

Stochastic Networks (M24)

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This course uses stochastic models to shed light on important issues in the design and control of communication networks. Randomness arises in communication systems at many levels: for example, the initiation and termination times of calls in a telephone network, or the statistical structure of the arrival streams of packets at routers in the Internet. How can routing, flow control and connection acceptance algorithms be designed to work well in uncertain and random environments?

The first part of the course will describe a variety of classical models that can be used to help understand the performance of large-scale communication networks. Queueing and loss networks will be studied, as well as random access schemes. Parallels will be drawn with models from physics, and with models of traffic in road networks.

The second part of the course will study congestion control algorithms in the Internet. This is an area of some practical importance, with network operators, hardware and software vendors, and regulators actively seeking ways of delivering new services reliably and effectively. The interplay between end-systems and the network has attracted the attention of economists as well as mathematicians and engineers.

Desirable previous knowledge

Mathematics that will be assumed to be known before the start of the course: Part IB Optimization and Markov Chains. Familiarity with Part II Applied Probability would be useful, but is not assumed.

Introductory reading

A feeling for some of the ideas of the course can be taken from

The mathematics of traffic in networks. In *Princeton Companion to Mathematics* (Edited by Timothy Gowers; June Barrow-Green and Imre Leader, associate editors) Princeton University Press, 2008. 862-870.

Literature

1. B. Hajek *Communication Network Analysis*.
2. P. Robert *Stochastic Networks and Queues*. Springer-Verlag, 2003. Chapter 4.
3. H. Chen and D.D. Yao *Fundamentals of Queueing Networks*. Springer-Verlag, 2001.
4. S. Asmussen *Applied Probability and Queues* - second edition. Springer-Verlag, 2003.
5. R. Srikant *The Mathematics of Internet Congestion Control*. Birkhauser, 2004.
6. S. Shakkottai and R. Srikant *Network Optimization and Control*. Foundations and Trends in Networking, NoW Publishers, 2007.