# Course: Math 7018 – Probabilistic methods in combinatorics

**Instructor** : Prasad Tetali,  office: Skiles 234,   email: tetali@math.gatech.edu
**Office Hours**: TBA

Suggested Textbook: **The Probabilistic Method**, by N. Alon and J. Spencer (with an appendix of problems by Paul Erdos), 2nd ed. (2000), John Wiley & Sons.

*Additional handouts will be given based on material from other sources, some of which are listed below.*
References:
- "Random Graphs," by Janson, Luczak, and Rucinski, John Wiley & Sons (2000).
- "Probabilistic Methods for Algorithmic Discrete Mathematics," Ed. by M. Habib et al. (1998), Springer-Verlag.
- "The Handbook of Combinatorics" (e.g. the chapter on *Combinatorial discrepancy theory* by J.Beck and V. Sos)

**Course Objective**. To develop an appreciation for the strength and beauty of the probabilistic techniques in combinatorics.

**Rough Outline**.

**1**. *The basic (first moment) method*: Examples from graph theory, combinatorics, and number theory, of the use of the probabilistic method, the use of linearity of expectation
**2**. *The second moment method*: Number-theoretic and Random graph applications.
**3**. *The Lovasz local lemma*: Basic lemma, its variations and applications
**4**. *Alterations*: Ramsey numbers, Property B, Packing and Recoloring
**5**. *Combinatorial discrepancy theory*: Balancing lights, Spencer's six standard deviations result, Beck-Fiala theorem and the Komlos conjecture
**6**. *Correlation inequalities*: The four functions theorem, FKG and XYZ inequalities
**7**. *Random graphs*: Chromatic number, Clique number, Sharp threshold phenomenon
**8**. *The Poisson paradigm*: Janson's inequalities
**9**. *Martingale Inequalities*: Azuma-Hoeffding inequality, Talagrand's inequality
**10**. *Entropy techniques*: Shearer's lemma and combinatorial enumeration applications
**11**. *Pseudorandomness and Derandomization*. Eigenvalues and Expanders.

**Grading policy**: Homeworks will be assigned and graded. There will be two Tests. Students (in pairs) may have to read and present a research article, relevant to the course.