



Date: 3rd Aug 2015

FIRST SEMESTER 2015-2016
COURSE HANDOUT (PART II)

In addition to Part I (General Handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

Course No.: CS G525
Course Title: Advanced Computer Networks
Instructor(s): **VIRENDRA S SHEKHAWAT**
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Note: This course is being offered in multi-campus mode (Pilani-Hyd) via Tele-Presence

Course Description:

This is a graduate level course on computer networking and assumes a student has a basic understanding of computer networks concepts. This course is a topics based course which primarily covers topics from Internet Architecture, Internet Congestion Control, Software Defined Networking, Delay Tolerant Networks, Wireless Networking, Quality of Service & Traffic Engineering, Network Performance & Management, Overlay Networks and Network Applications. Around 30 research papers/articles/case studies will be discussed on different aspects of computer networking. This course will introduce students to the basic design principles on which today's Internet is based upon along with the current and emerging research topics in computer networking area. In addition, this course will cover some recent proposals to improve network performance, functionality and scalability to meet emergent applications requirement.

Scope and Objectives:

- To understand the state of the art in network protocols, network architecture, and networked systems.
- To develop a strong understanding of the core concepts of computer networks
- To gain practice of reading the research papers and critically understanding the research of others
- To engage ourselves in networking research

Prescribed Text Book

There is no prescribed text book for this course. The course contents will be covered through several research papers. Students can consider following text books to refresh their basics on networking:





i) Kurose James F and Keith W. Ross: Computer Networking: A Top-Down Approach Featuring the Internet

ii) L. Peterson and B. Davie, Computer Networks: A Systems Approach

Note: Several technical papers/articles from the literature will be assigned throughout the semester. These papers/articles will be made available to the students through the course page.

Module No.	Topics	Learning Objectives
M1	Internet Design & Architecture: Overview of network building blocks, Network architecture, layers and protocols, Internet design: Challenges and Solutions	To understand the Internet Design Philosophy. Pitfalls in existing design and how future Internet design projects addresses these pitfalls.
M2	Traffic Management: Congestion control principles, TCP congestion control, IP routing: Intra-domain (OSPF/RIP) and Inter-domain (BGP), Adaptive Routing, Multipath and QoS Routing, Traffic Engineering Principles, MPLS Routing.	To understand the network traffic management mechanisms used in today's Internet. Different traffic engineering solutions and their limitations.
M3	Software Defined Networks (SDNs): SDN Controllers, Network Programmability, Network Function Virtualization, SDN Frameworks, Use cases for traffic monitoring & classification, bandwidth scheduling and monitoring.	To understand the network virtualization and it's functions virtualization using SDN. To learn how SDN enabled network makes difference w.r.t. traditional network.
M4	Delay Tolerant Networks (DTNs): Delay Tolerant Network Architecture, DTN Routing Protocols, DTN Application(s): Message Dissemination in Vehicular Networks, Adhoc Network for Disaster Rescue Management, Multimedia Content Delivery Network	To understand challenged/opportunistic networks and their limitations. To learn about modified network architecture which enables data transfers under delay and disruption. To learn how to leverage such networks to connect IP network for data transfer.
M5	Wireless Networks: Wireless Networks fundamentals, Mobile IP and Micromobility Protocols, TCP performance in Wireless Networks	To understand wireless networks & node mobility issues in IP network and solutions
M6	Overlay Network Applications: Overlay Network Applications & Protocols: P2P Networks, Content Distribution Networks (CDNs), Distributed searching systems, Resilient Overlay Networks, P2P Overlays for Delay Tolerant Networks	To learn about overlay architecture and it's uses in application domains like searching, content distribution, file sharing, real time content sharing, resilience routing, content caching etc.





Lecture Plan:

Lect. No.	Topics	Reading List
M1: Internet Design & Architecture		
0	Introduction to the course, Course plan and administration	Class Notes
1	Internet architecture and design principles	The Design Philosophy of The DARPA Internet Protocols [Clark 1988]
2-3	Internet Layering, Functionality Implementation (like Recovery from crashes, security, reliability etc.) at lower layers vs. Higher layers	End-to-End Argument in System Design [J H Saltzer 1984] A Brief History of The Internet [B Leiner 2009]
4-5	Next generation Internet design and challenges	Tussle in Cyberspace: Defining Tomorrow's Internet [Clark 2005] A Survey of the Research on Future Internet Architectures [Jianli Pan 2011]
6	Case Study of Future Internet Design Project: Named Data Networking (NDN)	NDN Project Technical Report [L Zhang 2010]
M2: Traffic Management		
7-8	Congestion Control Principles, TCP Congestion Control Models	Congestion Avoidance and Control [Jacobson 1988] Analysis of Increase and Decrease Algorithms for Congestion Avoidance in Computer Networks [Raj Jain 1989]
9	Load Balancing using Multipath TCP	How Hard Can It Be? Designing and Implementing a Deployable Multipath TCP [Raiciu 2012]
10-11	Internet Routing Basics, Interdomain Routing: Border Gateway Protocol (BGP)	BGP Routing Policies in ISP Networks [Caesar 2005] Some Foundational Problems in Interdomain Routing [Feamster 2004]
12-13	Internet Traffic Engineering (TE) as Route Optimization, TE Issues and Challenges: Robustness, TE Interactions, Interoperability	An overview of Routing Optimization for Internet Traffic Engineering [N Wang 2008]





	with Overlays	
14	Intradomain Routing: Protocols Characteristics and Limitations; Achieving QoS/Traffic Engineering with IP Routing Protocols	Traffic Engineering with Traditional IP Routing Protocols [Bernard 2002] Making Intra-Domain Routing Robust to Changing and Uncertain Traffic Demands: Understanding Fundamental Tradeoffs [David 2003]
M3: Software Defined Networks		
15	Software Defined Networking (SDN): Centralized and Distributed Control and Data Planes, SDN Architecture	Software Defined Networking: The New Norm of Networks, White Paper, [https://www.opennetworking.org 2012]
16	OpenFlow: Protocol to Program the Networks	OpenFlow: Enabling Innovation in Campus Networks [N Mckeown 2008]
17	SDN Controller: Framework to control and Manage Network, Case Study: Open Daylight Controller	Ten Things to Look for in an SDN Controller [https://www.necam.com]
18-19	SDN Applications: Network Function Virtualization, Network Topology Abstraction, Network Statistics, Traffic Monitoring, Bandwidth Scheduling	Class Notes
20	Is SDN provides sufficient abstraction to manage networks?	Fabric: A Retrospective on Evolving SDN [Casado 2012]
M4: Delay Tolerant Networks		
21-22	History of Delay Tolerant Networking (DTN), DTN Architecture, Bundle Protocol	A Delay-Tolerant Network Architecture for Challenged Internets [Kevin Fall 2003]
23-24	Routing in DTNs: Taxonomy and Design, Replication Based Routing Protocols, Open Issues and Challenges	Routing in a Delay Tolerant Network [Sushant Jain 2004] Routing in Delay/Disruption Tolerant Networks: A Taxonomy, Survey and Challenges [Yue Cao 2013]
25-26	Vehicular Networks as a case study of DTN: Message Dissemination in Vehicular Networks	Class Notes





M5: Wireless Networks		
27	Wireless Networking: An Overview	Class Notes
28-29	TCP Performance Issues in Wireless Links: Problems and Solutions	A Comparison of Mechanisms for Improving TCP Performance over Wireless Links [Balakrishanan 1996]
30-31	Network Centered IP Mobility Solutions	Mobility in IP Networks: From Link Layer to Application Layer Protocols and Architectures [T Johnson 2010]
M6: Overlay Networks Applications		
32	Overlay Networks: Advantages and Challenges, Resilient Overlay Networks (RON)	Resilient Overlay Networks [2001]
33	Lookup Problem in P2P Networks, Scalable P2P Lookup Service for Internet Applications, Chord Protocol	Chord: A Scalable Peer-to-peer Lookup Service for Internet Applications [Stoica 2001]
34-35	DNS and Naming System, DNS and CDN, HTTP and CDN Case Study: Akamai CDN	The Akamai Network: A Platform for High Performance Internet Applications [Nygren 2011]
36-37	An overlay approach to decouple sender and receiver to generalize the Multicast, Anycast and Mobility	Internet Indirection Infrastructure [Stoica 2002]
38-39	Mobile P2P Overlay Networks for DTNs: Challenges, Prophet Based Information Retrieval, Ad-hoc Storage Overlay System	Performance Evaluation of Content-Based Information Retrieval Schemes for DTNs [M.Chuah 2009] Ad-hoc Storage Overlay System (ASOS): A Delay-Tolerant Approach in MANETs [Yang 2006]
40	Review and Thanks Giving!!!	NA





Evaluation Scheme:

EC No.	Evaluation Component	Duration (hrs)	Weightage(%)	Date & Time	Nature of Component
1.	Mid Semester Test	1.5	25	7/10 10:00 - 11:30 AM	Close Book
2.	Term Project*	NA	30	NA	Open Book
3.	Comprehensive Examination	3	35	5/12 AN	Close Book
4.	Classroom Participation/Quizzes/Discussion Forum	NA	10	NA	Open Book

* Details will be discussed in the class.

Makeup Policy: Makeup for any component will be given only in genuine cases as per the CSIS department makeup policy guidelines. In all cases prior intimation must be given to the IC.

Chamber Consultation Hour (Pilani Campus) : T,Th:- 4:00 PM to 6:00 PM (RN. 6121R@ NAB)
(Hyderabad Campus) : Fri:- 10:00 to 12:00 noon (RN. B225)

Notices: Notices regarding the course will be displayed **ONLY** on the course page on LMS NALANDA.

Instructor-in-charge
CS G525

