

CSE 473S: Introduction to Computer Networks



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Audio/Video recordings of this lecture are available on-line at:

<http://www.cse.wustl.edu/~jain/cse473-16/>



- ❑ Why Study Computer Networking?
- ❑ Goal of This Course
- ❑ Instructor
- ❑ Grading
- ❑ Contents of the course
- ❑ Tentative Schedule

Why Study Computer Networking?

- ❑ Networking is the “plumbing” of computing
- ❑ Almost all areas of computing are network-based.
 - ❑ Distributed computing
 - ❑ Big Data
 - ❑ Cloud Computing
 - ❑ Internet of Things
- ❑ Fast growing field
- ❑ All top companies are networking companies: Apple, Google, Microsoft, Amazon, Facebook, Cisco, HP, Intel, IBM, ...

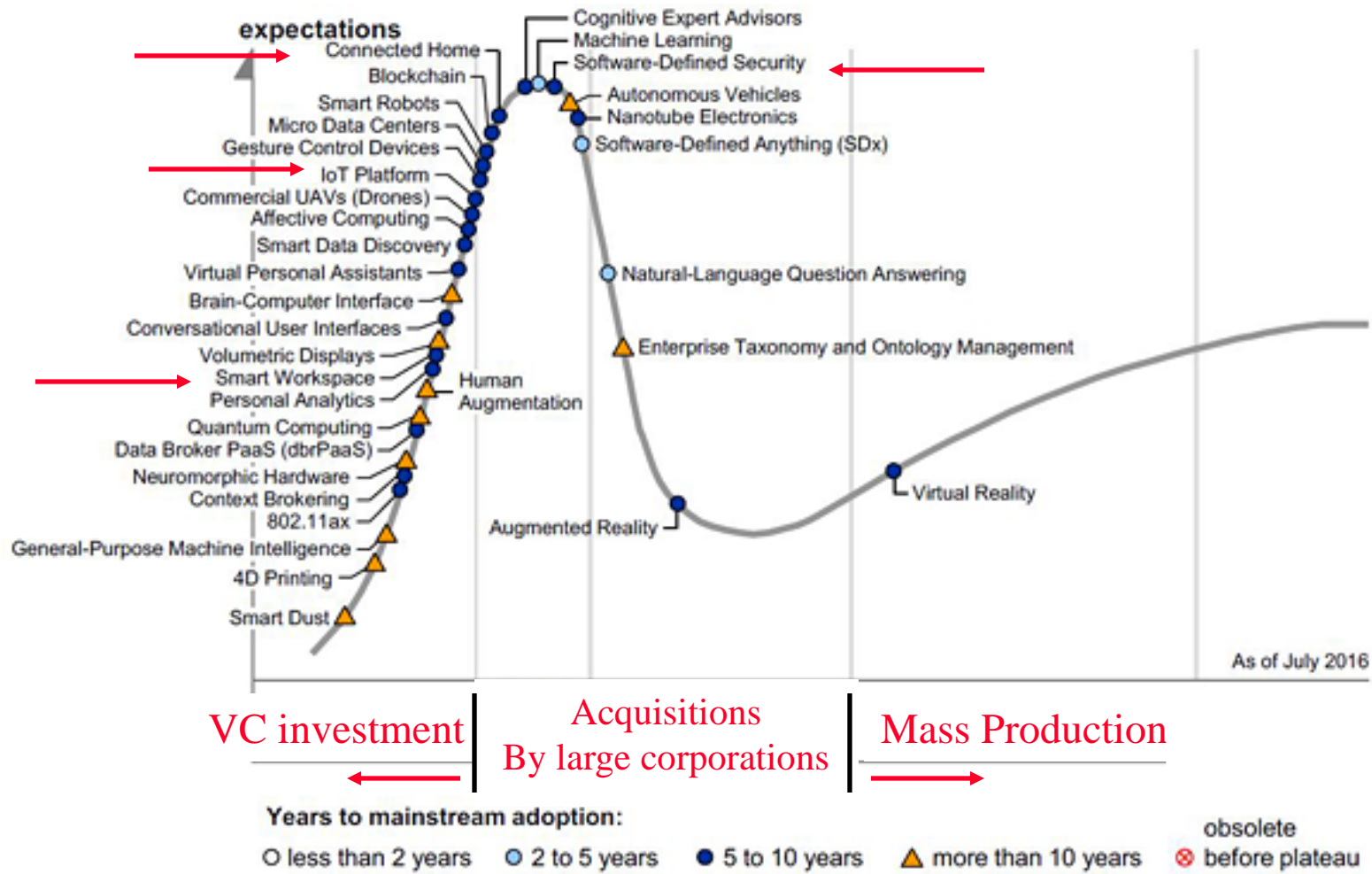


Current Hot Topics in Networking



1. Internet of Things
2. Security: Cyber Warfare
3. Datacenter Networking and Clouds
4. Mobile/Wireless Networking

Gartner Hype Cycle 2016



Ref: Gartner, "Hype Cycle for Emerging Technologies, 2016," July 2016, [subscribers only], gartner.com/document/3383817
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1. Internet of Things



Smart Watch



Smart TV



Smart Car



Smart Health



Smart Home



Smart Kegs



Smart Space



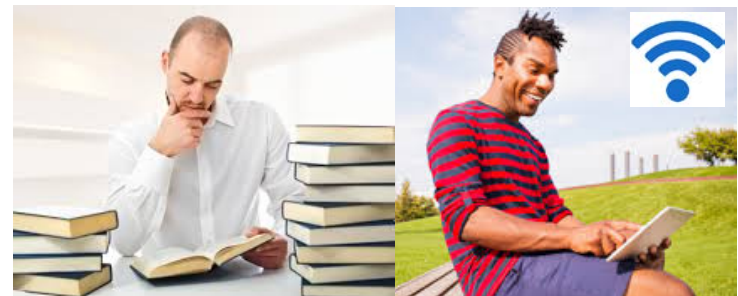
Smart Industries



Smart Cities

What's Smart?

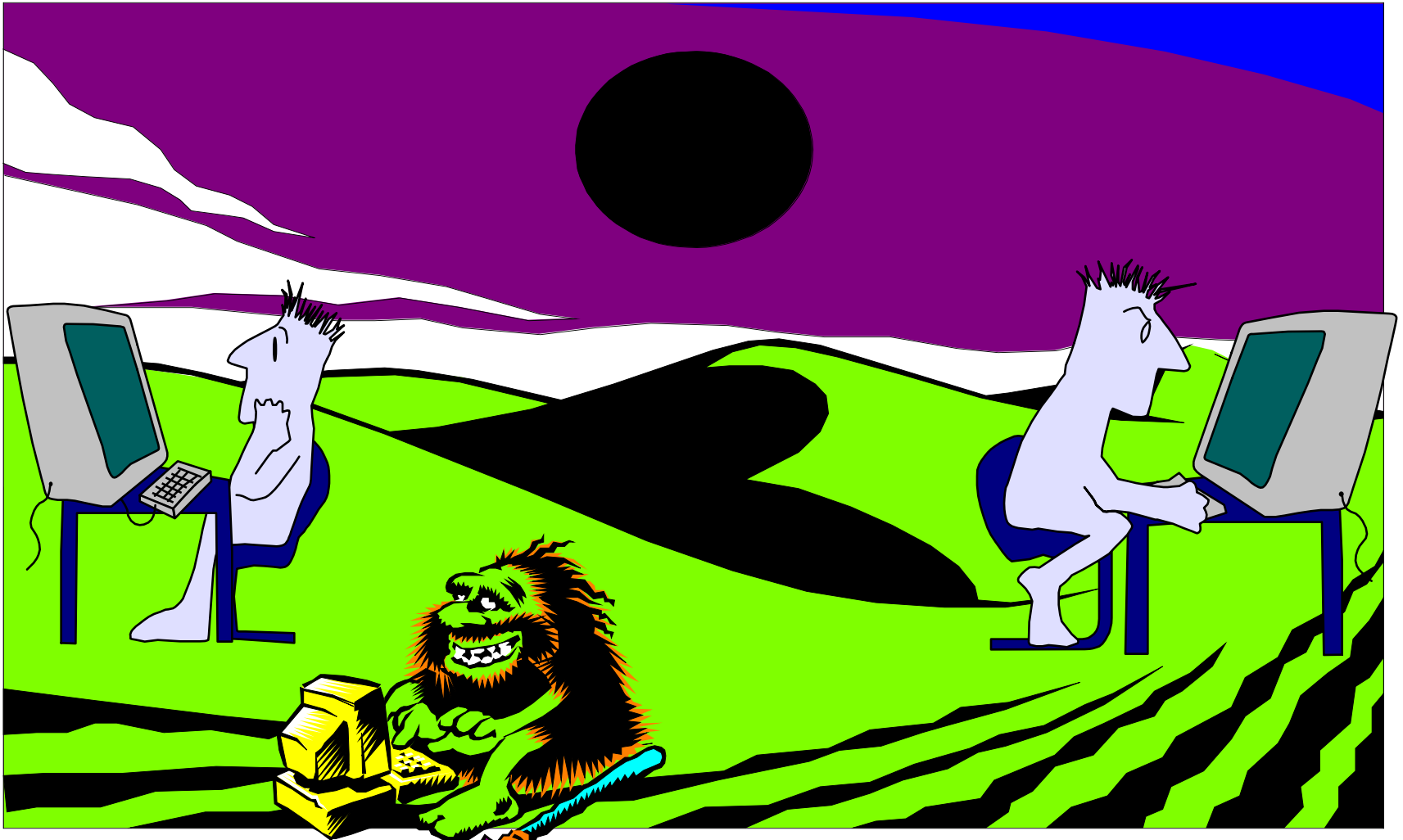
- ❑ Old: Smart = Can think \Rightarrow Computation
= Can Recall \Rightarrow Storage
- ❑ Now: Smart = Can find quickly, Can Delegate
 \Rightarrow Communicate = **Networking**
- ❑ Smart Grid, Smart Meters, Smart Cars, Smart homes, Smart Cities, Smart Factories, Smart Smoke Detectors, ...



Not-Smart

Smart

Cavemen of 2050



Internet of Harmful Things

Imagine, as researchers did recently at Black Hat, someone hacking your connected toilet, making it flush incessantly and closing the lid repeatedly and unexpectedly.



Ref: <http://www.computerworld.com/article/2486502/security0/worm-may-create-an-internet-of-harmful-things--says-symantec--take-note--amazon-.html>

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DEFCON 2015



DEFCON 2015 (Cont)

- ❑ Hacking a Linux rifle
- ❑ Hacking smart safes
- ❑ Wirelessly steal cars
- ❑ Hack a Tesla
- ❑ Hack ZigBee
- ❑ Hacking IoT baby monitors
- ❑ Hacking FitBit Aria
- ❑ Cracking crypto currency
- ❑ Hack out of home detention
- ❑ Insteon's false security
- ❑ Hacking RFID, NFC
- ❑ DARPA Cyber Grand Challenge **\$2M**



Ref: <https://www.ethicalhacker.net/features/opinions/first-timers-experience-black-hat-defcon>
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2. Security: Cyber Warfare

- ❑ Security of computers, companies, smart grid, and nations
- ❑ Nation States are penetrating other nations computers
5th domain of warfare (after land, sea, air, space)
- ❑ In 2010, US set up US Cyber Command
- ❑ UK, China, Russia, Israel, North Korea have similar centers
- ❑ Many cyber wars: North Korea vs. USA, Israel vs. Syria, South Korea vs. North Korea, India vs. Pakistan, ...



Old



New

Ref: http://en.wikipedia.org/wiki/Cyber_war

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3. Cloud Computing

- ❑ August 25, 2006: Amazon announced EC2
⇒ Birth of Cloud Computing in reality
(Prior theoretical concepts of computing as a utility)
\$10 B in 2016, a growth rate of 49% with 17% margins, much higher than the overall Amazon business



- ❑ Cloud Computing:
 - ❑ Applications through Internet (Google Docs)
 - ❑ Computing through Internet (Amazon EC3)
 - ❑ Storage and backup through Internet (iCloud, Google Drive)

4. Mobile/Wireless

- ❑ June 29, 2007: Apple announced iPhone
⇒ Birth of Mobile Internet, Mobile Apps
 - ❑ Almost all services are now mobile apps:
Google, Facebook, Bank of America, ...
- ❑ Wireless (WiFi) is ubiquitous (Intel Centrino)
- ❑ New Developments:
 - ❑ 5G: 1Gbps
 - ❑ Vehicular Networking



Goal of This Course

- ❑ First course in networking
- ❑ Fundamentals
- ❑ Broad coverage of key areas of networking
- ❑ Networking background for networking applications in other areas of computing
- ❑ This is a course on Networking Architecture
- ❑ This is not a course on network building or usage
- ❑ You will be able to understand protocols
- ❑ An example of the difference between architecture and implementation is the computer architecture course and a course on Intel Pentium Chip.
- ❑ This is the first course on networking.
- ❑ Basis for more advanced networking courses

What Will You Learn?

1. What messages and messages are exchanged when you fetch a web page?
2. What messages are used to send/receive emails?
3. How the names such as www.google.com gets translated to IP addresses such as 74.125.73.104?
4. What is done to avoid congestion under overload?
5. How is the path in the Internet determined?
6. What happens if bits in a packet get corrupted?
7. How WiFi or Ethernet works?
8. What is the difference between WiFi, Ethernet, IP, and TCP?
9. What is done to handle audio/video on the Internet?
10. How can you guarantee security on the Internet?

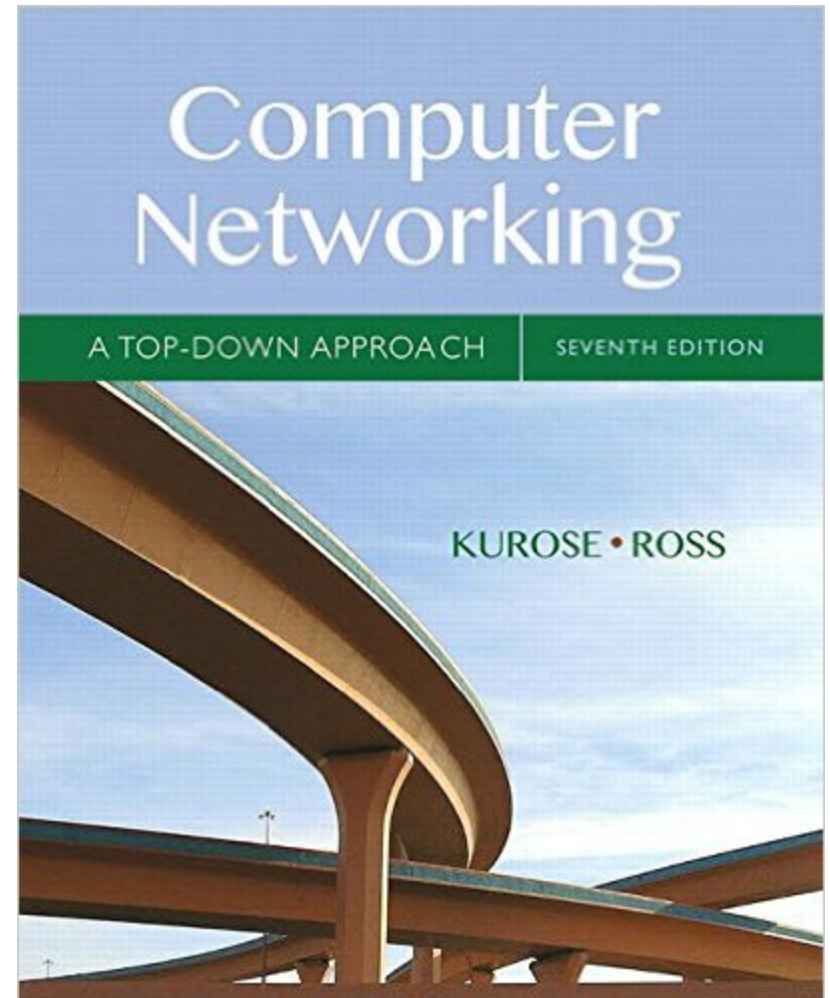
Networking Courses at WUSTL

1. **CSE 473: Introduction To Computer Networks** (every fall) – Prerequisite for all other networking classes
2. CSE 521S: Wireless Sensor Networks
3. CSE 537S: Mobile Computing
4. CSE 570S: Virtualization, Clouds, Big Data, SDN, IoT (Fall 2017)
5. **CSE 571S: Network Security** (Spring 2017)
6. ESE 572S: Signaling and Control in Communications Networks
7. **CSE 574S: Wireless and Mobile Networking** (Spring 2018)
8. CSE 577M: Design And Analysis of Switching Systems
9. CSE 7700: Research Seminar On Networking and Communications



Textbook

- ❑ J.F. Kurose and K.W. Ross, “Computer Networking” 7th Edition, Addison-Wesley, 2017, ISBN: 9780133594140 or 9780134296135, 864 pp. **Required.**
- ❑ Get the latest edition. Do not use older editions. If you use international edition, it should be dated later than 2016, should have 864 pages.



Textbook (Cont)

- ❑ It is recommended that you read the relevant chapter of the book chapter before coming to the class
⇒ Class time will be used for discussing and clarifying key concepts
- ❑ Only key concepts will be covered in the class.
You are expected to read the rest from the book.
- ❑ Please ask questions in the next class about any concepts that are not clear to you
- ❑ Material covered in the class will include some concepts from other textbooks. Please pay attention to the class lecture.

Prerequisite

- ❑ General knowledge of computer systems organization
 - ❑ Memory
 - ❑ System bus
 - ❑ Interrupt
 - ❑ CPU
 - ❑ Binary, decimal, hexadecimal representations
 - ❑ Bits, bytes
 - ❑ Storage: Memory and disk

- ❑ CSE 131: Computer Science I or equivalent

Tentative Schedule

Class	Date	Topic	Chapter
1	8/29/16	Course Overview	
2	8/31/16	Internet: Core and Edge, History (Part 1)	1
	9/5/16	<i>Labor Day Holiday</i>	
3	9/7/16	Internet: Core and Edge, History (Part 2)	1
4	9/12/16	Internet: Core and Edge, History (Part 3)	1
5	9/14/16	Application Layer (Part 1): HTTP, FTP	2
6	9/19/16	Application Layer (Part 2): SMTP, DNS	2
7	9/21/16	Application Layer (Part 3): P2P	2
		Transport Layer (Part 1): Design Issues	3
8	9/26/16	Transport Layer (Part 2): TCP	3
9	9/28/16	Transport Layer (Part 3): UDP	3
10	10/3/16	Transport Layer (Part 4): TCP Congestion Control	3
11	10/5/16	Mid-Term Exam 1	

Tentative Schedule (Cont)

Class	Date	Topic	Chapter
12	10/10/16	Exam 1 Review	3
13	10/12/16	Network Layer (Part 1): IP4	4
	10/17/16	<i>Fall Break</i>	4
14	10/19/16	Network Layer (Part 2): Routing Algorithms	4
15	10/24/16	Network Layer (Part 3): Routing Algorithms (Cont)	-
16	10/26/16	Network Layer (Part 4): Internet Routing Protocols: OSPF, RIP	4
17	10/31/16	Network Layer (Part 5): Internet Routing Protocols: BGP	4
18	11/2/16	The Link Layer and LANs: CSMA/CD	5
19	11/7/16	Mid-Term Exam 2	

Tentative Schedule (Cont)

Class	Date	Topic	Chapter
20	11/9/16	Exam 2 Review	
		The Link Layer and LANs (Part 2): Ethernet	5
21	11/14/16	The Link Layer and LANs (Part 3): VLANs	5
22	11/16/16	The Link Layer and LANs (Part 4): PPP and MPLS	5
		Wireless and Mobile Networks (Part 1): CDMA	6
23	11/21/16	Wireless and Mobile Networks (Part 2): WiFi	6
		Multimedia Networking	7
	11/23/16	<i>Thanksgiving Holiday</i>	
24	11/28/16	Security in Computer Networks: Cryptography	8
25	11/30/16	Network Management	9
26	12/5/16	Network Management (Part 2)	
28	12/7/16	Final Exam	

- **Note that the final exam is on December 7, 2016. The dates for all exams are fixed. No substitute exams.**

Exams

- ❑ There are two mid-terms and one final exam.
- ❑ All exams are 1 hour long. One note sheet of 8.5”x11” (both sides) is allowed along with a simple calculator (TI-30).
- ❑ Exams consist of numerical as well as multiple-choice (true-false) questions.
- ❑ There is a negative grading on incorrect multiple-choice questions. Grade: +1 for correct. $-1/(n-1)$ for incorrect.
- ❑ Everyone including the graduating seniors are graded the same way.
- ❑ Your grade depends upon the performance of the rest of the class.

Grading

- ❑ Mid-Term Exams (Best of 2) 30%
- ❑ Final Exam 30%
- ❑ Class participation 5%
- ❑ Homeworks 20%
- ❑ Labs 15%
- ❑ Academic integrity is expected in homeworks

Homework Submission

- ❑ All homeworks are due on the following Monday at the beginning of the class unless specified otherwise.
- ❑ Any late submissions, if allowed, will **always** have a penalty.
- ❑ All homeworks should be submitted in hardcopy unless specified otherwise
- ❑ All homeworks are identified by the class handout number.
- ❑ All homeworks should be on a separate sheet.
Your name should be on every page.
- ❑ Please write CSE473 in the subject field of all emails related to this course.
- ❑ Use word “Homework” in the subject field on emails related homework. Also indicate the homework number.

Homework 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 homework.
 - ❑ For Excel, set the print area and scale the page accordingly to fit to a page. (See Page Setup)

Quizzes

- There may be a short 5-minute quiz at the beginning of each class to check if you have read the topics covered in the last class.

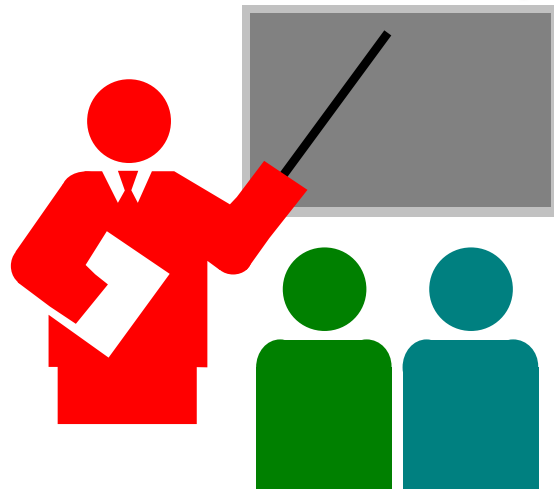
Office Hours

- ❑ Monday: 11:00AM to 12:00 noon
Wednesday: 11:00AM to 12:00noon
- ❑ Office: Jolly 208
- ❑ Teaching Assistants:
 - ❑ Han Wang, Wang.Han@wustl.edu
 - ❑ Eric Nicholson, nicholson@wustl.edu
 - ❑ Siddhant Sirohi, s.sirohi@wustl.edu
 - ❑ Steven Bosch, s.bosch@wustl.edu

Class Discussions

- ❑ We will use Piazza for class discussion.
- ❑ Find our class page at:
<https://piazza.com/wustl/fall2016/cse473/home>
- ❑ You can sign up at:
<https://piazza.com/wustl/fall2016/cse473>

Summary



- ❑ Computer networking is important for all areas of computing
- ❑ First course in computer networking
- ❑ Goal: To prepare you for a career in networking
- ❑ Get ready to work hard

Quiz 0: Prerequisites

True or False?

T F

1. Transmitting 100 bytes @ 800 bit/sec will take 1 sec.
2. A system with 32kB memory can hold only 16000 ASCII characters
3. A system with 2GB memory is same as that with 2GB disk.
4. Interrupts are used by CPU to stop an ongoing I/O.
5. Binary representation of 9 is 1001
6. 0A in Hexadecimal is 11 in decimal system.
7. For $I = A \sin(2\pi ft + \phi)$, the frequency is f .
8. 5 modulo 2 is 1
9. Two entries "P" and "Q" are pushed sequentially on a stack. A "pop" operation on the stack will produce P.
10. If x is 0, then after $x++$, x will be 1.

Marks = Correct Answers _____ - Incorrect Answers _____ = _____

Reading

- Read Chapter 1 of Kurose and Ross

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<http://rajjain.com>

Related Modules



Computer Networks and Internet,
http://www.cse.wustl.edu/~jain/cse473-16/ftp/i_1cni.pdf

CSE473S: Introduction to Computer Networks (Fall 2016),
<http://www.cse.wustl.edu/~jain/cse473-16/index.html>



Wireless and Mobile Networking (Spring 2016),
<http://www.cse.wustl.edu/~jain/cse574-16/index.html>

CSE571S: Network Security (Fall 2014),
<http://www.cse.wustl.edu/~jain/cse571-14/index.html>



Audio/Video Recordings and Podcasts of
Professor Raj Jain's Lectures,
<https://www.youtube.com/channel/UCN4-5wzNP9-ruOzQMs-8NUw>