Instructor
Professor Xin Li, lixints@cs.jhu.edu, www.cs.jhu.edu/~lixints
Office: Malone Hall 215, 410-516-5847
Office hours: Wednesdays 11am–12 pm or by appointment

Meetings
Tuesday and Thursday, 12:00–1:15 pm, Hodson 211

Textbook

Online Resources
Any related online material will be posted at the course website http://www.cs.jhu.edu/~lixints/class/fall19.html.

Course Information
- This is a graduate level course studying the applications of combinatorics and graph theory in computer science. We will start with some basic combinatorial techniques such as counting and pigeon hole principle, and then move to advanced techniques such as the probabilistic method, spectral graph theory and additive combinatorics. We shall see their applications in various areas in computer science, such as proving lower bounds in computational models, randomized algorithms, coding theory and pseudorandomness. Students may receive credit for only one of EN.601.430 and EN.601.630.
- Prerequisites
  - Discrete Math or permission. Probability theory and linear algebra strongly recommended.
- Selective Elective

Course Goals
Specific Outcomes for this course are that:
- Students will learn to establish a formal foundation of the theory of computation.
- Students will learn to analyze and solve problems formally and mathematically.

This course will address the following Criterion 3 Student Outcomes:
- An ability to apply knowledge of computing and mathematics appropriate to the discipline (a)
- An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution (b)
Tentative Course Topics

- Basic Techniques: Counting; Pigeon hole principle and resolution refutation lower bound; Matching and Hall’s theorem; The sunflower lemma and formula lower bounds.
- The Probabilistic Method: Basic method; Lovaz local lemma and its constructive proof; Linearity of Expectation; The deletion method; The entropy function and Shearer’s lemma; Random walks and randomized algorithm for finding satisfying assignment for 2-CNF.
- Spectral Graph theory: Basic properties of graph spectrum; Cheeger’s inequality and approximation of graph expansion; Expander graphs and applications to super concentrators and pseudorandomness; Error correcting codes and expander codes.
- Ramsey Type Theorems and Constructions of Ramsey Graphs.
- Additive Combinatorics: Sum product theorem, Szemeredi-Trotter theorem, Kakeya set problem and applications to randomness extractors.
Course Expectations & Grading
There will be four or five homework problem sets, one mid-term exam and one final exam or project. Grading will be based on the following rule:

- Homework: 40%.
- Mid-term exam: 30%.
- Final exam or project: 30%.

Key Dates
The mid-term exam will be held in class on October 15. The final exam, if any, will be cumulative. If it’s not a take home exam, it will take place 6pm to 9pm, December 19. No make-up exams will be given, unless you have legitimate reasons, so plan accordingly. For the midterm, you may bring a single, 8.5x11 inch, handwritten sheet of paper (you may use both sides). For the final exam you may bring two sheets. No calculators are allowed (they won’t be necessary).

Assignments & Readings
Assignments and further readings will be posted on the course website http://www.cs.jhu.edu/~lixints/class/fall19.html

Gradescope: https://gradescope.com/coursescode: M5DPX7
Piazza: piazza.com/jhu/fall2019/en601430630

Ethics
The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful, abiding by the Computer Science Academic Integrity Policy:

Cheating is wrong. Cheating hurts our community by undermining academic integrity, creating mistrust, and fostering unfair competition. The university will punish cheaters with failure on an assignment, failure in a course, permanent transcript notation, suspension, and/or expulsion. Offenses may be reported to medical, law or other professional or graduate schools when a cheater applies.

Violations can include cheating on exams, plagiarism, reuse of assignments without permission, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. Ignorance of these rules is not an excuse.

Academic honesty is required in all work you submit to be graded. Except where the instructor specifies group work, you must solve all homework and programming assignments without the help of others. For example, you must not look at anyone else’s solutions (including program code) to your homework problems. However, you may discuss assignment specifications (not solutions) with others to be sure you understand what is required by the assignment.

If your instructor permits using fragments of source code from outside sources, such as your textbook or on-line resources, you must properly cite the source. Not citing it constitutes plagiarism. Similarly, your group projects must list everyone who participated.

Falsifying program output or results is prohibited.

Your instructor is free to override parts of this policy for particular assignments. To protect yourself: (1) Ask the instructor if you are not sure what is permissible. (2) Seek help from the instructor, TA or CAs, as you are always encouraged to do, rather than from other students. (3) Cite any questionable sources of help you may have received.

On every exam, you will sign the following pledge: “I agree to complete this exam without unauthorized assistance from any person, materials or device. [Signed and dated]”.

Your course instructors will let you know where to find copies of old exams, if they are available.

[In addition, the specific ethics guidelines for this course are:]
(1) **Collaboration policy:** While you should first think about homework problems on your own, I encourage you to discuss homework problems with your classmates. However, you must write up your own solutions. Students found sharing the same paragraph in their homework will receive 0 point for the homework, and risk further punishment such as automatic failure and report to the University. Furthermore, you must acknowledge any collaboration by writing the names of your collaborators on the front page of the assignment. You don’t lose points by having collaborators.

(2) **Citation policy:** Try to solve the problems without reading any published literature or websites, besides the class text. If, however, you do use a solution or part of a solution that you found in the literature or on the web, you must cite it. Furthermore, you must write up the solution in your own words. You will get at most half credit for solutions found in the literature or on the web. Using solutions from other resources without citation is considered plagiarism and will result in 0 point and potential further punishment as in (1).

(3) **Late Policy:** Homework are due at the beginning of the class. You have a total of two late days that you can use for your assignments without penalty (for example, you can use one late day for one assignment and one late day for another assignment, or use two late days for one assignment). A day here means 24 hours. Once your late days are used up, your homework will not be graded.

Report any violations you witness to the instructor.

You can find more information about university misconduct policies on the web at these sites:

- **Undergraduates:** [https://studentaffairs.jhu.edu/policies-guidelines/undergrad-ethics/](https://studentaffairs.jhu.edu/policies-guidelines/undergrad-ethics/)
- **Graduate students:** [http://e-catalog.jhu.edu/grad-students/graduate-specific-policies/#misconduct](http://e-catalog.jhu.edu/grad-students/graduate-specific-policies/#misconduct)

**Students with Disabilities**

Any student with a disability who may need accommodations in this class must obtain an accommodation letter from Student Disability Services, 385 Garland, (410) 516–4720, studentdisabilityservices@jhu.edu.