

## **IT4503 Data Communication and Networks (Optional)**

### **INTRODUCTION**

This is one of the optional courses designed for Semester 4 of the Bachelor of Information Technology Degree program. This course on Data Communication and Networks is an introduction to the fundamental concepts on data communication and design, deployment, and management of computer networks.

**CREDITS: 04**

### **LEARNING OUTCOMES**

After successful completion of this course students will be able to:

- Identify the different components and their respective roles in a communication system
- Propose efficient, cost effective, reliable and available technology to establish communication links
- Design an enterprise network employing the common LAN technologies and be able to evaluate the advantages and disadvantages
- Configure a PC to work as a host in a TCP/IP network and to use the IP based commands to facilitate the trouble shooting process
- Describe the technical issues related to the Wide Area Networks and identify the common technologies available in establishing WAN infrastructure
- Describe the specific role of a network management system

### **OUTLINE OF SYLLABUS**

<b>Topic</b>	<b>Hours</b>
1- Fundamentals of digital communications	03
2- Physical layer characterization	08
3- Data transmission mechanisms	10
4- Data coding for error recovery and compression	06
5- Network architectures	04

6- Internet Protocols	12
7- Local Area Networks	12
8- Introduction to Network Monitoring and Management	05
Lectures	30
Learning activities	30
<b>Total for the subject</b>	<b>60</b>

### **SYNOPSIS/OVERVIEW**

This course introduces the fundamental concepts of data communication and networks. The learner is provided with the theoretical frameworks to understand the issues related to data communication and design and deployment of networks. The course covers topics in a wide range from the signal analysis to the network management. The topics are selected to give the students the skills needed to analyze and describe the issues related to data communication at different levels of details; from the level of electrical signals to the application level issues. Students are also introduced to the techniques used to manage computer networks and secure them.

### **PEDAGOGICAL FRAMEWORK**

The main pedagogical framework of the course focuses on activity based learning. Students are supposed to do all the learning activities to cover the learning content.

### **EXPECTATIONS/EXAMINATIONS/REQUIREMENTS**

The learners are expected to analyze and solve problems related to data communication and networks. The ability to propose a networking solution for a given scenario is an essential skill that the learners must acquire by following this course. Set of questions are provided to the learner at the end of the content of each chapter and two assignments are provided one at the end of the first half of the syllabus and the other at the end of the full syllabus. Marks for the activities and quizzes are not counted but marks for the assignments are tracked

by the LMS and a pass grade is issued. Obtaining pass grades for the two assignments and Final Exam are mandatory for the completion of Semester 4.

## **REQUIRED MATERIALS**

### **Main Reading**

**Ref 1:** Tanenbaum Andrew S., Computer Networks, 4<sup>th</sup> edition  
(2<sup>nd</sup> Impression 2006)

**Ref 2:** Halsall Fred, Data Communications, Computer Networks and OSI, 4<sup>th</sup> edition  
(10<sup>th</sup> Indian reprinting 2005)

**Ref 3:** William Stallings, Data and Computer Communications, 7th Edition  
(3<sup>rd</sup> Impression 2007)

**Ref 4:** Teacher's note

### **Supplementary Reading**

**Ref 5:** Comer Douglas E, Internetworking with TCP/IP, Volume 1-Principles,  
Protocols and Architecture, 4th edition, 2002, Prentice-Hall

## **DETAILED SYLLABUS:**

### **Section 1: Fundamentals of digital communications (3hrs)**

#### **Instructional Objectives**

- Describe the basic concept of communications and the electronic implementation of communications
- Identify the characteristics and the analyze the signals

#### **Material /Sub Topics**

- 1.1. Introduction to digital communications [Ref 3: pg.72-77]
  - 1.1.1. Definitions of terms
  - 1.1.2. Signal propagation
  - 1.1.3. Sine waves
  - 1.1.4. Square waves
  - 1.1.5. Amplitude
  - 1.1.6. Frequency
  - 1.1.7. Phase

## 1.2. Channel Effects on transmission

[Ref 1: pg.85-90]/ [Ref 2: pg.48-56] / [Ref 3: pg.93-103]

### 1.2.1. Frequency spectra and Fourier analysis

### 1.2.2. Attenuation

### 1.2.3. Limited Bandwidth

### 1.2.4. Delay Distortion

### 1.2.5. Noise

### 1.2.6 Data rate in Channels

#### 1.2.6.1. Nyquist's Theorem

#### 1.2.6.2. Shannon's Theorem

## **Section 2: Physical layer characterization (8 hrs)**

### **Instructional Objectives**

- Describe the different types of signals
- Describe how digital data can be transmitted using analog transmission facilities
- Map a binary pattern into a signal encoded using different encoding schemes
- Select a suitable transmission medium/media for the implementation of a communication network
- Recognize the constraints related to the practical usage of transmission media
- Recognize the pin configurations of the interfaces and cables

### **Material /Sub Topics**

#### 2.1. Modulation

[Ref 1: pg.125-130] / [Ref 2: pg.74-83] / [Ref 3: pg.146-182]

##### 2.1.1. Analog Modulation: Amplitude, Frequency, Phase

##### 2.1.2. Digital Modulation: PSK, QPSK, QAM

#### 2.2. Data Encoding

[Ref 1: pg.274-275] / [Ref 2: pg.128-130] / [Ref 3: pg.146-157]

##### 2.2.1 Binary Encoding (RTZ, NRZ)

##### 2.2.2 Manchester Encoding

##### 2.2.3 Differential Manchester Encoding

### 2.3. Transmission Media

[Ref 1: pg.90-118] / [Ref 2: pg.41-48] / [Ref 3: pg.110-140]

#### 2.3.1 Twisted Pair Cables

#### 2.3.2 Co-axial Cables

#### 2.3.3 Fiber Optic Cables

#### 2.3.4 Wireless Media

### 2.4. Physical Layer Interfaces

[Ref 2: pg.61] / [Ref 2: pg.97-105] / [Ref 3: pg.209-217]

#### 2.4.1 RS 232 / EIA 232

### 2.5. Last Mile Access Technologies

[Ref 1: pg.166-169] / [Ref 1: pg.709-711] / [Ref 1: pg.130-134]

#### 2.5.1 Wired: xDSL, FTTH

#### 2.5.2 Wireless: GPRS, EDGE, HSPDA

## **Section 3: Data transmission mechanisms (10 hrs)**

### **Instructional Objectives**

- Describe the design issues related to data transfer
- Identify the problem of flow control and describe available solutions
- Compare and contrast the circuit and packet switching technologies
- Identify the connectivity facilities made available by the public carriers
- Describe the concept and the use of multiplexing technologies

### **Material /Sub Topics**

#### 3.1. Communication Modes [Ref 1: pg.129] / [Ref 2: pg.117] / [Ref 3: pg.73]

##### 3.1.1 Simplex

##### 3.1.2 Half-duplex

##### 3.1.3 Full-duplex

#### 3.2. Transmission Modes [Ref 2: pg.115-117] / [Ref 2: pg.21]

##### 3.2.1 Serial Transmission

##### 3.2.2 Parallel Transmission

#### 3.3. Synchronization

[Ref 2: pg.123-141] / [Ref 3: pg.188-192]

##### 3.3.1 Asynchronous transmission

##### 3.3.2 Synchronous Transmission

### 3.4. Switched Communications

[Ref 1: pg.146-151]/ [Ref 1: pg.343-350] / [Ref 3: pg.314-348]

3.4.1 Delay and error sensitivities of data and real time traffic

3.4.2 Circuit switching (PSTN)

3.4.3 Packet Switching

3.4.3.1 Datagram mode

3.4.3.2 Virtual Circuit mode

3.4.4 Integrated switching (ISDN)

3.5. Type of Services [Ref 1: pg.32-33] / [Ref 2: pg.503]

3.5.1 Connection Oriented Services

3.5.2 Connectionless Services

3.6. Flow Control

[Ref 1: pg.200-223]/ [Ref 2: pg.214-216] / [Ref 3: pg.225-231]

3.6.1 Stop-and-Wait Protocol

3.6.2 Sliding Window Protocol

3.7. Multiplexing [Ref 1: pg.137-143]/

[Ref 2: pg.88-92] / [Ref 3: pg.259-287]

3.7.1 Frequency Division Multiplexing

3.7.2 Synchronous Time Division Multiplexing

3.7.3 Statistical Time Division Multiplexing

## **Section 4: Data coding for error recovery and compression (6 hrs)**

### **Instructional Objectives**

- Describe the different types of errors that affects data transmission
- Describe error detection and correction methods
- Propose suitable error detection/correction algorithms to a given situation and justify their use
- Describe the advantages of data compression and try out the mechanisms available

### **Material /Sub Topics**

4.1. Transmission Errors [Ref 2: pg.141-142]

4.2. Error Control [Ref 1: pg.191-192] / [Ref 2: pg.141-142]

4.2.1 Feedback Error Recovery : ARQ

4.2.2 Forward Error Correction

- 4.3. Error Detection and Correction[Ref 1: pg.192-200] / [Ref 2: pg.141-153]
  - 4.3.1 Simple Parity Check
  - 4.3.2 Block Sum Check
  - 4.3.3 Hamming Codes
  - 4.3.4 Cyclic Redundancy Check
- 4.4. Lossless Data Compression [Ref 2: pg.153-165]
  - 4.5.1 LZW
  - 4.5.2 Huffman Encoding

## **Section 5: Network Architectures (4 hrs)**

### **Instructional Objectives**

- Describe the advantages of a layered architecture
- Illustrate the roles of each layer in the OSI model when two hosts are in the process of communication
- Give a description of the emergence and the evolution of computer networks
- Discuss the selection of suitable geometric layout for a network based on the standard topologies
- Outline the features of the different types of computer networks

### **Material /Sub Topics**

- 5.1. Introduction to Computer Networks[Ref 1: pg.1-80]
- 5.2. Network Topologies: Bus, Star, Ring  
[Ref 1: pg.16-17]/ [Ref 2: pg.288-291]
- 5.3. Types of Networks [Ref 1: pg.15-21] / [Ref 2: pg.21-26] /  
[Ref 2: pg.287-288] / [Ref 2: pg.499-502]
  - 5.3.1 Local Area Networks
  - 5.3.2 Wide Area Networks
  - 5.3.3 Personal Area Networks
- 5.4. Layered Network Model  
[Ref 1: pg.37-49] / [Ref 2: pg.29-37] / [Ref 3: pg.36-63]
  - 5.4.1 OSI model
  - 5.4.2 TCP/ IP model

**Section 6: Internet Protocols (12 hrs)****Instructional Objectives**

- Give a description of the TCP/IP protocol suite including the roles of major protocols
- Able to configure an IP address block into a given number of subnets
- Use the IP based diagnostic commands to support troubleshooting in IP networks
- Describe the IP routing mechanisms (unicast and multicast) and their algorithmic basis
- Describe the popular application layer protocols in the Internet
- Recognize the limitations of IP version 4 and the advantages of IP version 6

## 6.1 Introduction [Ref 1: pg.41-44]/ [Ref 1: pg.524-526]

## 6.1.1 History of Internet Protocols

## 6.1.2 Internet Protocol stack

## 6.2 IP Addressing and Routing (Version 4)

[Ref 1: pg.433-448]/ [Ref 1: pg.350-366]/ [Ref 1: pg.370-372]/

[Ref 1: pg.454-462, 711-714]

[Ref 2: pg.511-523]/ [Ref 3: pg.633-653]

## 6.2.1 IP address classes / CIDR

## 6.2.2 Subnetting :Fixed and variable length

## 6.2.3 Unicast routing algorithms :RIP , OSPF

## 6.2.4 IP multicasting

## 6.3 Transport Layer protocols

[Ref 1: pg.524-555] / [Ref 2: pg.657-672] / [Ref 3: pg.699-718]

## 6.3.1 TCP

## 6.3.2 UDP

## 6.4 IP Support Protocols

[Ref 1: pg.449-454] / [Ref 2: pg.523-526] / [Ref 2: pg.531-534]

## 6.4.1 ARP

## 6.4.2 DHCP

## 6.4.3 ICMP

- 6.5 Application Layer Protocols [Ref 1: pg.579-660] / [Ref 2: pg.830-836] /  
[Ref 2: pg.773-785] / [Ref 3: pg.762-791]
- 6.5.1 Domain Name System (DNS)
- 6.5.2 Email – SMTP, POP, IMAP
- 6.5.3 FTP
- 6.5.4 HTTP
- 6.5.5 RTP and Vo IP
- 6.6 Overview of IP version 6 [Ref 1: pg.464-473] / [Ref 2: pg.534-536]

## **Section 7: Local Area Networks (12 hrs)**

### **Instructional Objectives**

- Compare and contrast different LAN technologies such as IEEE 802 LAN standards
- 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 the other outside networks
- Describe the problems associated in deploying a wireless LAN and propose solutions

- 7.1 Introduction to LANs [Ref 1: pg.16-17]/ [Ref 3: pg.482-485]
- 7.2 LAN Architectures [Ref 1: pg.248-258]/ [Ref 1: pg.276-306]/  
[Ref 1: pg.310-317]/ [Ref 1: pg.162-166]/ [Ref 1: pg.322-328]/  
[Ref 3: pg.518-536]
- 7.2.1 Channel Access Methods : Aloha, CSMA, CSMA/CD, CSMA/CA, MACA, CDMA, Token Passing
- 7.2.2 IEEE 802 standards :802.3 , 802.11 ,802.15
- 7.2.3 Switch Ethernet :Fast Ethernet, Gigabit Ethernet, 10Gb Ethernet
- 7.2.4 Wireless LANs: 802.11 [Ref 1: pg.267-270,292-302]
- 7.2.4.1 Frequency Bands (ISM)
- 7.2.4.2 Operating Modes: adhoc Managed
- 7.2.4.3 Variants: 802.11 a/ b/ g/ n
- 7.3 LAN interconnecting devices: Hubs, L2 /L3 Switch,  
Wireless Access Point, Router

**Section 8: Introduction to Network Monitoring and Management (5 hrs)****Instructional Objectives**

- Describe how remote monitoring works
- Describe the concepts of class of service and quality of service
- Identify the techniques of securing a private network

## 8.1 Remote Monitoring Techniques [Ref 2: pg.785-789]/ [Ref 3: pg.791-801]

## 8.1.1 Polling

## 8.1.2 Traps

## 8.1.3 SNMP and MIBs

## 8.2 Security management

[Ref 1: pg.328-336]/ [Ref 1: pg.657-659]/ [Ref 1: pg.776-785]

## 8.2.1 Firewalls and NAT

## 8.2.2 VLANs, VPNs

**8.2.3** Proxy Servers**8.2.4** Wireless security

## 8.3 Performance Management [Ref 1. pg.397-417]

## 8.3.1 Quality of Service over IP

## 8.3.2 Service Level Managements

**Activities -**

Please refer to the activities on the e-learning material in your Learning Management System (LMS).

**Assessment -**

You will get two online assignments as Assignment Quiz 1 and Assignment Quiz 2. The final exam will be conducted at the end of this course.

Examination Paper will consist of two parts.

- Part 1: 1 Hour paper consisting of Multiple Choice Question (25<MCQ<30)
- Part 2: 1 Hour paper consisting of Structured Questions (3 Questions)

**Contact details -**

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