Software Design (113643)

Margo Seltzer

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None

Computer Science 324

Human-Computer Communication through Natural, Graphical, and Artificial Languages (111666)

Stuart Shieber

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None

Computer Science 324

Human-Computer Communication through Natural, Graphical, and Artificial Languages (111666)

Stuart Shieber

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None

Computer Science 326

Intelligent Interactive Systems and Human-Computer (126331)

Krzysztof Gajos

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course

Computer Science 326

Intelligent Interactive Systems and Human-Computer (126331)

Krzysztof Gajos

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 327

Tools for Reliable Meaningful Efficient Communication (160962)

Madhu Sudan

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None

Computer Science 327

Tools for Reliable Meaningful Efficient Communication (160962)

Madhu Sudan

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course

Computer Science 328

Mathematical Logic, Theory of Computation (133437)

Harry Lewis

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 328

Mathematical Logic, Theory of Computation (133437)

Harry Lewis

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 344

Computer Architecture: Modeling and Design (116858)

David Brooks

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course

Computer Science 344

Computer Architecture: Modeling and Design (116858)

David Brooks

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None

Computer Science 346

High-Performance Computer Systems (117841)

Michael Smith

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course

Computer Science 346

High-Performance Computer Systems (117841)

Michael Smith

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 348

Computer Vision (120091)

Todd Zickler

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course

Computer Science 348

Computer Vision (120091)

Todd Zickler

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None

Computer Science 352

Cryptography: Unbreakable Codes and Financial Cryptography (111744)

Michael Rabin

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None

Computer Science 352

Cryptography: Unbreakable Codes and Financial Cryptography (111744)

Michael Rabin

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course

Computer Science 356

Computational Complexity, Parallel Computation, Computational Learning, Neural Computation (113027)

Leslie Valiant

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 356

Computational Complexity, Parallel Computation, Computational Learning, Neural Computation (113027)

Leslie Valiant

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 358

Computational Complexity, Cryptography, and Pseudorandomness (115136)

Salil Vadhan

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 358

Computational Complexity, Cryptography, and Pseudorandomness (115136)

Salil Vadhan

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None

Computer Science 360

On-line Algorithms and Randomized Algorithms (109883)

Michael Mitzenmacher

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 360

On-line Algorithms and Randomized Algorithms (109883)

Michael Mitzenmacher

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 362

Software Systems: Security, Performance, and Robustness (160959)

James Mickens

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None

Computer Science 362

Software Systems: Security, Performance, and Robustness (160959)

James Mickens

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course

Computer Science 364

Programming Languages and Security (126329)

Stephen Chong

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course

Computer Science 364

Programming Languages and Security (126329)

Stephen Chong

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 365

SEAS Teaching Practicum (125374)

John Girash

2016 Fall (4 Credits) **Schedule:** R 0200 PM - 0359 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Gain effective skills for teaching applied sciences. Topics: presentation and communication, grading and giving feedback on assignments, cognition and learning, classroom practice and student interactions. Seminar style with an emphasis on observation, practice, feedback, discussion, and reflection.

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 372

Topics in Theory for Society (204561)

Cynthia Dwork

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 376

Computer Graphics (121071)

Steven Gortler

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 376

Computer Graphics (121071)

Steven Gortler

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 378

Sketching Algorithms for Massive Data (110261)

Jelani Nelson

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None

Computer Science 378

Sketching Algorithms for Massive Data (110261)

Jelani Nelson

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course

Computer Science 380

Algorithms for Social Data (110263)

Yaron Singer

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 380

Algorithms for Social Data (110263)

Yaron Singer

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 382

Natural Language Understanding and Generation (160961)

Alexander Rush

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 382

Natural Language Understanding and Generation (160961)

Alexander Rush

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS Divisional Distribution	None

Computer Science 384

Advanced Control, Estimation, and Analysis of Robots and Dynamical Systems (160963)

Scott Kuindersma

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 384

Advanced Control, Estimation, and Analysis of Robots and Dynamical Systems (160963)

Scott Kuindersma

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 386

Machine Learning (160970)

Finale Doshi-Velez

2017 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 386

Machine Learning (160970)

Finale Doshi-Velez

2016 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS Divisional Distribution	None
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course