

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: Teacher'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 – **Ref 2:** Page 229
 - 1.1.1 Characterisation: source, channel, sink – **Ref 2:** Page 21 , **Ref 4:** Page 258,365,381
 - 1.1.2 Channel effects: noise, bandwidth, attenuation, distortion – **Ref 2:** Page 519,29,20 , **Ref 4:** Page 94,62,90,52,102
 - 1.1.3 Channel properties: data rate, simplex/duplex – **Ref 2:** Page 292,470,205,232 , **Ref 4:** Page 85,93,94, 220,221,222,97,169
 - 1.1.4 Data rate limits in channels – **Ref 2:** Page 13,15 , **Ref 4:** Page 94
 - 1.1.5 Nyquist's theorem – **Ref 4:** Page 94
 - 1.1.6 Shannon's theorem – **Ref 2:** Page 80 , **Ref 4:** Page 94,95
 - 1.1.7 Transmission Media – **Ref 2:** Page 19 , **Ref 4:** Page 95
 - 1.1.8 Twisted pair cables – **Ref 2:** Page 19 , **Ref 4:** Page 96
 - 1.1.9 Co-axial cables – **Ref 2:** Page 20 , **Ref 4:** Page 97
 - 1.1.10 Fiber optic cables – **Ref 2:** Page 20 , **Ref 4:** Page 99
 - 1.1.11 Wireless media – **Ref 2:** Page 17,513 , **Ref 4:** Page 10,13,18,70
- 1.2 Synchronization and Baseband encoding – **Ref 2:** Page 125,126
 - 1.2.1 Asynchronous transmission – **Ref 4:** Page 249,325
 - 1.2.2 Synchronous transmission – **Ref 4:** Page 156,157
 - 1.2.3 Encoding: NRZ, NRZI, 4B/5B and variants – **Ref 4:** Page 125,126,127,128,129
- 1.3 Multiplexing – **Ref 2:** Page 191-202 , **Ref 4:** Page 125,132,135,152,527
 - 1.3.1 Frequency division multiplexing – **Ref 4:** Page 132-134
 - 1.3.2 Synchronous time division multiplexing – **Ref 4:** Page 135,154,185,259,324
 - 1.3.3 Statistical time division multiplexing – **Ref 4:** Page 135,154,185,259,324
 - 1.3.4 Error control methods – **Ref 2:** Page 291,292 , **Ref 4:** Page 202
 - 1.3.5 Error detection – **Ref 2:** Page 437 , **Ref 4:** Page 209
 - 1.3.6 Error correction – **Ref 2:** Page 431,437,442,618 , **Ref 4:** Page 204

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 – **Ref 2:** Page 22,60 , **Ref 4:** Page 162-168,356
 - 2.1.1 Introduction to packet switching – **Ref 2:** Page 22 **Ref 4:** Page 356
 - 2.1.2 Circuit switching vs. packet switching – **Ref 2:** Page 30 , **Ref 4:** Page 162
 - 2.1.2.1 Types of services – **Ref 4:** Page 356
 - 2.1.2.2 Connection oriented services (virtual services) – **Ref 4:** Page 356
 - 2.1.2.3 Connectionless services (Datagram) – **Ref 4:** Page 356
- 2.2 Network topologies: Bus, Star, Ring – **Ref 2:** Page 470,475,492
- 2.3 Types of networks – **Ref 2:** Page 494,515,669
 - 2.3.1 Fixed vs. mobile networks – **Ref 2:** Page
 - 2.3.2 Local area networks – **Ref 4:** Page 19
 - 2.3.3 Wide area networks – **Ref 4:** Page 23
 - 2.3.4 Personal area networks – **Ref 4:** Page 18
- 2.4 Layered Architecture – **Ref 2:** Page 47
 - 2.4.1 OSI model (The seven layer ISO OSI reference model) – **Ref 2:** Page 52 , **Ref 4:** Page 41,51
 - 2.4.2 IP model (The five layer Internet protocol stack) – **Ref 4:** Page 41-46

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 version6
- Understand what QoS means and the mechanisms available to achieve QoS

Material / Sub Topics

- 3.1 Introduction – **Ref 2:** Page 53
 - 3.1.1 History of Internet protocols – **Ref 2:** Page 63
 - 3.1.2 Internet protocol stack – **Ref 2:** Page 50
 - 3.1.3 IP addressing and Routing (Version 4) – **Ref 2:** Page 487

- 3.1.4 Subnetting : Fixed and variable length – **Ref 4:** Page 444,445,446,447
- 3.1.5 Unicast Routing – **Ref 2:** Page 400,402,404,410,412
- 3.1.6 Multicast Routing – **Ref 2:** Page 409 , **Ref 4:** Page 382

- 3.2 Transport Layer protocols – **Ref 2:** Page 185
 - 3.2.1 TCP – **Ref 2:** Page 51,57,62,163,230,252,269,301,711 , **Ref 4:** Page 552
 - 3.2.2 UDP – **Ref 2:** Page 51,62,93157,198,301 , **Ref 4:** Page 541
- 3.3 IP support protocols – **Ref 2:** Page 5 , **Ref 4:** Page 465
 - 3.3.1 ARP – **Ref 2:** Page 462,497,510 , **Ref 4:** Page 465,467-469
 - 3.3.2 DHCP – **Ref 2:** Page 345-350,495,510 , **Ref 4:** Page 465,470
 - 3.3.3 ICMP – **Ref 2:** Page 353,430 , **Ref 4:** Page 465-467

- 3.4 Application Layer Protocols – **Ref 2:** Page 96
 - 3.4.1 Domain Name System (DNS) – **Ref 2:** Page 131 , **Ref 4:** Page 611
 - 3.4.2 Email – SMTP, POP, IMAP – **Ref 4:** Page 638,644 , **Ref 2:** Page 121,127,129
 - 3.4.3 FTP – **Ref 2:** Page 116 , **Ref 2:** Page 455,554
 - 3.4.4 HTTP – **Ref 2:** Page 98,124,181,499,596 , **Ref 4:** Page 683

- 3.5 IP version 6 – **Ref 2:** Page 356 , **Ref 4:** Page 455
 - 3.5.1 IPv 6 datagram format – **Ref 2:** Page 356 , **Ref 4:** Page 455
 - 3.5.2 Interoperability of IPv4 with IPv6 – **Ref 2:** Page , **Ref 4:** Page 455

- 3.6 Quality of service – **Ref 2:** Page 652 , **Ref 4:** Page 404
 - 3.6.1 VoIP, Multimedia over IP – **Ref 2:** Page 612 , **Ref 4:** Page 308
 - 3.6.2 RTP and RTSP, Integrated and differentiated services – **Ref 2:** Page 624,595,666 , **Ref 4:** Page 546

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 – **Ref 2:** Page 433,526,726 , **Ref 4:** Page 19-23,70,277,299,342
- 4.2 Conventional LAN Architectures – **Ref 2:** Page 527
 - 4.2.1 Access protocols: CSMA/CD, Token passing – **Ref 2:** Page 450-459 **Ref 4:** Page 268-270,285,286
 - 4.2.2 Interconnecting devices: Hubs, L2/ L3 Switches – **Ref 4:** Page 340

- 4.3 IEEE 802 MAC layer standards: 802.3, 802.11, 802.15 – **Ref 2:** Page 474,532,540 , **Ref 4:** Page 280-283,70,299
- 4.4 Switched Ethernet variants: Fast Ethernet, Gigabit Ethernet, 10Gb Ethernet – **Ref 4:** Page 288-290
- 4.5 Wireless LANs: (802.11) – **Ref 2:** Page 526 , **Ref 4:** Page 70
 - 4.5.1 Access methods: CSMA/CA – **Ref 2:** Page 526,531 , **Ref 4:** Page 303,304,306,308,309
 - 4.5.2 Frequency Bands: ISM – **Ref 2:** Page 548-550 , **Ref 4:** Page 112,114
 - 4.5.3 Operating Modes: adhoc, managed – **Ref 2:** Page 512,517,526,528 , **Ref 4:** Page 70,71,299,300, 389
 - 4.5.4 Variants: 802.11 a/b/ g/ n – **Ref 4:** Page 300,326,373
 - 4.5.5 Wireless interconnection devices: Hub, Router – **Ref 4:** Page 340
 - 4.5.6 Bluetooth (802.15) wireless personal area network – **Ref 2:** Page 544,545

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 – **Ref 2:** Page 514,519,726 , **Ref 4:** Page 105,277,299,312,539
- 5.2 Infrastructure based and ad hoc mode networking in wireless networks – **Ref 2:** Page 516,517
- 5.3 Wireless signal propagation and its impairments – **Ref 2:** Page 520,585
 - 5.3.1 Multipath propagation, Diffraction, Reflection, Path loss – **Ref 2:** Page 21,519,
- 5.4 CDMA – **Ref 2:** Page 522 , **Ref 4:** Page 135,136,175-178
- 5.5 Mobility in Wide area networks – **Ref 2:** Page 541, 555,570,575
 - 5.5.1 Mobility within the same IP subnet – **Ref 2:** Page 541
 - 5.5.2 Various degrees of mobility from the point of view of Network layer – **Ref 2:** Page
 - 5.5.3 Mobile IP – **Ref 2:** Page 564 , **Ref 4:** Page 485
 - 5.5.4 Mobile Adhoc Networks and MANET Routing – **Ref 2:** Page 518,556 , **Ref 4:** Page 389
 - 5.5.5 Wireless mobility and its impact on higher layers of the network – **Ref 2:** Page 575
- 5.6 Broadband wireless (802.16) – **Ref 4:** Page 312,313

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., – **Ref 4:** Page 96, 97

6.2 Virtual LANs provisioning on switched networks – **Ref 4:** Page 332,342

6.3 Virtual Private Networks service provision by service providers – **Ref 2:** Page 718 , **Ref 4:** Page 821

6.4 IP NAT and proxy provision –

6.5 Last mile access solutions (e.g., xDSL, FTTH) – **Ref 2:** Page 15,16 , **Ref 4:** Page 147,151

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 – **Ref 2:** Page 602

7.1.1 Peer to peer networks – **Ref 4:** Page 748

7.1.2 Opportunistic networks –

7.2 Software defined networks (SDN) – **Ref 2:** Page 786,787

7.2.1 History and evolution –

7.2.2 Programmable networks –

7.2.3 Network virtualization – **Ref 2:** Page 486

7.3 Internet of Things –