Theory of Probability (MATH-UA 233), Summer 2018 term

Prerequisites: MATH-UA 123 **Calculus III or** MATH-UA 213 **Math for Economics III** (for Economics majors) with a grade of C or better and/or the equivalent, **and** MATH-UA 140 **Linear Algebra** with a grade of C or better and/or the equivalent.

Dates and time: Monday through Thursday 2.10 PM – 4.15 PM between 05/21/2018 – 06/28/2018 in room WWH 102. No class on Monday, May 28.

Office hours: Mondays and Thursdays 5pm to 6pm in WWH805. Or by appointment: gaal@cims.nyu.edu.

Grading: 20% homeworks, 30% midterm and 50% final.

Final: On June 28th. **Midterm**: On June 11th. Closed book exams, no calculator.

Text: There is no textbook for this course. A good reading is *A first course in probability* by S. M. Ross as well as *Probability and Statistics* by DeGroot and Schervish. Homeworks will be partly assigned from Ross' book.

For students with strong interest in probability and background in analysis, not specifically for this course *Probability theory : a comprehensive course* by A. Klenke. Latter is freely available through NYU online library. There is **no requirement to acquire any of the books**.

Homework: There will be weekly homeworks due every Tuesday. Homeworks will be announced gradually during the week before the due date, but no later than Friday. There will be about 12 problems each week, so plan ahead and start working on problems on time. **Readability** and attention to detail is expected in the homeworks and will be part of its grading. If you have a rather chaotic handwriting please consider LaTex.

Syllabus (preliminary)

1st week (May 21–24): Sets, set operations, functions. Basic counting (permutations, combinations). The binomial theorem. Axioms and interpretation of probability, freedom of modeling.

2nd week (May 29–31): Conditional probability and independence, continuity of measures, product probability measures, random variables.

3rd week (June 4–7): Discrete distributions (binomial, Poisson, geometric), Poisson limit of the binomial distribution, Poisson rates, expectation and variance.

4th week (June 11–14): i.i.d. Bernoulli trial, continuous distributions (uniform, exponential, gamma), expectations and variance in the continuous case. Joint distributions and marginals. Change of variables formula (in 1D)

5th week (June 18–21): Density transformation (in 2D), convolution, moment generating functions, normal distribution (1D and 2D). Quantiles, quasi-inverses and VaR. Conditional density and discrete conditional expectation. Chebyshev inequalities (general, quadratic, exponential) and the weak law of large numbers.

6th week (June 25–27): Some outlook at regression and PCA using 2D Gaussians. Large deviation for sum of i.i.d. Bernoulli's (via exponential Chebyshev). The central limit theorem and its applications (using Berry–Esseen theorem). Review of class topics.