



College of Business and Economics

**School of Consumer Intelligence and
Information Systems**

**Department of Applied Information
Systems**

Learning Guide

**Communication Networks 2A
CMN02A1**

Bongisizwe Buthelezi

2022 (Semester 1)

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1 Introduction

1.1 Welcome

Welcome to the CMN02A1 (Communication Networks 2A) semester module for Semester 1, 2022. This learning guide is designed to assist you through this course and will guide you with preparation for classes and assessments.

The aim of this module is to introduce the student to IT infrastructure with computer networks, with a particular emphasis on the Internet and on the TCP/IP protocol suite. Mapping of the TCP/IP stack to the ISO OSI Model will be also discussed.

Please note that Module A and B are independent modules, therefore you must pass all modules with 50% to pass the overall Development Software subject. An integrated teaching and learning approach is followed in this module. This means that learning is facilitated by more than one support resource, e.g., textbook, face-to-face contact with tutors, lectures, Blackboard, this learning guide and any other additional reference material – each of which is complementary to the other.

1.2 School Information

School Name	School of Consumer Intelligence and Information Systems
Director	Mercy Mpinganjira
School Secretary	Fareea Dangor
Contact Details	+27 (0) 11 559 3200 C Ring 601 Auckland Park Kingsway Campus

Table 1: School Information

1.3 Department Information

Department Name	Applied Information Systems
Head of Department	Stella Bvuma
Department Secretary	Martha Winter
Contact Details	+27 (0) 11 559 1139 G Purple 4 Auckland Park Bunting Road Campus

Table 2: Department Information

1.4 Deputy Head of Department (Undergraduate Programmes) Information

DHoD: Undergraduate Programmes	Wikus Erasmus
Contact Details	+27 (0) 11 559 1165 werasmus@uj.ac.za B Red 5 Auckland Park Bunting Road Campus

Table 3: Deputy Head of Department (Undergraduate Programmes) Information

1.5 Programme Coordinator Information

Programme Coordinator	Patrick Ndayizigamiye
Contact Details	+27 (0) 11 559 1223 ndayizigamiyep@uj.ac.za E Red 6 Auckland Park Bunting Road Campus

Table 4: Programme Coordinator Information

1.6 Academic Coordinator Information

Academic Coordinator	Nomusa Mtshali
Contact Details	+27 (0) 11 559 1375 G Purple 4 Auckland Park Bunting Road Campus

Table 5: Academic Coordinator Information

1.7 Lecturer Information

Module Lecturer	Bongisizwe Buthelezi
Contact Details	+27 (0) 11 559 1139 berasmus@uj.ac.za G Purple 4 Auckland Park Bunting Road Campus

Table 6: Lecturer Information

1.8 Purpose and Use of This Learning Guide

The purpose of this learning guide is to provide students with important administrative, organisational and module information and as such, a frame of reference and road map to

guide students in their planning and preparation in this module through the semester. It is of critical importance that students continually refer to the learning guide throughout the semester.

This learning guide and all other supporting resources (including the prescribed textbook and lecture slides) are all complementary to each other. All these resources comprise an inclusive and integrated learning experience aimed at achieving the outcomes of this module. This is especially important since the limitations imposed by the global **COVID-19** pandemic have necessitated an unusual and untraditional approach to delivering the module's content.

Section 3 details more information on the format and structure of this module for this semester.

1.9 Student Conduct

Academic honesty and general ethical behaviour are important for the holistic development of an individual, particularly in the early years of student life.

UJ does not tolerate plagiarism of any type, and sanctions are applied to offenders. For more information and the complete Student Plagiarism Policy document, follow the appropriate link on this module's Blackboard site. See also Section 3.16 of this learning guide.

UJ has developed an extensive policy framework, in order to enhance the teaching and learning experience of its students. This policy framework has implications for both teaching staff and for students. Please note that it is your responsibility to be familiar with these policies:

- UJ Academic Regulations
- Student Charter: Rights and Responsibilities
- UJ Assessment Policy

Links to some of these as well as other important policies are given on this module's Blackboard site.

2 Module and Programme Information

2.1 The Place of the Programme in the Academic Disciplinary Progression

This module is part of the Diploma in Business Information Technology (DI1401) programme, which is offered by the School for Consumer Intelligence and Information Systems in the College of Business and Economics.

The purpose of the programme is to develop the applied competence of students in developing, analysing, interpreting and applying information technology business management principles and methods. The programme prepares students to meaningfully contribute to the effective and efficient business management of information technology in organisations.

On completion of the programme students will be able to demonstrate competence in:

- analysis and understanding of the interdependency between business and Information Technology
- making decisions and accepting responsibility
- communicating effectively using models, visual and language skills
- working effectively in a team
- collecting, organising and critically evaluating information in order to assess the situation correctly
- demonstrating an understanding that the problem-solving contexts do not exist in isolation and therefore look at the system as a whole

2.2 Module Name, Code, NQF Level, NQF Credits and Prerequisites

Module Name	Communication Networks 2A
Module Code	CMN02A1
NQF Level	6
NQF Credits^a	16
Prerequisites	None

^a Calculated according to notional hours.

Table 7: Module NQF Information

2.3 Module Purpose and Outcomes

The purpose this module is to introduce the student to computer networks. The main focus will be on the Internet and on the TCP/IP protocol suite. The TCP/IP stack will be mapped to the ISO OSI Model.

By the end of the module, students should be able to demonstrate understanding of computer networking in general through:

- an ability to discuss the history of the Internet, including its critical success factors;
- a demonstrable ability to use some common network tools and applications;
- identifying network building blocks;
- justifying the layered architecture which is favoured in network protocols; and
- showing an understanding of the TCP/IP protocol suite by articulating how the key protocols in the suite work together.

Additionally, through assessments, students should be able to:

- discuss the mapping between the TCP/IP protocol stack and the ISO OSI reference model;
- explain routing in the Internet, including an understanding of the function of the key fields of the Internet Protocol (IP) headers;
- distinguish between the two service models used at the transport layer of the Internet, namely guaranteed delivery and best effort; and
- explain the client-server model which is ubiquitous in communication networks.

3 Administrative and Organisational Information

3.1 Prescribed Textbook

The details of the prescribed textbook for this module are seen below in Figure 1 and Table 8:

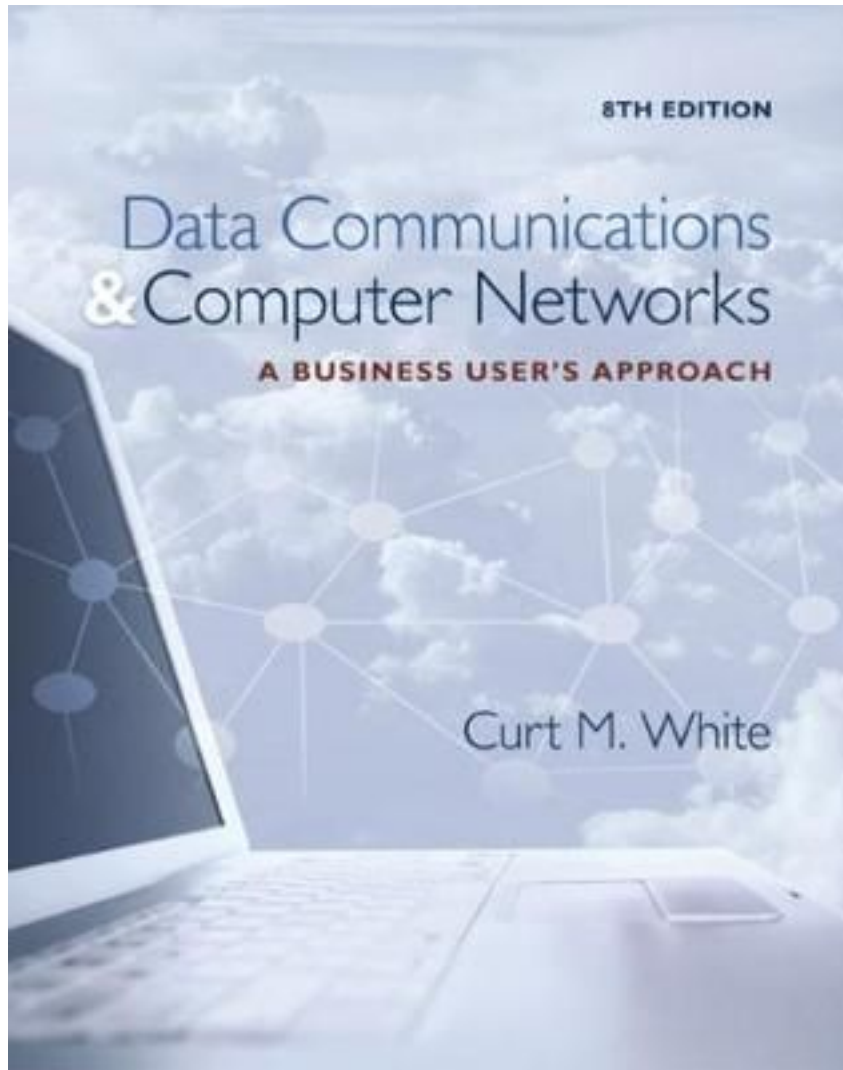


Figure 1: Prescribed Textbook Image

Title	Data Communications & Computer Networks – A Business User's Approach (Eighth Edition)
Author	Curt White
ISBN	9781305116634

Table 8: Prescribed Textbook Information

3.2 Recommended Texts

In addition to the prescribed textbook, Table 9 lists recommended texts that can be used for this module.

Type	Title (ISBN)	Author
Book *	Computer Networks and Internets, 6e (9780133587937)	Comer, Douglas E
Book *	Computer Networking: A Top-Down Approach, 8e (9780135928523)	Kurose, James F and Ross, Keith W

Table 9: Recommended Texts Information

* Books are available through the UJ Library (some as e-books). For some, the latest version may not be readily available.

3.3 Module Delivery and Assessment Approach

Due to the limitations and challenges imposed by the global **COVID-19** pandemic, it has become necessary to explore otherwise unusual and untraditional approaches to module delivery. To this end, the bulk of the module content will be delivered online, predominantly via the module's Blackboard platform. All material and module communication will be through this platform, and so too will all the assessments and their associated submissions.

Furthermore and more importantly, the assessment approach that will be taken for this module is that of **Continuous Assessment**. This means that rather than having a final examination opportunity at the end of the semester, which usually carries a lot of weight towards the *Final Mark* of the module, there will be **Continuous Assessment** opportunities throughout the semester which will **ALL** count towards the *Final Mark* for the module. See Section 3.10 below for further details.

3.4 Semester Work Schedule

For a detailed account of the work schedule for the semester, please refer to Learning Unit 0, ***Introduction and Administration Matters*** on this module's Blackboard site. This is an administrative Learning Unit which contains additional handy information and details regarding all the administration and logistics for this module. An important document which forms part of this Learning Unit is the **Module Schedule**. This is a live document for the entire semester that outlines the module's roadmap, including important dates and submissions.

The module's timetable is also an important component. See Table 10 for this module's semester timetable.

PLEASE NOTE: Because of the hybrid approach to the module's material delivery, this timetable may change with notice as, when, and where necessary. Any important additions or alterations to the module's attendance schedule will be communicated via Blackboard from time to time.

Group	Day & Period	Times	Venue
ALL (Class Session)	Mondays: 5 & 6	11:20 - 12:05; 12:10 - 12:55;	B RED 21
	Tuesdays: 4	10:30 - 11:15;	
Group K (Tutorial Session)	Mondays: 7, 8 & 9	13:00 - 13:45; 13:50 - 14:35; 14:40 - 15:25;	G PURPLE 3
Group L (Tutorial Session)	Fridays: 2, 3 & 4	08:50 - 09:35; 09:40 - 10:25; 10:30 - 11:15;	G PURPLE 3

Table 10: Module Semester Timetable

3.5 Tutorial Arrangements

All **Tutorial Sessions** will be conducted online (unless otherwise communicated). Each session will have at least one dedicated tutor to assist with the session. This should give enough opportunity for students to interact with the tutor(s) in order to clarify any questions or concepts that may have been missed during the **Class Sessions**.

3.6 Class and Tutorial Attendance

Attending both **Class Sessions** and **Tutorial Sessions** is an important aspect of this module. Although not compulsory, it remains in your own best interest to attend all scheduled sessions. It is a known fact that regular attendance increases the success of a student.

In particular, students are required to attend a minimum of 80% of all scheduled classes (this includes both the **Class Sessions** and **Tutorial Sessions**). See **Academic Regulations, Par 5.11, Class Attendance**.

Attendance registers are taken in this module and your attendance record is taken into consideration. This is especially important where unsatisfactory progress is being considered or in a case where you need to apply for special consideration for admission to an exam or assessment.

Refer to Learning Unit 0, ***Introduction and Administration Matters***, for additional handy information and details regarding the Class and Group Structure for the module. This information has all the relevant information about the module's **Theory Sessions** and **Tutorial Sessions**, including tutor information, attendance dates and venues. Also refer to the important information contained in the **Module Schedule** document as well as the preceding Sections 3.4 and 3.5.

3.7 Blackboard Access and Use

This module makes use of Blackboard contained within uLink. Students must ensure that they have access from the start of the course. Students are also responsible to access Blackboard on a regular basis as all module-related material (including lecture slides, illustrations, additional material, announcements, assessments, etc.) will be posted on Blackboard on a regular basis.

Students can access the Blackboard environment via the student portal which is accessible via the website link: <http://student.uj.ac.za/>

3.8 Consulting Times

Dedicated consultation times will be posted on Blackboard from time to time. Students are encouraged to adhere to the information made available.

Students are also able to schedule one-on-one or group appointments with the lecturer using the contact information posted above under Section 1.7. Please ensure that you include all the details for reference to your query or appointment when making such appointments.

3.9 Assessment Programme for the Semester

Refer to Learning Unit 0, ***Introduction and Administration Matters***, for additional handy information and details regarding the schedule of assessments for the module for this semester. Refer especially to the important information contained in the **Module Schedule** document, which may be updated from time to time.

3.10 Composition / Calculation of Final Mark

The *Final Mark* for this module will be composed of all the assessment elements that will be undertaken throughout the semester. Because the assessment approach that will be taken for this module is that of **Continuous Assessment**, there is no notion of a *Semester Mark* or an *Examination Mark*. Instead, all assessments that will be conducted throughout the semester will contribute to the *Final Mark* as indicated in Table 11.

Assessment	Weight (%)
Assignments	60
Short or Discussion Exercises	40
TOTAL	100

Table 11: Final Mark Composition

For the exact number of *Assignments* and *Short or Discussion Exercises*, refer to Learning Unit 0, ***Introduction and Administration Matters*** and to the important information contained in the **Module Schedule** document, which may be updated from time to time.

In addition to the above:

- A minimum pass mark of 50% is required.
- To pass with distinction, a student has to achieve at least 75% in the module.

3.11 Access to the Last Summative Assessment Opportunity

Because the assessment approach that will be taken for this module is that of **Continuous Assessment**, there is no summative assessment at the end of the semester.

3.12 Access to Replacement and Supplementary Assessment Opportunities

Students have an opportunity to access a replacement or supplementary assessment opportunity should they not meet the minimum requirement of 50% to pass the module. Such an opportunity is granted by the Faculty Office to those students who obtain a *Final Mark* of between 30% and 49% derived from the **Continuous Assessment** opportunities during the period of the module.

3.13 Collection of Assessment Scripts

All the assessments will be conducted and submitted online via Blackboard, so there will not be any hardcopy material that would constitute an *assessment script* in this module.

3.14 Request / Application for Remarking

Following all the module assessments (see Section 3.9 above), there will be a dedicated set of timeslots during which students can have an opportunity to have their assessments reviewed. This is usually a week following the availability of the results of the assessments, but all necessary information is made available via Blackboard.

3.15 Grievances and Appeals

Students should consult with their lecturer if they experience any problems. Should the matter not be resolved, students must escalate the matter to the *i)* Programme Coordinator responsible for their programme, failing which, to the *ii)* Deputy Head of Department responsible for their programme, and failing which, to the *iii)* Head of Department (in that particular order). This should be done via the Departmental Secretary whose details appear in Section 1.3. Students are urged to consult timeously and not when the matter becomes a crisis.

3.16 Dishonesty and Plagiarism

Dishonesty and plagiarism will not be tolerated. The University and the College of Business and Economics view the issue of plagiarism in a serious light. Evidence of plagiarism or dishonesty will be dealt with according to the University's and/or College's Regulations.

The issue of plagiarism as referred to in the Faculty Guidelines for Ethics in Research outlines:

Plagiarism is to:

- present the ideas, words or results of another person as your own, without acknowledging the original author;
- use the ideas or words of another person without giving due credit to that person or source;
- use sentences, paragraphs or parts of articles and books without quotation marks and/or appropriate acknowledgement;
- download sentences, paragraphs or sections of writings from the Internet and to use them without quotation marks and/or proper acknowledgement;
- use another person's direct words without quotation marks, even when you acknowledge the source;
- use ideas without making them properly your own, even though you might have acknowledged the original source;
- formulate your words so closely to those of the original author that it is obvious that you could not have written them without having had the source next to you, i.e. your paraphrasing of the author's words is too close to the original author's use of the words, even if you did acknowledge your source.

Source: Boot, et al. and Schuklenk.

If you use the words and ideas of other people, their words must be clearly indicated in quotation marks and used correctly, and their source indicated to avoid being guilty of plagiarism. No copying of textbooks is allowed.

Plagiarism is wrong because:

- It is theft of intellectual property.
- The person (plagiarist) lies about the contribution made to the project.
- The person (plagiarist) cannot give a true account of how the research was carried out.

Source: Udo Schuklenk (University of the Witwatersrand).

There are benefits to be derived from consciously avoiding plagiarism. By deliberately avoiding plagiarism, students learn:

- the value of doing original work;
- to develop professional skills such as doing research, giving attention to detail and analysing arguments;

- to act with honesty and integrity in their professional lives; and
- to write professionally and engage in debate.

Source: Faculty of Law, the University of the Witwatersrand.

4 Study Components (Learning Units)

4.1 Learning Unit 1 - Introduction to Computer Networks and Data Communications

4.1.1 Learning Unit Overview

Learning Unit 1, *Introduction to Computer Networks and Data Communications*, introduces computer networks and data communications fundamentals. The world of computer networks and data communications is a surprisingly vast and increasingly significant field of study. Once considered primarily the domain of communications engineers and technicians, computer networks now involve business managers, computer programmers, system designers, office managers, home computer users, and everyday citizens. It is virtually impossible for the average person on the street to spend 24 hours without directly or indirectly using some form of computer network. Examples of computer networks include banking, transportation, education, retail sales, and telecommunications.

4.1.2 Learning Unit Objectives

The objective of this Learning Unit is to assist the student to:

- Define the basic terminology of computer networks.
- Recognize the individual components of the big picture of computer networks.
- Outline the basic networks.
- Cite the reasons for using a network model and explain how they apply to current network systems.
- List the layers of the TCP/IP protocol suite and describe the duties of each layer.
- List the layers of the OSI model and describe the duties of each layer.
- Compare the OSI and TCP/IP models and list their differences and similarities.

4.1.3 Key Terms

American National Standards Institute (ANSI)	Institute of Electrical and Electronics Engineers (IEEE)	protocol
campus area network (CAN)	Interfacing	router
client / server system	International Organization for Standardization (ISO)	server
cloud	International Telecommunication Union-Telecommunication Standardization Sector (ITU-T)	Simple Mail Transfer Protocol (SMTP)

cloud computing	Internet Protocol (IP)	Simple Network Management Protocol (SNMP)
compression	local area network (LAN)	subnetwork
computer network	logical connection	switch
computer terminal	metropolitan area network (MAN)	synchronization point
convergence	multiplexing	TCP/IP protocol suite
data communications	network cloud	Telnet
data network	network architecture	token management
Electronic Industries Association (EIA)	network management	voice network
encapsulation	node	wide area network (WAN)
File Transfer Protocol (FTP)	Open Systems Interconnection (OSI) model	wireless
frame	personal area network (PAN)	workstation
Hypertext Transfer Protocol (HTTP)	physical connection	

4.2 Learning Unit 2 - Fundamentals of Data and Signals

4.2.1 Learning Unit Overview

Learning Unit 2, *Fundamentals of Data and Signals*, examines the fundamentals of data and signals. Data and signals are two of the basic building blocks of any computer network, but they are not two terms that mean the same thing. Stated simply, a signal is the transmission of data. Both data and signals can be in either analog or digital form, which gives us four possible combinations: transmitting digital data using digital signals, transmitting digital data using discrete analog signals, transmitting analog data using digital signals, and transmitting analog data using analog signals.

4.2.2 Learning Unit Objectives

The objective of this Learning Unit is to assist the student to:

- Distinguish between data and signals and cite the advantages of digital data and signals over analog data and signals.
- Identify the three basic components of a signal as amplitude, frequency, and phase.
- Discuss the bandwidth of a signal and how it relates to data transfer speed.
- Identify signal strength and attenuation and how they are related.
- Outline the basic characteristics of transmitting digital data with digital signals, analog data with digital signals, digital data with analog signals, and analog data with analog signals.
- List and be able to draw diagrams of the basic digital encoding techniques, including the advantages and disadvantages of each.

- Identify the different shift keying techniques and describe their advantages, disadvantages, and uses.
- Identify the two most common digitization techniques, pulse code modulation and delta modulation, and describe their advantages and disadvantages.
- Identify the different data codes and how they are used in communication systems.

4.2.3 Key Terms

4B/5B	differential Manchester	phase shift keying
amplification	digital data	pulse amplitude modulation (PAM)
amplitude	digital signals	pulse code modulation (PCM)
amplitude shift keying	digitization	quadrature amplitude modulation
analog data	EBCDIC	quadrature phase shift keying
analog signals	effective bandwidth	quantization error
ASCII	frequency	quantization levels
attenuation	frequency shift keying	quantization noise
bandwidth	hertz (Hz)	sampling rate
baud rate	intermodulation distortion	self-clocking
bipolar-AMI	Manchester	Shannon's theorem
bits per second (bps)	modulation	shift keying
codec	noise	signals
data	nonreturn to zero inverted (NRZI)	slope overload noise
data code	nonreturn to zero-level (NRZ-L)	spectrum
data rate	Nyquist's theorem	Unicode
decibel (dB)	period	
delta modulation	phase	

4.3 Learning Unit 3 - Conducted and Wireless Media

4.3.1 Learning Unit Overview

All communications media can be divided into two categories: physical or conducted media, such as wires, and radiated or wireless media, which use radio waves. Learning Unit 3, ***Conducted and Wireless Media***, introduces the various types of media used for data communications across these two categories. Conducted media include twisted pair wire, coaxial cable, and fiber optic cable. In wireless transmission, various types of electromagnetic waves, such as radio waves, are used to transmit signals. This Learning Unit examines seven basic groups of wireless media used for the transfer of data: terrestrial microwave transmissions, satellite transmissions, cellular radio systems, personal communication systems, pagers, infrared transmissions, and multichannel multipoint distribution service.

4.3.2 Learning Unit Objectives

The objective of this Learning Unit is to assist the student to:

- Outline the characteristics of twisted pair wire including the advantages and disadvantages and the differences between Category 1, 2, 3, 4, 5, 5e, 6, and 7 twisted pair wire.
- Describe when shielded twisted pair wire works better than unshielded twisted pair wire.
- Outline the characteristics of coaxial cable including the advantages and disadvantages.
- Outline the characteristics of fiber optic cable including the advantages and disadvantages.
- Outline the characteristics of terrestrial microwave systems including the advantages and disadvantages.
- Outline the characteristics of satellite microwave systems including the advantages and disadvantages and including the differences between low earth orbit, middle earth orbit, and geosynchronous earth orbit satellites.
- Describe the basics of cellular telephones, including all the current generations of cellular systems.
- Outline the characteristics of short-range transmissions, including Bluetooth.
- Outline the characteristics of broadband wireless systems including the advantages and disadvantages.
- Apply the media selection criteria of cost, speed, distance and expandability, environment, and security to various media in a particular application.

4.3.3 Key Terms

1xEV (1 x Enhanced Version)	downlink	propagation delay
62.5/125 cable	Evolution Data Only (EV-DO)	propagation speed
8.3/125 cable	fiber-optic cable	reflection
Advanced Mobile Phone Service (AMPS)	free space optics	refraction
backbone	General Packet Radio Service (GPRS)	repeater
baseband coaxial	geosynchronous-Earth-orbit (GEO) satellite	right-of-way
Bluetooth	global positioning system (GPS)	satellite microwave
braided coaxial cable	Global System for Mobile (GSM) Communications	scatternet
broadband coaxial	highly elliptical orbit (HEO) satellite	shielded twisted pair (STP)

broadband wireless system	infrared transmission	single-mode transmission
Category 1	line-of-sight transmission	single-stranded coaxial cable
Category 1-7 (CAT 1-7)	Long Term Evolution (LTE)	terrestrial microwave
Category 2	low-Earth-orbit (LEO) satellite	thick coaxial cable
Category 3	media selection criteria	thin coaxial cable
Category 4	middle-Earth-orbit (MEO) satellite	Time Division Multiple Access (TDMA)
Category 5	mobile service area (MSA)	twisted pair wire
Category 6	multimode transmission	ultra-wideband
Category 7	near-field communications	Universal Mobile Telecommunications System (UMTS)
CDMA2000 1xRTT	passive device	unshielded twisted pair (UTP)
coaxial cable	Personal Communications Services (PCS)	uplink
Code Division Multiple Access (CDMA)	photo diode	Very Small Aperture Terminal (VSAT)
crosstalk	photo receptor	WiMax
data transmission speed	photonic fiber	wireless fidelity (Wi-Fi)
Digital-Advanced Mobile Phone Service (D-AMPS)	piconet	ZigBee

4.4 Learning Unit 4 - Making Connections

4.4.1 Learning Unit Overview

Learning Unit 4, ***Making Connections***, which spans Chapters 4 & 5 of the prescribed textbook, introduces the notion of INTERFACING (in Part I) which is aimed at enhancing the understanding of the interconnection between a computer and a device such as a modem. Interfacing a device to a computer is considered a physical layer activity since it deals directly with analog signals, digital signals, and hardware components. This Learning Unit will examine the four basic components of an interface: electrical, mechanical, functional and procedural, and then introduce several of the more common interface standards.

Part II introduces the concept of MULTIPLEXING and COMPRESSION. Under the simplest conditions, a medium can carry only one signal at any moment in time. Many times, however, it becomes necessary for a medium to carry multiple signals at the same time. This technique of transmitting multiple signals over a single medium is multiplexing. Multiplexing is a technique performed at the physical layer of the OSI model or the interface layer of the Internet model. It also becomes necessary to compress the data (for instance to half or less of its original size) in order to be able to squeeze more data over a communications line or into a storage space. This is achieved through the various techniques of compression.

4.4.2 Learning Unit Objectives

The objective of Part I of this Learning Unit (covered by Chapter 4 of the prescribed book) is to assist the student to:

- List the four components of all interface standards.
- Discuss the basic operations of the USB and EIA-232F interface standards.
- Cite the advantages of FireWire, Lightning, SCSI, iSCSI, InfiniBand, and Fibre Channel interface standards.
- Outline the characteristics of asynchronous, synchronous, and isochronous data link interfaces.
- Recognize the difference between half-duplex and full-duplex connections.
- Identify the operating characteristics of terminal-to-mainframe connections and why they are unique compared to other types of computer connections.

The objective of Part II of this Learning Unit (covered by Chapter 5 of the prescribed book) is to assist the student to:

- Describe frequency division multiplexing and list its applications, advantages, and disadvantages.
- Describe synchronous time division multiplexing and list its applications, advantages, and disadvantages.
- Outline the basic multiplexing characteristics of T-1 and SONET/SDH telephone systems.
- Describe statistical time division multiplexing and list its applications, advantages, and disadvantages.
- Cite the main characteristics of wavelength division multiplexing and its advantages and disadvantages.
- Describe the basic characteristics of discrete multitone.
- Cite the main characteristics of code division multiplexing and its advantages and disadvantages.
- Apply a multiplexing technique to a typical business situation.
- Describe the difference between lossy and lossless compression.
- Describe the basic operation of run-length, JPEG, and MP3 compression.

4.4.3 Key Terms

asynchronous connection	functional component	polling
channel	guard band	primary
chip spreading codes	half-duplex connection	procedural component
coarse wavelength division multiplexing (CWDM)	hub polling	roll-call polling
code division multiplexing (CDM)	InfiniBand	RS-232
compression	interfacing	run-length encoding
daisy-chaining	iSCSI (Internet SCSI)	SCSI (Small Computer System Interface)
data communicating equipment (DCE)	isochronous connection	secondary
data terminating equipment (DTE)	JPEG	selection
de facto standard	lambda	start bit
demultiplexor	Lightning	statistical time division multiplexing (Stat TDM)
dense wavelength division multiplexing (DWDM)	lossless compression	stop bit
discrete multitone (DMT)	lossy compression	synchronous connection
DS-1 signaling	mechanical component	Synchronous Digital Hierarchy (SDH)
EIA-232F	MP3	Synchronous Optical Network (SONET)
electrical component	MPEG	synchronous time division multiplexing (Sync TDM)
fiber exhaust	multiplexing	synchronous transport signals (STS)
Fibre Channel	multiplexor	T-1 multiplexing
FireWire	multipoint connection	Thunderbolt
frame	parity bit	time division multiplexing (TDM)
frequency division multiplexing (FDM)	perceptual encoding	Universal Serial Bus (USB)
full-duplex connection	point-to-point connection	wavelength division multiplexing (WDM)

4.5 Learning Unit 5 - Errors, Error Detection, and Error Control

4.5.1 Learning Unit Overview

Learning Unit 5, *Errors, Error Detection, and Error Control*, introduces and briefly covers the topic of errors when it comes to computer networks and data communications. Given that noise is inevitable and errors happen, something needs to be done to detect error conditions. This learning unit examines some of the more common error detection methods and compares them in terms of efficiency and efficacy. Once an error has been detected, what action should a receiver take? There are three options: toss the

frame/packet, return an error message to the transmitter, or correct the error without help from the transmitter.

4.5.2 Learning Unit Objectives

The objective of this Learning Unit is to assist the student to:

- Identify the different types of noise commonly found in computer networks.
- Specify the different error prevention techniques and be able to apply an error prevention technique to a type of noise.
- Compare the different error detection techniques in terms of efficiency and efficacy.
- Perform simple parity and longitudinal parity calculations and enumerate their strengths and weaknesses.
- Cite the advantages of cyclic redundancy checksum and specify what types of errors cyclic redundancy checksum will detect.
- Cite the advantages of arithmetic checksum, and specify what types of applications use arithmetic checksum.
- Differentiate the basic forms of error control and describe under what circumstances each may be used.
- Follow an example of a Hamming self-correcting code.

4.5.3 Key Terms

arithmetic checksum	forward error correction	odd parity
attenuation	generating polynomial	piggybacking
crosstalk	Hamming code	simple parity
cyclic redundancy checksum (CRC)	Hamming distance	sliding window protocol
echo	impulse noise	Stop-and-wait error control
error control	jitter	timeout
even parity	longitudinal parity	white noise

4.6 Learning Unit 6 - Local Area Networks

4.6.1 Learning Unit Overview

Learning Unit 6, **Local Area Networks**, defines the local area network as a communication network that interconnects a variety of data communicating devices within a small geographic area and broadcasts data at high data transfer rates with very low error rates. It also goes on to list the primary function, activities, and application areas of a local

area network since it first made its appearance in the 1970s. The Learning Unit further explores the most popular configuration for a local area network (the star-wired bus) while also drawing on the much older technology called the star topology. Towards the end, it looks at some of the protocols for the local area network as well as the Ethernet.

4.6.2 Learning Unit Objectives

The objective of this Learning Unit is to assist the student to:

- State the definition of a local area network.
- List the primary function, activities, and application areas of a local area network.
- Cite the advantages and disadvantages of local area networks.
- Identify the physical and logical local area networks.
- Specify the different medium access control techniques.
- Recognize the different IEEE 802 frame formats.
- Describe the common wired local area network systems.

4.6.3 Key Terms

backplane	full-duplex switch	print server
backward learning	Gigabit Ethernet	quality of service
bidirectional	hot swappable	Rapid Spanning Tree Protocol (RSTP)
bus / tree local area network	hub	runts
bus LAN	link aggregation	shared network
carrier sense multiple access with collision detection (CSMA/CD)	local area network (LAN)	shared segment network
collision	logical design	Spanning Tree Protocol (STP)
collision window	logical link control (LLC) sublayer	star-wired bus LAN
contention-based protocol	medium access control (MAC) sublayer	store-and-forward device
cut-through architecture	medium access control protocol	switch
dedicated segment network	network interface card (NIC)	tap
Ethernet	nondeterministic protocol	transparent
Fast Ethernet	passive device	trees
file server	physical design	virtual LAN
filter	Power over Ethernet (PoE)	

4.7 Learning Unit 7 - Introduction to Metropolitan Area Networks and Wide Area Networks

4.7.1 Learning Unit Overview

Learning Unit 7, *Introduction to Metropolitan Area Networks and Wide Area Networks*, introduces the metropolitan and wide area networks. A network that expands beyond a metropolitan area is a wide area network. Wide area networks share a few characteristics with local area networks: they interconnect computers, they use some form of media for the interconnection, and they support network applications. More importantly, however, wide area networks differ from local area networks in a number of ways. Wide area networks include both data networks, such as the Internet, and voice networks, such as telephone systems, whereas local area networks in almost all cases include only data networks. Wide area networks can interconnect thousands, tens of thousands, or more workstations so that any one workstation can transfer data to any other workstation. As the name implies, wide area networks can cover large geographic distances, including the entire earth. All of this is covered in this Learning Unit, together with some of the important routing and congestion management approaches for these networks.

4.7.2 Learning Unit Objectives

The objective of this Learning Unit is to assist the student to:

- Distinguish local area networks, metropolitan area networks, and wide area networks from each other.
- Identify the characteristics of metropolitan area networks and explain how they compare and contrast with wide area and local area networks.
- Describe how circuit switched, datagram packet switched, and virtual circuit packet switched networks work.
- Identify the differences between a connectionless network and a connection-oriented network and give an example of each.
- Describe the differences between centralized routing and distributed routing, citing the advantages and disadvantages of each.
- Describe the differences between static routing and adaptive routing, citing the advantages and disadvantages of each.
- Document the main characteristics of flooding and use hop count and hop limit in a simple example.
- Discuss the basic concepts of network congestion including quality of service.

4.7.3 Key Terms

adaptive routing	distributed routing	network congestion
backward explicit congestion notification (BECN)	explicit congestion control	node
bandwidth profile	fail over	Open Shortest Path First (OSPF) protocol
broadcast network	failover time	packet-switched network
buffer preallocation	flooding	reliable service
centralized routing	forward explicit congestion notification (FECN)	Routing Information Protocol (RIP)
circuit-switched network	hop count	service level agreement
connection admission control	hop limit	station
connectionless network application	implicit congestion control	subnetwork
connection-oriented network application	Metro Ethernet	virtual circuit
datagram	metropolitan area network (MAN)	weighted network graph
Dijkstra's least-cost algorithm	network cloud	wide area network (WAN)

4.8 Learning Unit 8 - The Internet

4.8.1 Learning Unit Overview

Many people think the Internet is only the service that allows a person to browse web pages and click links, but it is actually much more. Learning Unit 8, ***The Internet***, introduces the Internet and two of its most common protocols: the Internet Protocol (IP) and the Transmission Control Protocol (TCP). Prior to these protocols, one of the first services, and still one of the more popular offered on the Internet, is the file transfer protocol (FTP), which allows a user to upload or download files. Other services offered by the Internet include remote login, Internet telephony, electronic mail, listservs, voice over IP, and streaming audio and video. The protocols mentioned above are supported by a host of secondary protocols, which include Internet Control Message Protocol (ICMP), User Datagram Protocol (UDP), and Address Recognition Protocol (ARP). This Learning Unit also discusses the future of the Internet, since the Internet is not a static entity, but continues to grow by adding new networks and new users every day.

4.8.2 Learning Unit Objectives

The objective of this Learning Unit is to assist the student to:

- Discuss the responsibilities of the Internet Protocol (IP) and how IP can be used to create a connection between networks.
- Discuss the responsibilities of the Transmission Control Protocol (TCP) and how it can be used to create a reliable end-to-end network connection.
- Identify both IPv4 addresses and IPv6 addresses.

- Identify the relationships between TCP/IP and the protocols ICMP, UDP, ARP, DHCP, NAT, and tunneling protocols.
- Describe the responsibility of the Domain Name Service and how it converts a URL into a dotted decimal IP address.
- Describe the major Internet applications and services.
- Discuss the business advantages of the World Wide Web.
- Recognize that the Internet is constantly evolving and that IPv6 and Internet2 demonstrate that evolution.

4.8.3 Key Terms

Address Resolution Protocol (ARP)	instant messaging (IM)	Real-Time Protocol (RTP)
ARPANET	Internet Control Message Protocol (ICMP)	Real-Time Streaming Protocol (RTSP)
blog	Internet Message Access Protocol (!MAP)	remote login
cookie	Internet of Things (IoT)	Session Initiation Protocol (SIP)
datagram	Internet Protocol (IP)	socket
domain name	intranet	streaming audio and video
Domain Name System (DNS)	IP multicasting	subnet masking
Dynamic Host Configuration Protocol (DHCP)	IPSec	Telnet
e-commerce	IPv6	Transmission Control Protocol (TCP)
electronic data interchange (EDI)	listserv	tunneling protocol
electronic mail (e-mail)	Internet2	tweet
ENUM	micro-marketing	Twiner
e-retailing	MILNET	Uniform Resource Locator (URL)
Extended Simple Mail Transfer Protocol (ESMTP)	Multiprotocol Label Switching (MPLS)	User Datagram Protocol (UDP)
extranet	Multipurpose Internet Mail Extensions (MIME)	virtual private network (VPN)
File Transfer Protocol (FTP)	Network Address Translation (NAT)	Voice over IP (VoIP)
H.323	Point-to-Point Protocol (PPP)	Voice over wireless LAN (VoWLAN)
Hypertext Markup Language (HTML)	Post Office Protocol version 3 (POP3)	VoIP gateway
Hypertext Transfer Protocol (HTTP)	private VoiP	World Wide Web (WWW)

5 Annexures

5.1 Medical Certificate Compliance

Medical certificates need to comply with the following:

**The Ethical and Professional Rules of the Medical and Dental Professions Board
of the Health Professions Council of South Africa**

In terms of the Ethical and Professional Rules of the Medical and Dental Professions Board of the Health Professions Council of South Africa, the medical profession has introduced the following rules with respect to medical certificates:

Rule 15(1): A practitioner shall only grant a certificate of illness if such certificate contains the following information, namely:

- a. the name, address and qualification of the practitioner;
- b. the name of the patient;
- c. the employment number of the patient (if applicable);
- d. the date and time of the examination;
- e. whether the certificate is being issued as a result of personal observations by the practitioner during an examination, or as the result of information received from the patient and which is based on acceptable medical grounds;
- f. a description of the illness, disorder or malady in layman's terminology with the informed consent of the patient: Provided that if the patient is not prepared to give such consent, the medical practitioner or dentist shall merely specify that, in his or her opinion based on an examination of the patient, the patient is unfit to work;
- g. whether the patient is totally indisposed for duty or whether the patient is able to perform less strenuous duties in the work situation;
- h. the exact period of recommended sick leave;
- i. the date of issuing of the certificate of illness; and
- j. a clear indication of the identity of the practitioner who issued the certificate which shall be personally and originally signed by him or her next to his or her initials and surname in printed or block letters.

Rule 15(2): If pre-printed stationery is used, a practitioner shall delete words which are irrelevant.

Rule 15(3): A practitioner shall issue a brief factual report to a patient where such a patient requires information concerning himself or herself.

5.2 Action Words Dictionary

The action words below are often used in required activities, assignments and / or tests / examinations; here you can find out exactly what is expected of you.

Word	Description
Apply	Put to practical use or make use of a relevant equation or law.
Argue	Give reasons or cite evidence in support of an idea, action, or theory, typically with the aim of persuading others to share one's view.
Calculate	Determine the value, using formulae or specific calculation methods.
Classify	Group concepts or subjects together based on certain characteristics or commonalities.
Compare	Point out the similarities and differences between objects or points of view. The word <i>contrast</i> can also be used.
Convert	Transform a quantity expressed in one unit to a quantity expressed in another unit.
Define	Give a short and clear description of a term or concept.
Demonstrate	Show clearly/prove/make clear by reasoning or evidence/illustrate and explain, especially with many examples.
Derive	Deduce or infer something from the given information.
Describe	Tell in detail how a process works or how a subject appears. You need not comment on the process or the subject or give your own point of view.
Differentiate	Find differences between objects or statements.
Discuss	Explain terms or concepts in your own words. Give comments or give your own point of view.
Distinguish	Write down the differences between subjects or concepts.
Draw	Create a drawing, diagram or representation of a subject or concept.
Explain	Write about the subject in your own words. Clarify or give reasons – use examples or illustrations. You must prove that you understand the content.
Formulate	Express in a concise, systematic way.
Identify	Establish the identity or recognise a process.
Illustrate	Explain by means of detailed descriptions and drawings.
Interpret	Explain or clarify the meaning of a concept/value.
List	Briefly write down the facts or main points (see also Name).
Motivate	Give a reason(s) for your answer.
Name	Briefly write down the facts or main points (see also List).
Organise	Arrange data according to certain criteria.
Predict	Use the facts available to derive an outcome.
Relate	Show the relation/connection of entities, how the concepts can be linked.
Solve	Find an answer by using critical thinking and/or calculations.
Summarise	Briefly state/list/write down only the most important detail/facts.
Understand	Show insight into or know the meaning/nature of a concept or term.

Table 17: Action Words Dictionary