CSE 570S: Recent Advances in Networking

Raj Jain
Washington University in Saint Louis
Saint Louis, MO 63130
Jain@cse.wustl.edu

These slides and audio/video recordings are available on-line at:

http://www.cse.wustl.edu/~jain/cse570-21/

Student Questions

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    ❑ Third Level
      ❖ Fourth Level
        ✓ Fifth Level

Overview

- Goal of this Course
- Contents of the course
- Tentative Schedule
- Project
- Grading

Student Questions

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    - Third Level
      - Fourth Level
        - Fifth Level

Networking = "Plumbing"

- Networking is the "plumbing" of computing
- Almost all areas of computing are network-based.
  - Distributed computing
  - Big Data
  - Cloud Computing
  - Internet of Things
  - Smart Cities
- Networking is the backbone of computing.

Student Questions

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    - Third Level
      - Fourth Level
        - Fifth Level

Networking is already great!

Networking is Fueling All Sectors of Economy

❑ Networking companies are among the most valued companies: Apple, AT&T, Samsung, Verizon, Microsoft, China Mobile, Alphabet, Comcast, NTT, IBM, Intel, Cisco, Amazon, Facebook, …

⇒ All tech companies that are hiring currently are networking companies

❑ Note: Apple became highly valued only after it switched from computing to communications (iPhone)

Networking = Economic Indicator

Student Questions

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      ❖ Fourth Level
        ✓ Fifth Level

Goal of This Course

❑ Recent networking topics

❑ Topics of interest to industry

❑ Comprehensive course – cover many topics

❑ Data Center Networking, Virtualization, Software Defined Networking, Big Data, Cloud Computing, Internet of Things

❑ Breadth First

❑ Graduate course: (Advanced Topics)
   ⇒ Lot of independent reading and writing
   ⇒ Project/Survey paper (Research techniques)

Student Questions

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         ❖ Fourth Level
            ✓ Fifth Level

Objectives: What You Will Learn?

Top 10 Topics in Networking

1. Data Center Networking
2. Virtualization
3. Cloud Computing
4. Software Defined Networking (SDN)
5. Network Function Virtualization (NFV)
6. Internet of Things (IoT)
7. Software Defined Intelligence
8. Blockchains
9. Quantum Communications

Student Questions

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    - ❑ Third Level
      - ❖ Fourth Level
        - ✓ Fifth Level

Data Center Networking

1. How are data centers networks different from those in homes or offices?

2. What are the standards for data center layout?

3. How have Ethernet and other protocols been changed to accommodate data centers?

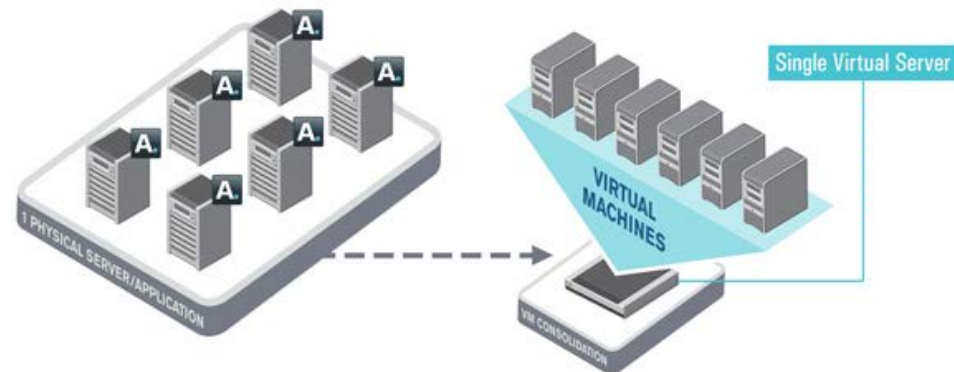4. How and why connect multiple data centers on a single Ethernet?

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      - ❖ Fourth Level
        - ✓ Fifth Level

Virtualization

1. Why virtualize?
2. How are servers virtualized?
3. How is storage virtualized?
4. What networking components are virtualized and how?
5. What are new networking standards related to virtualization?

Cloud Computing

1. What is cloud computing?
2. What are different types of cloud services?
3. How is different from other forms of computing: Grid, Cluster, ..
4. What new technologies are required to enable cloud computing?
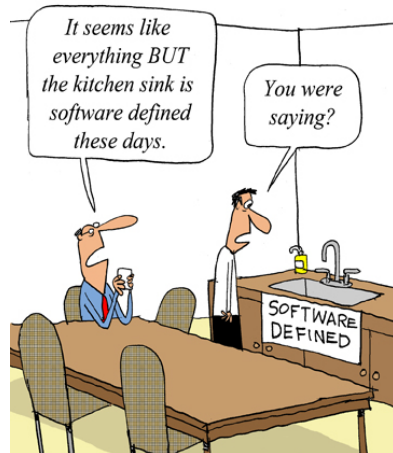5. What is fog (vs. cloud) computing?

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Software Defined Networking

1. What is software defined networking?
2. Why is the industry running to adopt this new technology so fast?
3. What new facilities are enabled by SDN?
4. What is the difference between SDN and OpenFlow?
5. What are different flavors of SDN?

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Network Function Virtualization (NFV)

1. What is NFV?
2. NFV and SDN Relationship
3. ETSI NFV ISG Specifications
4. Concepts, Architecture, Requirements, Use cases
5. Proof-of-Concepts and Timeline

[Source: LightReading]

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        - ✓ Fifth Level

Internet of Things

1. What is so unique about Internet of Things (compared to current Internet)?

2. What are the new IEEE/IETF protocols for IoT?

3. What are different kinds of things: M2M, Sensors, RFID, …

4. How clouds can help IoT?

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      - ❖ Fourth Level
        - ✓ Fifth Level

Blockchain

❑ Blockchain is the technology that made Bitcoin secure

❑ Blockchain was invented by the inventor of Bitcoin

❑ After Bitcoin became successful, people started looking into the technology behind Bitcoin and found:

  ➢ Blockchain is the key for its success

  ➢ Blockchains can be leveraged for other applications

Student Questions

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Other Topics

❑Machine Learning and Deep Learning applications for networking

❑Quantum communication

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Non-Goals

❑ The following current issues are not covered in this course:

➢ Wireless developments – 4G, 5G, Pico Cell, Femto cell (Covered in CSE 574 – Wireless Networking)

➢ Security – Are clouds secure?
Security and Privacy issues of IoT.
(Covered in CSE 571 – Network security)

❑ These issues require background not covered in CSE 473.

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Reading Material

1. Technical Papers
2. Industry whitepapers
3. Standards documents
4. Wikipedia, http://en.wikipedia.org/wiki/
5. Books

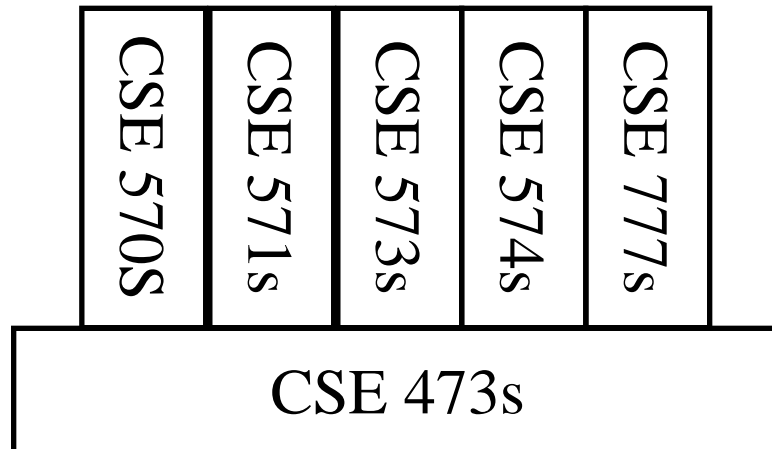**Student Questions**

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Networking Courses at WUSTL

❑ CSE 473s: Introduction to Computer Networks

❑ CSE 570S: Recent Advances in Networking

❑ CSE 571S: Network Security

❑ CSE 573s: Protocols for Computer Networks

❑ CSE 574s: Wireless and Mobile Networking

❑ CSE 777s: Research Seminar in Networking

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CSE 570S | CSE 571s | CSE 573s | CSE 574s | CSE 777s

CSE 473s

Prerequisite: CSE473S

❑ Protocol Layers: ISO/OSI reference model

❑ TCP/IP protocol stack

❑ LAN Addressing: Unicast vs. multicast, Local vs. Global

❑ Extended LANs: Hubs vs. Bridges vs. Routers vs. Switches

❑ VLANs

❑ IPv4 and IPv6 Address: Public vs. Private Addresses

❑ Subnets

❑ Address Resolution Protocol (ARP)

❑ Internet Control Message Protocol (ICMP)

❑ TCP connection setup, Checksum (pseudo-header), Slow start

❑ TCP vs. UDP

❑ Hypertext Transfer Protocol (HTTP)

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✓ Fifth Level

Tentative Schedule 1

Date	Day	Topic
8/30	Monday	Course Overview
9/1	Wednesday	Networking Trends 2021
9/6	Monday	**Labor day holiday**
9/8	Wednesday	Data Center Network Topologies (Part 1)
9/13	Monday	Data Center Network Topologies (Part 2)
		Data Center Ethernet (Part 1)
9/15	Wednesday	Data Center Ethernet (Part 2)
9/20	Monday	Carrier IP
9/22	Wednesday	Carrier Ethernet
9/27	Monday	**Exam 1**

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Tentative Schedule 2

Date	Day	Topic
9/29	Wednesday	Project Guidelines (Part 1)
10/4	Monday	Virtual Bridging
10/6	Wednesday	LAN Extension and Virtualization Using L3 Protocols
10/11	Monday	Virtual Routing Protocols
10/13	Wednesday	Virtual Routing Protocols (Part 2)
10/18	Monday	**Fall Break**
10/20	Wednesday	Project Guidelines (Part 3)
10/25	Monday	IoT (IoT)
10/27	Wednesday	Data-Link Layer and Management Protocols for IoT
11/1	Monday	**Exam 2**

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Tentative Schedule 3

Date	Day	Topic
11/3	Wednesday	Networking Layer Protocols for IoT 1: 6LoWPAN
11/8	Monday	Networking Layer Protocols for IoT 2: RPL
		Messaging Protocols for IoT: MQTT
11/10	Wednesday	Introduction to OpenFlow(Part 1)
11/15	Monday	Software Defined Networking (SDN)
11/17	Wednesday	Network Function Virtualization (NFV)
11/22	Monday	Blockchains for Computer Networking
11/24	Wednesday	**Thanksgiving break**
11/29	Monday	Quantum Computing for Networking
12/1	Wednesday	TBD
12/6	Monday	TBD
12/8	Wednesday	**Final Exam**

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        ✓ Fifth Level

Projects

❑ Hands-on project or a survey paper related to the topics of the course

❑ Some hands-on project and survey topics will be assigned.
Some you can suggest for approval.

❑ Average 6 Hrs./week/person on project + 9 Hrs./week/person on class

❑ Recent Developments: Last 2 to 4 years
⇒ Not in books

❑ Will be published on my website,
Better ones may be submitted to magazines or journals

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        ✓ Fifth Level

Project Requirements

❑ Comprehensive Survey:
Technical Papers, Industry Standards, Products

❑ No copyright violations:
⇒ You need to re-draw all figures
⇒ You need to summarize all ideas in your *own* words
⇒ Cannot copy any part of text or figure unmodified
⇒ Short quotes ok
⇒ Any unmodified figures need permissions
Any infringement will result in forfeiture of grades even after graduation.

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❖ Fourth Level
✓ Fifth Level

Example of Projects

❑ Current Autonomic Networking Models and Architectures

❑ Automotive Ethernet Technologies and Protocols

❑ 10 Gigabit Ethernet and Backplane Ethernet

❑ An Enterprise Blockchain Solution for an Infrastructure-as-a-Service Platform

❑ Decentralized Internet

❑ A Survey of Information-Centric Networking Approaches

❑ The State of Intent-Based Networking

❑ Machine Learning Techniques for Intrusion Detection Systems

❑ Quantum Communications and its Recent Advances

❑ Time-Sensitive Networking for Real-Time Ethernet

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      - ✓ Fifth Level

Example of Projects (Cont.)

❑ Performance Comparison of Big Data Analysis using Hadoop in Physical and Virtual Servers

❑ A Survey of Balloon Networking Applications and Technologies

❑ Recent Information-Centric Networking Approaches

❑ Recent Advances in Named Data Caching and Routing

❑ For a sample of previous projects reports, see
http://www.cse.wustl.edu/~jain/cse570-19/index.html
http://www.cse.wustl.edu/~jain/cse570-18/index.html
http://www.cse.wustl.edu/~jain/cse570-15index.html
http://www.cse.wustl.edu/~jain/cse570-13/index.html

You can suggest a topic for approval or select from a list of topics that will be provided.

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Project Schedule

Mon 10/4   Topic Selection

Mon 10/11   References Due

Mon 10/25   Outline Due

Mon 11/15   Final Paper Due $\Rightarrow$ Peer reviewed

Mon 11/22   Reviews Returned

Mon 11/29   Revised Report Due

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Office Hours

❑ Monday/Wednesday:11 AM to 12 Noon
(By Appointment)

❑ Teaching Assistant:

  ➢ TBA

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        ✓ Fifth Level

Grading

❑Exams (Best of 2 mid terms + Final) 60%

❑Class participation   5%

❑Home Works   15%

❑Project   20%

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Exams

❑ Exams consist of numerical, fill-in-the-blank and multiple-choice (true-false) questions.

❑ There is negative grading on incorrect multiple-choice questions. Grade: +1 for correct. -1/(n-1) for incorrect. For True-False: +1 for Correct, -1 for Incorrect This ensures that random marking will produce an average of 0.

❑ Everyone including the graduating students are graded the same way.

❑ Highest score achieved becomes 100% for that exam.

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✓ Fifth Level

Exams (Cont.)

❑ All exams are closed book.
One 8.5"X11" cheat sheet with your notes on both sides is allowed.

❑ No smart phones allowed.
Only simple TI-30 or equivalent calculator allowed for calculations.

❑ Exam dates are fixed and there are no substitute exams
Plan your travel accordingly.

❑ Best of the two mid-terms is used.

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        ✓ Fifth Level

Home Work Submission

❑ All home works are due on the following Monday before the class unless specified otherwise.

❑ Any late submissions, if allowed, will *always* have a penalty.

❑ All home works should be submitted online on canvas

❑ All home works are identified by the class handout number.

❑ All home works should be on a separate file.
  Your name should be on every page.

❑ Please write CSE570 in the subject field of all emails related to this course.

❑ Use word "Home work" in the subject field on emails related home work. Also indicate the home work number.

Student Questions

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Home Work Grading

❑ Grading basis: Method + Correct answer

❑ Show how you got your answer

➢ Show intermediate calculations.

➢ Show equations or formulas used.

➢ If you use a spreadsheet, a statistical package, or write a program, print it out and turn it in with the home work.

➢ For Excel, set the print area and scale the page accordingly to fit to a page. (See Page Setup)
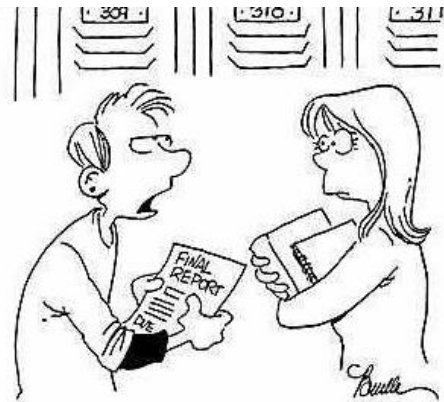
Student Questions

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❑ Third Level

❖ Fourth Level

✓ Fifth Level

Academic Integrity

❑ Academic integrity is expected in home works

❑ All solutions submitted are expected to be yours and not copied from others or from solution manuals or from Internet

❑ All integrity violations have to be reported to the department.

"I don't know what plagiarizing is, so I'm gonna take the easy way out and just copy something off the internet."

Student Questions

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        ✓ Fifth Level

Cartoon Source: https://www.tarleton.edu/stulife/judicial/integrity/index.html

Class Discussions

❑ We will use Piazza for class discussion.

❑ Find our class page at:

❑ https://piazza.com/wustl/fall2021/cse570

Student Questions

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Summary
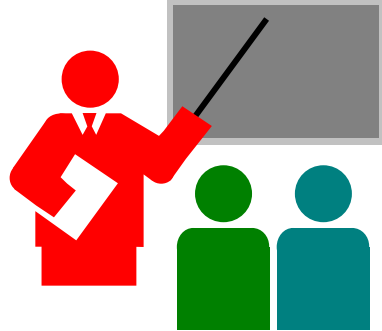
❑ Goal: To prepare you for the current job market in networking

❑ Teach you how to keep up with the latest in your field

❑ There will be a significant amount of self-reading and writing

❑ Get ready to work hard

Student Questions

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        ✓ Fifth Level

Google Search Modifiers

- filetype:pdf, doc, ppt, pptx
- site:wustl.edu
- intitle:trend
- inurl:trend
- allintitle:Networking Trends
- Allinurl:
- " " $\Rightarrow$Exact Phrase
- OR
- AND
- + $\Rightarrow$ Must include
- - $\Rightarrow$ Not include
- ~X $\Rightarrow$ X or similar
- * $\Rightarrow$ Wildcard

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Ref: https://bynd.com/news-ideas/google-advanced-search-comprehensive-list-google-search-operators/

Project Home Work 1

❑ Search web pages, books, and journal articles from IEEE XPlorer, ACM Digital Library, MOBIUS, Safari books, ILLIAD at Olin Library for **one** of the following topics:
1. Networking Trends
2. Data Center Networking
3. Software Defined Networking
4. Internet of Things
5. Quantum Communications
6. Blockchains

❑ On the web try the following search points:
➢ https://library.wustl.edu
➢ https://scholar.google.com
➢ https://books.google.com
➢ https://dl.acm.org/
➢ https://searchnetworking.techtarget.com/
➢ https://ieeexplore.ieee.org

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✓ Fifth Level

Project Home Work 1 (Cont.)

❑ Ignore all entries dated 2016 or before. Also ignore all entries that do not indicate topic or similar words in the title. List others in the following format (5 each):

➢ Author, "Title," publisher, year, ISBN. (for 5 books)

➢ "Title," URL [One line description] (for 5 web pages)

➢ Author, "Title," source (for 5 technical/magazine articles)

❑ For the books, include whether the book is available at WUSTL, MOBIUS, Safari, or ILLiad

❑ Serially number the references and submit electronically

❑ Make a list of other interesting search points and share in class.

Student Questions

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❑ Third Level

❖ Fourth Level

✓ Fifth Level

Common Mistakes in Project Home Work #1

❑ Not indicating where the book can be found in WUSTL

❑ Listing books/Magazines/journals that have little to do with the topic – may show up in search engines because of a minor mention of the topic or words

❑ Web Pages – No one line descriptions

❑ Incomplete bibliographic data for journal articles.
Need volume, issue, year, pages.

❑ Missing journals. Need names of journals dealing with the topic chosen.

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Quiz 0: Prerequisites

True or False?

T F

☐☐ Subnet mask of 255.255.255.254 will allow 254 nodes on the LAN.

☐☐ Time to live (TTL) of 8 means that the packet can travel at most 8 hops.

☐☐ IP Address 128.256.210.12 is an invalid IP address

☐☐ Network Address Translator (NAT) connects a private network to Internet.

☐☐ DHCP server is used for automatic assignment of IP address

☐☐ DNS helps translate a name to a MAC address

☐☐ Port 80 is used for FTP.

☐☐ IPv6 addresses are 32 bits long.

☐☐ New connection setup message in TCP contains a syn flag.

☐☐ 192.168.0.1 is a public address.

☐☐ Spanning tree algorithm is used to find a loop free path in a layer 2 network.

Marks = Correct Answers _____ - Incorrect Answers _____ = _____

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        ✓ Fifth Level

Student Questionnaire

❑ Name: _____

❑ Email: _____

❑ Phone: _____

❑ Degree: _____ Expected Date: _____

❑ Technical Interest Areas:

_____

_____

❑ Prior networking related courses/activities:

_____

_____

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http://rajjain.com

http://www.cse.wustl.edu/~jain/cse570-21/m_01int.htm

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Related Modules

CSE 567: The Art of Computer Systems Performance Analysis
https://www.youtube.com/playlist?list=PLjGG94etKypJEKjNAa1n_1X0bWWNyZcof

CSE473S: Introduction to Computer Networks (Fall 2011),
https://www.youtube.com/playlist?list=PLjGG94etKypJWOSPMh8Azcgy5e_10TiDw

CSE 570: Recent Advances in Networking (Spring 2013)

https://www.youtube.com/playlist?list=PLjGG94etKypLHyBN8mOgwJLHD2FFIMGq5

CSE571S: Network Security (Spring 2011),
https://www.youtube.com/playlist?list=PLjGG94etKypKvzfVtutHcPFJXumyyg93u

Video Podcasts of Prof. Raj Jain's Lectures,
https://www.youtube.com/channel/UCN4-5wzNP9-ruOzQMs-8NUw

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