

IT4405 – Computer Networks (Compulsory)

INTRODUCTION

This course provides a comprehensive insight into the fundamental concepts in data communications, computer network systems and protocols both fixed and mobile, on how to design simple networks and a review of emerging trends in the networking field. Computer Network security is not covered here.

CREDITS: 03

LEARNING OUTCOMES

After Successful completion of this course students will be able to

- Understand the principles that underlie data communications.
- Identify the different components and their respective roles in a communication system
- Propose efficient, cost effective, reliable and appropriate technology to establish communication links
- Design an enterprise network employing the common LAN technologies with access to service providers and be able to evaluate the advantages and disadvantages
- Describe the technical issues related to the Wide Area Networks and identify the common technologies available in the establishing WAN infrastructure
- Identify possible solutions for the transitions of network infrastructure from the IPv4 to IPv6
- Incorporate wireless and mobile networking technologies into existing networking infrastructure and enhance the network functionalities
- Understand the potential of software defined networks and the prepare for the next evolution in communication networks

MINOR MODIFICATIONS

When minor modifications are made to this syllabus, those will be reflected in the Virtual Learning Environment (VLE) and the latest version can be downloaded from the relevant course page of VLE. Please inform your suggestions and comments through the VLE. <http://vle.bit.lk>

ONLINE LEARNING MATERIALS AND ACTIVITIES

You can access all learning materials and this syllabus in the VLE: <http://vle.bit.lk> , if you are a registered student of BIT degree program. It is very important to participate in learning activities given in the VLE to learn this subject.

ONLINE ASSIGNMENTS

The assignments consist of two quizzes, assignment quiz 1 (it covers the first half of the syllabus) and assignment quiz 2 (it covers the second half of the syllabus). Maximum mark for a question is 10,

minimum mark for a question is 0 (irrespective of negative scores). Final assignment mark is calculated considering 40% of assignment quiz 1 and 60% of assignment quiz 2. Pass mark for the online assignments in a course is 50. You are advised to do online assignments before the final exam of the course. It is compulsory to pass all online assignments to partially qualify to obtain year 2 certificate.

FINAL EXAMINATION

Final exam of the course will be held at the end of the semester. Each course in the semester 4 is evaluated using a two hour question paper.

OUTLINE OF SYLLABUS

Topic	Hours
1. Data Transmission Concepts	07
2. Packet Network Architectures	08
3. Internet Protocol Suite	09
4. Local Area Networks	09
5. Mobile Wide Area Networks	05
6. Network Design	04
7. Miscellaneous topics	03
Total for the subject	45

REQUIRED MATERIALS

MAIN READING

Ref 1: William Stallings, Data and Computer Communications, 10th Edition (2013)

Ref 2: Computer Networking, A Top-Down Approach, James F. Kurose & Keith W. Ross, 6th edition (2012)

Ref 3: Teachers's note

SUPPLEMENTARY READING

Ref 4: Tanenbaum Andrew S., Computer Networks, 5th edition (2010)

Ref 5: Mobile Communications, Jochen Schiller, Second Edition, Addison Wesley, 2003

Ref 6: Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, 5th Edition (2011)

DETAILED SYLLABUS:

Topic 1: Data Transmission Concepts (7 hours)

Instructional Objectives

- Understand communication channel properties and the way they affect data transmissions
- Describe characteristics of different physical media
- Discuss how to select a suitable mix of transmission media for the implementation of a communication network solution
- Describe the concept and the use of multiplexing technologies for increasing the throughput
- Map a binary data stream to a digital signal using different encoding schemes
- Describe error control mechanisms and their application instances

Materials / Sub Topics

1.1 The Channel Model

- 1.1.1 Characterisation: source, channel, sink
- 1.1.2 Channel effects: noise, bandwidth, attenuation, distortion
- 1.1.3 Channel properties: data rate, simplex/duplex

- 1.1.4 Data rate limits in channels
- 1.1.5 Nyquist's theorem
- 1.1.6 Shannon's theorem

- 1.1.7 Transmission Media
- 1.1.8 Twisted pair cables
- 1.1.9 Co-axial cables
- 1.1.10 Fiber optic cables
- 1.1.11 Wireless media

1.2 Synchronization and Baseband encoding

- 1.2.1 Asynchronous transmission
- 1.2.2 Synchronous transmission
- 1.2.3 Encoding: NRZ, NRZI, 4B/5B and variants

1.3 Multiplexing

- 1.3.1 Frequency division multiplexing
- 1.3.2 Synchronous time division multiplexing
- 1.3.3 Statistical time division multiplexing

- 1.3.4 Error control methods
- 1.3.5 Error detection
- 1.3.6 Error correction

Topic 2: Packet Network Architectures (8 hours)

Instructional Objectives

- Describe the emergence and the evolution of data networks and the Internet
- Discuss the selection of suitable geometric layout for a network topology
- Outline the main features of different types of computer networks
- Discuss the concept of protocols, protocol layering and the need for a layered architecture
- Illustrate the role of each layer in the OSI model and in the process – process communication, services provided by each layer

Materials / Sub Topics

2.1 Packet switching

2.1.1 Introduction to packet switching

2.1.2 Circuit switching vs. packet switching

2.1.2.1 Types of services

2.1.2.2 Connection oriented services (virtual services)

2.1.2.3 Connectionless services (Datagram)

2.2 Network topologies: Bus, Star, Ring

2.3 Types of networks

2.3.1 Fixed vs. mobile networks

2.3.2 Local area networks

2.3.3 Wide area networks

2.3.4 Personal area networks

2.4 Layered Architecture

2.4.1 OSI model (The seven layer ISO OSI reference model)

2.4.2 IP model (The five layer Internet protocol stack)

Topic 3: Internet protocol suite (9 hours)

Instructional Objectives

- Describe the popular application layer protocols in the Internet
- Describe the role played by transport layer protocols such as TCP/IP
- Describe the Network Layer protocols and IP routing mechanisms
- Configure an IP address block into a given number of subnets
- Recognize the limitations of IP version 4 and the advantages of IP version 6
- Understand what QoS means and the mechanisms available to achieve QoS

Material / Sub Topics

3.1 Introduction

3.1.1 History of Internet protocols

3.1.2 Internet protocol stack

3.1.3 IP addressing and Routing (Version 4)

3.1.4 Subnetting : Fixed and variable length

- 3.1.5 Unicast Routing
- 3.1.6 Multicast Routing

- 3.2 Transport Layer protocols
 - 3.2.1 TCP
 - 3.2.2 UDP
- 3.3 IP support protocols
 - 3.3.1 ARP
 - 3.3.2 DHCP
 - 3.3.3 ICMP

- 3.4 Application Layer Protocols
 - 3.4.1 Domain Name System (DNS)
 - 3.4.2 Email – SMTP, POP, IMAP
 - 3.4.3 FTP
 - 3.4.4 HTTP

- 3.5 IP version 6
 - 3.5.1 IPv 6 datagram format
 - 3.5.2 Interoperability of IPv4 with IPv6

- 3.6 Quality of service
 - 3.6.1 VoIP, Multimedia over IP
 - 3.6.2 RTP and RTSP, Integrated and differentiated services

Topic 4: Local area networks (9 hours)

Instructional objectives

- Compare and contrast different LAN technologies as described by IEEE 802 LAN standards
- Describe the link layer protocols with an emphasis on collision detection and MAC addressing
- Describe the problem of channel allocation in the LAN segments and the solutions used
- Design a large Ethernet network using hubs and switches and to suggest the suitable devices to provide the connectivity to outside networks
- Describe wireless LAN techniques and protocols, and understand how wireless LAN MAC policies differ to those on wired LANS

Material / Sub Topics

- 4.1 Introduction to LANs
- 4.2 Conventional LAN Architectures
 - 4.2.1 Access protocols: CSMA/CD, Token passing
 - 4.2.2 Interconnecting devices: Hubs, L2/ L3 Switches
- 4.3 IEEE 802 MAC layer standards: 802.3, 802.11, 802.15
- 4.4 Switched Ethernet variants: Fast Ethernet, Gigabit Ethernet, 10Gb Ethernet
- 4.5 Wireless LANs: (802.11)

- 4.5.1 Access methods: CSMA/CA
- 4.5.2 Frequency Bands: ISM
- 4.5.3 Operating Modes: adhoc, managed
- 4.5.4 Variants: 802.11 a/b/ g/ n
- 4.5.5 Wireless interconnection devices: Hub, Router
- 4.5.6 Bluetooth (802.15) wireless personal area network

Topic 5: Mobile Wide area Networks (5 hours)

Instructional Objectives

- Identify the ways in which wireless networks differ from wired wide area networks, and their consequences for data communication
- Identify the wide area wireless network categories, approaches for handling mobility in a IP environment
- Discuss the CDMA technology in wireless networks
- Introduce Mobile IP and mobility management between networks

Materials / Sub topics

- 5.1 Introduction to Wireless networks
- 5.2 Infrastructure based and ad hoc mode networking in wireless networks
- 5.3 Wireless signal propagation and its impairments
 - 5.3.1 Multipath propagation, Diffraction, Reflection, Path loss
- 5.4 CDMA
- 5.5 Mobility in Wide area networks
 - 5.5.1 Mobility within the same IP subnet
 - 5.5.2 Various degrees of mobility from the point of view of Network layer
 - 5.5.3 Mobile IP
 - 5.5.4 Mobile Adhoc Networks and MANET Routing
 - 5.5.5 Wireless mobility and its impact on higher layers of the network
- 5.6 Broadband wireless (802.16)

Topic 6: Network Design (4 hours)

Instructional objectives

- Understand the options available for a network designer in designing an end to end solution
- Understand the concept of virtual LANs, virtual private networks

Materials / Sub topics

- 6.1 Structured cabling standards: CAT5, CAT5e etc.,
- 6.2 Virtual LANs provisioning on switched networks
- 6.3 Virtual Private Networks service provision by service providers
- 6.4 IP NAT and proxy provision
- 6.5 Last mile access solutions (e.g., xDSL, FTTH)

Topic 7: Miscellaneous topics (3 hours)

Reading material: Teacher will provide lecture notes and may suggest further readings

Instructional Objectives

- To ensure awareness of fundamental shifts in networking concepts that is taking place such as software defined networks for their programmable network approach
- To ensure awareness of networking concepts used in new applications such as ubiquitous computing and fault tolerant content delivery

Materials / Sub topics

- 7.1 Content Distribution Networks
 - 7.1.1 Peer to peer networks
 - 7.1.2 Opportunistic networks
- 7.2 Software defined networks (SDN)
 - 7.2.1 History and evolution
 - 7.2.2 Programmable networks
 - 7.2.3 Network virtualization
- 7.3 Internet of Things