ICM5404 —
Special Topics on Digital Communications: Advanced Probability for Communications

Course Brief :

This course intends to provide students with the necessary background on advanced probability theories for communications. It is our hope that students, after taking this course, are capable of self-reading *theoretical* papers in communications. Enhancing students' capability for theoretical research is another objective of this course. Accordingly, not only proofs for theories will be introduced in detail, but also their implications in communications will be stated in lectures. Students who take this course are recommended to have certain knowledge on fundamental probabilistic theories.

Instructor :

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Text :

It suffices to read the lecture slides for the preparation of exam.

Lecture Schedule :

Friday BCD (9:00am∼12:00pm)

Class Room :

To be determined.

Teaching Assistant :

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Grading System :

The final grade of this course will be contributed equally from a final exam and a study report.

The study report is due one week after the final exam. A late submission will be deducted 50% from its final grade. In the study report, students may try to apply what they have learned from this course to a self-created or application-oriented problem. As an example, a partial solution with some conjectures on the unsolved part of the self-created problem will make a fine report. It can also be a summary with novel personal extension about a theoretical paper that you are interested in, and that is relevant to what we have lectured. A copy of the studied paper shall be attached when submitting the report.

Coverage :

- Patrick Billingsley, *Probability and Measure*, 3rd Edition, Wiley, 1995.
  - Section 6: Law of large numbers (including the strong law, and the weak law), Borel-Cantelli lemmas.
  - Section 9: Large deviations, the law of the iterated logarithm, moment generating functions versus large deviations, Chernoff's theorem.
  - Section 20: Random variables, convergence in probabilities.
  - Section 21: Characterization of relation between expectation values and (1) limits, (2) distributions, (3) moments.
    Several inequalities regarding expectation values will also be covered.
  - Section 22: Sums of independent random variables, and their relation with the strong/weak law and moment generating functions.
    Komogrov's zero-one law and maximal inequality will also be covered.
  - Section 25: Weak convergence in distributions.
  - Section 26: Characteristic functions inversion, uniqueness theorem, the continuity theorem.

  - Section 27: The central limit theorem, Lindeberg and Lyapounov theorems.
  - Section 28: Infinitely divisible distributions.
  - Section 37: Brownian Motion.
- More advanced topics:
  - Berry-Esseen Theorem (William Feller, *An Introduction of Probability Theory and Application*, 2nd edition, Volume II, Wiley, 1971);
  - Basic order statistics selected from:
    * *Order Statistics*, 2nd edition, Herbert A. David, 1981;
    * *Order Statistics: Applications*, N. Balakrishnan & C. R. Rao, 1998
    * *Ordered Random Variables*, Mohammad Ahsanullah and Valery B. Nevzorov, Nova Science Publishers, Inc., 2001.
  - Derivation of error probability for Differential BPSK (John G. Proakis, *Digital Communications*, Appendix B, 4rd edition, McGraw-Hill International Editions, 2001.)