IIT Mandi
Course Proposal

Course number	: CS 549
Course name	: Performance Analysis of Computer Networks
Credits	: 3-0-0-3
Prerequisites	: IC 210 Probability, statistics and random variables or equivalent, CS 310 Introduction to Communicating and Distributed Processes or consent of the instructor.
Intended for	: BTech CSE & EE, MTech/MS/PhD in the area.
Elective/Core	: Discipline elective for BTech CSE and EE, free elective for others
Semester	: Any

Preamble: This course offers a first formal introduction to performance analysis of various components of computer networks. It revisits some of the modules covered in Introduction to Communicating and Distributed Processes (CS 310) and provides an analytical framework for them. To understand this analytical framework some basic knowledge of probability, random processes (IC 210) is required. Students will be introduced to various analytical tools and measurement techniques that would enable them to analyse the performance of computer networks.

Objective: The Internet plays a crucial role in our daily lives. This course will introduce an analytical framework for the underlying principles that make the Internet work. Descriptive theory and analysis will be complemented with simple experiments aimed at enabling the students to validate the underlying concepts. The main components of the course are:

- Introduction to queueing theory. Modeling and analysis of various queueing systems.
- Multiaccess communication schemes used in wired and wireless LANs. Performance evaluation of these schemes, using analysis and measurement experiments.
- Routing algorithms and their performance evaluation.

Upon completion of this course, students will

1. develop an intuitive understanding of processes and phenomena unique to networks.
2. get an analytical understanding of how files (data) are transferred from a server to a client over the Internet.
3. have a handle on the basic tools of queueing theory and their limitations.
4. understand and analyze protocols that govern communication over multiaccess channels.
5. obtain a conceptual understanding of routing algorithms.
6. analyze the performance of various aspects of computer networks, and conduct experiments to corroborate the analytical results.

Modules: Topics to be covered are:

Introduction to computer networks (3 lectures) A brief history and introduction to the Internet, Review of networking and layering.

Multiaccess communication and its analysis (9 lectures) Slotted multi-access and the ALOHA system, Carrier sensing multiple access slotted ALOHA, Local Area Networks: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) and Ethernet: Slotted CSMA/CD, unslotted CSMA/CD and IEEE 802 standards, Link scheduling and Network capacity.

Routing algorithms and their analysis (8 lectures) Algorithms for shortest path routing - Dijkstra's Algorithm, Bellman-Ford Algorithm and Generalized Dijkstra's Algorithm, Optimal routing.

Queueing theory (10 lectures) Brief review of Random processes, Introduction to Markov chains and queueing theory, traffic models, deterministic and stochastic analysis; Delay modeling using queueing theory Little's law, M/M/1, M/M/m, M/M/m/m, M/G/1 queueing systems, priority queueing.

Measurement techniques and experiment design (6 lectures) Workloads, Monitors, Experiment design - 2^k, $2^k r$ factorial designs.

Advanced topics (4 lectures) Network economics, Mobile IP, Multimedia streaming, VoIP, Content Distribution Networks, Software-defined networking and network function virtualization.

Textbooks:

1. *Data networks,* D. Bertsekas and R.G. Gallager, 1992, Prentice-hall.
2. *Communication networking: an analytical approach*, Anurag Kumar, D. Manjunath and Joy Kuri, 2004, Elsevier.
3. *Computer networking: a top-down approach*, J.F. Kurose and K.F. Ross, 2010, Pearson.

Additional References:

1. *The art of computer systems performance analysis,* R. Jain, 2013, Wiley India.
2. *Probability and Statistics with Reliability, Queueing, and Computer Science Applications*, K.S. Trivedi, 2016, John Wiley and Sons Ltd.
3. *Network algorithms: an interdisciplinary approach to designing fast networked devices*, G. Varghese, 2004, Morgan Kaufmann.
4. *Notes for ECE 567 Communication network analysis*, B. Hajek, 2006, University of Illinois. http://www.ifp.illinois.edu/~hajek/Papers/networkanalysis.html