Department of CSE

Details of Lesson Plan

S.No.	Particulars	Details
1.	Course Name	Computer Networks
2.	Course Code	COM-502
3.	Academic Year	2024-25
4.	Semester	5th
5.	Number of Lesson plans	48
6.	Faculty Assigned	Ms. Vishalika / Mr. Shubham

Vishalika

Faculty Signature

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Lesson Plan No. 1	Course Name: Computer Networks Introduction to Course	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Understand the basic concepts of computer networks. b. Recognize the importance of computer networks in modern society. c. Identify various career opportunities in the field of computer networks. d. Describe future trends in networking technology.
Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube video

Teaching Development	1. **Introduction** (10 minutes)
	 • Ask questions:
	 1. When you send an email to your friend in the USA, how does the email reach your friend's inbox?
	 2. Who manages the end-to-end delivery of this email?
	 3. Which path does email follow?
	 4. What is happening in the middle and how?
	
	 • The invisible glue which ties data communications together and makes the magic happen is "Computer Networks" - a collection of network devices, protocols, techniques, mechanisms, frameworks and tools which enable computer systems to communicate with each other.
	
	 • Hence, the study of computer networks is critical for the advancement of nations, society and the entire world.
	
	 • Discuss course outcomes.
	
	 2. **Development** (30 minutes)
	
	 Why Computer Networks?
	 - Discuss the importance of connectivity in today's digital age.
	 - Benefits such as resource sharing, communication, and data exchange
	
	 - Show a video on Introduction to Computer Networks:
	 YouTube Video: "Introduction to Computer Networks" by Techterms
	 (https://www.youtube.com/watch?v=aHJElrgj6UA)
	
	 Career & Job Perspective
	 - Network Administrator, Network Engineer, Cybersecurity Specialist
	 - Discussion on certifications:
	     o Cisco Certified Network Associate (CCNA)
	     o CompTIA Network+
	     o Certified Information Systems Security Professional (CISSP)
	 - Introduction to networking courses available on platforms like Coursera and LinkedIn Learning
	
	 Future Trends in Networking (10 minutes)

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	- Real-time examples and emerging technologies
	   o Internet of Things (IoT)
	   o 5G and beyond
	   o Software-Defined Networking (SDN)
	   o Network Function Virtualization (NFV)
	- Discuss how these trends are shaping the future of networking and job opportunities

Closure	1. Summarize the lesson, correlating with learning outcomes 2. Encourage students to explore further reading and online resources **Suggested Reading:** "Computer Networking: A Top-Down Approach" by James Kurose and Keith Ross, Chapter 1, pp 1-36. "Data Communications and Networking" by Behrouz A. Forouzan, Chapter 1, pp 1-26.
Evaluation	Reflective Questions (What Why Who?). Allow students to answer and discuss. 1. What is a computer network, and why is it important in today's digital age? 2. Can you think of some everyday activities that rely on computer networks? 3. Which career roles in computer networking interest you the most, and why? Spend 5 minutes to wrap up and consolidate the learnings

Lesson Plan No. 1.1	Course Name: Computer Networks Topic: Introduction to Data Communication Systems	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Understand the basic concepts of data communication systems. b. Identify different types of communication systems and their applications. c. Explain the components of a communication system. d. Recognize the importance of data communication in modern technology.
Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube video

Teaching Development	1. **Introduction** (5 minutes)
	Ask students:
	• What do you understand by the term "data communication"?
	• How often do you use data communication in your daily life?
	• Explain the relevance of data communication in today's interconnected world.
	
	2. **Development** (30 minutes)
	  1. What is Data Communication?
	
	    • **Definition:**
	    o Explain data communication as the exchange of data between devices through a transmission medium.
	    o Emphasize the role in various applications like the internet, emails, and mobile communication.
	    • **Importance:**
	    o Discuss how data communication enables the sharing of resources, information, and collaborative work.
	
	  2. Basic Components of Data Communication
	
	    • **Message:** The data to be communicated.
	    • **Sender:** The device that sends the data.
	    • **Receiver:** The device that receives the data.
	    • **Transmission Medium:** The physical path through which the data travels (e.g., cables, wireless).
	    • **Protocol:** Rules that govern data communication (e.g., TCP/IP).
	
	  3. Protocols in Data Communication
	
	    • **Common Protocols:**
	    o Discuss protocols like HTTP, FTP, SMTP, and their roles in communication.
	    • **Real-time example:** Sending an email using SMTP.

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4. Applications of Data Communication

- **Real-World Applications:**
  - Discuss examples like online banking, social media, and cloud services.
- **Case Study:**
  - Walk through a scenario of a video call, identifying components and protocols involved.

- Show a YouTube video on how the internet works:
  YouTube: (https://www.youtube.com/watch?v=Sfzo4xm5eX8)

3. **Exercise (5 minutes)**

- Ask students to summarize the components of data communication and their roles.
- Discuss the answers with the class.

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Closure

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Summarize the Lesson Learning Outcomes and get affirmation from students on these.
Suggested Reading
"Data and Computer Communications" by William Stallings, Chapter 2, pp. 30-45.
"Computer Networking: A Top-Down Approach" by James Kurose and Keith Ross, Chapter 1, pp. 1-35.

Homework:
Write a short essay on the importance of protocols in data communication and upload it on the Camu.

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Evaluation

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1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
   - How would you define data communication in your own words?
   - What are the basic components of data communication?
   - Why are protocols necessary?

Spend 5 minutes to wrap up and consolidate the learnings.

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Lesson Plan No. 1.2	Course Name: Computer Networks Topic: Synchronous and Asynchronous Systems, Serial and Parallel Systems	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Explain the difference between synchronous and asynchronous communication systems. b. Identify the key characteristics and uses of serial and parallel communication systems. c. Compare the advantages and disadvantages of each system.
Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube NPTEL videos d. Use of Nearpod/Tutorial sheets tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	 - Begin with a brainstorming session. Ask students: What do they think are the differences between synchronous and asynchronous communication? Can they identify any examples of serial and parallel systems?
	 - Briefly introduce the topic and outline the objectives of the lesson.
	2. **Development** (30 minutes)
	  a. **Synchronous Communication Systems.**
	  - Define synchronous communication.
	  - Explain how data is transmitted in a synchronized manner using a common clock signal
	  - Discuss examples and applications of synchronous systems (e.g., real-time video conferencing).
	  b. **Asynchronous Communication Systems**
	  - Define asynchronous communication
	  - Explain how data is transmitted without a common clock signal, using start and stop bits.
	  - Discuss examples and applications of asynchronous systems (e.g., email, texting).
	  c. **Serial Communication Systems**
	  - Define serial communication.
	  - Explain how data is transmitted one bit at a time over a single channel.
	  - Discuss the advantages (e.g., simpler wiring, longer distances) and disadvantages (e.g., slower data rate) of serial communication.
	  - Provide examples (e.g., USB, RS-232).
	  d. **Parallel Communication Systems**
	  - Parallel Communication Systems
	  - Explain how data is transmitted multiple bits at a time over multiple channels.
	  - Discuss the advantages (e.g., higher data rate) and disadvantages (e.g., complex wiring, shorter distances) of parallel communication.
	  - Provide examples (e.g., computer buses, parallel ports).

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	e. Comparison of Systems
	    - Compare synchronous vs. asynchronous systems in terms of timing, complexity, and applications.
	    - Compare serial vs. parallel systems in terms of speed, wiring, and typical use cases.
	3. Exercise (5 minutes) –
	    - Briefly summarize the key points of the lesson.
	    - Encourage students to think about and share examples of where they encounter these systems in daily life.

Closure	1. Recap the main points covered: definitions and characteristics of synchronous and asynchronous systems, serial and parallel systems, and their comparisons. 2. Allow students to ask questions and discuss any doubts or thoughts they have.
Evaluation	1. Assess student comprehension through informal checks during the lesson, such as questioning and observation. 2. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 3. Encourage active participation and provide feedback.

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Lesson Plan No. 1.3	Course Name: Computer Networks Topic: Dataflow - Simplex, Half-Duplex, and Full-Duplex	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Explain the concepts of simplex, half-duplex, and full-duplex communication. b. Identify the key characteristics and differences between these modes of dataflow. c. Discuss the applications and examples of each mode of dataflow.
Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube NPTEL videos d. Use of Nearpod/Tutorial sheets tool for online quiz
Teaching Development	1. **Introduction** (5 minutes) - Begin with a brainstorming session. Ask students: What do they understand by dataflow in communication systems? Can they think of any examples where data is sent in only one direction or in both directions? - Briefly introduce the topic and outline the objectives of the lesson. 2. **Development** (30 minutes) a. **Simplex Communication.** - Define simplex communication. - Explain how data is transmitted in only one direction (unidirectional). - Discuss examples and applications of simplex communication (e.g., keyboard to computer, television broadcast). b. **Half-Duplex Communication** - Define half-duplex communication. - Explain how data is transmitted in both directions, but not simultaneously. - Discuss examples and applications of half-duplex communication (e.g., walkie-talkies, CB radios). c. **Full-Duplex Communication** - Define full-duplex communication. - Explain how data is transmitted in both directions simultaneously. - Discuss examples and applications of full-duplex communication (e.g., telephone systems, modern Ethernet networks). d. **Comparison of Dataflow Modes** - Compare simplex, half-duplex, and full-duplex in terms of directionality, efficiency, and typical use cases. - Highlight the advantages and disadvantages of each mode. 3. Exercise (5 minutes) – - Briefly summarize the key points of the lesson.

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		- Encourage students to think about and share examples of where they encounter these modes of dataflow in their daily lives
Closure		1. Recap the main points covered: definitions and characteristics of simplex, half-duplex, and full-duplex communication, and their comparisons. 2. Allow students to ask questions and discuss any doubts or thoughts they have.
Evaluation		1. Assess student comprehension through informal checks during the lesson, such as questioning and observation. 2. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 3. Encourage active participation and provide feedback.

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Lesson Plan No. 1.4	Course Name: Computer Networks Topic: Uses of Computer Networks	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Explain what a computer network is. b. Identify the different uses of computer networks. c. Discuss the benefits and applications of computer networks in various fields.
Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube NPTEL videos d. Use of Nearpod/Tutorial sheets tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	- Begin with a brainstorming session. Ask students: What do they know about computer networks? Can they give examples of how they use networks in their daily lives?
	- Briefly introduce the topic and outline the objectives of the lesson.
	
	2. **Development** (30 minutes)
	  a. **Definition of a Computer Network.**
	    - Define a computer network.
	    - Explain the basic concept of interconnected computers sharing resources.
	    - Discuss examples and applications of simplex communication (e.g., keyboard to computer, television broadcast).
	  b. **Uses of Computer Networks**
	    - Discuss how networks enable communication through email, instant messaging, social media, and video conferencing.
	    - Explain how networks allow for sharing hardware (e.g., printers, scanners) and software resources (e.g., applications, data files).
	    - Explain how networks provide access to information through the internet, intranets, and extranets.
	    - Discuss how networks are used in streaming services, online gaming, and digital media sharing.
	    - Discuss how networks enable remote work, virtual offices, and telecommuting.
	  c. **Benefits of Computer Networks**
	    - Explain how networks improve efficiency and productivity by enabling quick access to information and resources.
	    - Discuss how networks can easily scale to accommodate growth in users and resources.
	  d. **Applications of Computer Networks**
	    - Provide real-world examples of network applications in various fields such as education, healthcare, business, government, and entertainment.

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	3. Exercise (5 minutes) – - Briefly summarize the key points of the lesson. - Encourage students to think about and share examples of computer networks they use and how they benefit from them.
Closure	1. Recap the main points covered: definition of computer networks, uses of computer networks, benefits, and applications in various fields. 2. Allow students to ask questions and discuss any doubts or thoughts they have.
Evaluation	1. Assess student comprehension through informal checks during the lesson, such as questioning and observation. 2. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 3. Encourage active participation and provide feedback.

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Lesson Plan No. 1.5	Course Name: Computer Networks Topic: Categories of Computer Networks	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: 　a.　Identify the different categories of computer networks. 　b.　Explain the characteristics of each network category. 　c.　Discuss the applications and advantages of each type of network.
Teaching Aids (if any)	a.　Presentation slides. b.　Projector c.　You Tube NPTEL videos d.　Use of Nearpod/Tutorial sheets tool for online quiz
Teaching Development	1.　**Introduction** (5 minutes) 　-　Begin with a brainstorming session. Ask students: What types of computer networks do they know? Can they give examples of where these networks are used? 　-　Briefly introduce the topic and outline the objectives of the lesson. 2.　**Development** (30 minutes) 　a.　**Personal Area Network (PAN)** 　**-** Define PAN. 　**-** Explain its characteristics, including short range (typically within a few meters). 　**-** Discuss applications and examples (e.g., Bluetooth connections between devices like smartphones, laptops, and wearables). 　b.　**Local Area Network (LAN)** 　- Define LAN. 　- Explain its characteristics, including a limited geographic area (e.g., a single building or campus). 　- Discuss applications and examples (e.g., home networks, office networks, school networks). 　c.　**Metropolitan Area Network (MAN)** 　- Define MAN. 　- Explain its characteristics, including coverage of a city or large campus. 　- Discuss applications and examples (e.g., city-wide Wi-Fi networks, large university networks). 　d.　**Wide Area Network (WAN)** 　- Define WAN. 　- Explain its characteristics, including large geographic areas (e.g., countries, continents). 　- Discuss applications and examples (e.g., the Internet, corporate networks connecting multiple locations). 　e.　**Virtual Private Network (VPN)** 　**-** Define VPN. 　**-** Explain its characteristics, including secure, encrypted connections over public networks.

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	- Discuss applications and examples (e.g., remote work, secure access to corporate networks). **f. Comparison of Network Categories** - Compare the different types of networks in terms of range, speed, cost, and typical use cases. - Highlight the advantages and disadvantages of each type. 3. Exercise (5 minutes) – - Briefly summarize the key points of the lesson. - Encourage students to think about and share examples of different types of networks they use or are familiar with.
Closure	1. Recap the main points covered: definitions and characteristics of PAN, LAN, MAN, WAN and VPN, and their comparisons. 2. Allow students to ask questions and discuss any doubts or thoughts they have.
Evaluation	1. Assess student comprehension through informal checks during the lesson, such as questioning and observation. 2. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 3. Encourage active participation and provide feedback.

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Lesson Plan No. 1.6	Course Name: Computer Networks Topic: Protocols and Standards	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	  a. Explain what protocols and standards are in the context of computer networks.
	  b. Identify key network protocols and their functions.
	  c. Discuss the importance of standards in ensuring interoperability and efficiency in networks.

Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube NPTEL videos d. Use of Nearpod/Tutorial sheets tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	  - Begin with a brainstorming session. Ask students: What do they understand by the terms 'protocol' and 'standard'? Can they name any network protocols they are familiar with?
	  - Briefly introduce the topic and outline the objectives of the lesson.
	
	2. **Development** (30 minutes)
	  a. Definition of Protocols and Standards
	    - Define what a protocol is in networking (a set of rules that govern data communication).
	    - Define what a standard is (an agreed-upon set of guidelines or specifications for hardware and software).
	  b. Key Network Protocols
	    - Explain how TCP ensures reliable data transmission.
	    - Describe how IP handles addressing and routing of packets.
	    - Discuss how HTTP is used for transferring web pages.
	    - Explain how FTP is used for transferring files between computers.
	    - Discuss how SMTP is used for sending emails.
	    - Explain how UDP is used for faster, but less reliable, data transmission.
	  c. Importance of Standards
	    - Discuss how standards ensure interoperability between different devices and networks.
	    - Explain how standards facilitate communication and data exchange, reduce costs, and promote innovation.
	    - Discuss applications and examples (e.g., city-wide Wi-Fi networks, large university networks).
	  d. Real-World Applications
	    - Provide examples of how protocols and standards are applied in real-world scenarios (e.g., internet browsing, online gaming, email communication).
	
	3. Exercise (5 minutes) –
	  - Briefly summarize the key points of the lesson.

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		- Encourage students to think about and share examples of how they use different protocols and standards in their daily lives.
Closure		1. Recap the main points covered: definitions and importance of protocols and standards, key network protocols, and examples of standards.
		2. Allow students to ask questions and discuss any doubts or thoughts they have.
Evaluation		1. Assess student comprehension through informal checks during the lesson, such as questioning and observation.
		2. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
		3. Encourage active participation and provide feedback.

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Lesson Plan No. 1.7	Course Name: Computer Networks Topic: OSI Reference Model	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	   a. Explain what the OSI Reference Model is and why it is important.
	   b. Identify and describe the seven layers of the OSI model.
	   c. Understand the functions and protocols associated with each layer.

Teaching Aids (if any)	a. Presentation slides.
	   b. Projector
	   c. You Tube NPTEL videos
	   d. Use of Nearpod/Tutorial sheets tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	   - Begin with a brainstorming session. Ask students: Have they heard of the OSI model? What do they know about it?
	   - Briefly introduce the topic and outline the objectives of the lesson.
	
	2. **Development** (30 minutes)
	   a. **Overview of the OSI Reference Model**
	     - Define the OSI (Open Systems Interconnection) model.
	     - Explain its importance in standardizing network communications and ensuring interoperability between different systems.
	     - Explain the different layers of OSI model.
	   b. **Application Layer**
	     - Describe how it provides network services directly to end-users.
	     - Mention common protocols like HTTP, FTP, SMTP.
	   c. **Presentation Layer**
	     - Explain its role in data translation, encryption, and compression.
	     - Mention concepts like data encryption and formatting (e.g., ASCII, JPEG).
	   d. **Session Layer**
	     - Discuss its function in establishing, maintaining, and terminating sessions.
	     - Mention protocols like RPC.
	   e. **Transport Layer**
	     - Explain how it ensures reliable data transfer and error recovery.
	     - Mention protocols like TCP and UDP
	   f. **Network Layer**
	     - Describe how it handles logical addressing and routing.
	     - Mention protocols like IP, ICMP.
	   g. **Data Link Layer**
	     - Explain its role in physical addressing and error detection/correction.
	     - Mention protocols like Ethernet, PPP.
	   h. **Physical Layer**
	     - Discuss its function in transmitting raw bitstreams over a physical medium.

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	- Mention physical elements like cables, switches, and electrical signals.
	3. Exercise (5 minutes) – - Briefly summarize the key points of the lesson. - Encourage students to think about and share examples of how they use different layers of the OSI model in their daily network interactions.
Closure	1. Recap the main points covered: overview of the OSI model, the seven layers, their functions, and associated protocols. 2. Allow students to ask questions and discuss any doubts or thoughts they have.
Evaluation	1. Assess student comprehension through informal checks during the lesson, such as questioning and observation. 2. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 3. Encourage active participation and provide feedback.

Lesson Plan No. 1.8	Course Name: Computer Networks Topic: OSI Reference Model	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	    a. Identify and describe the seven layers of the OSI model.
	    b. Understand the functions and protocols associated with each layer.

Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube NPTEL videos d. Use of Nearpod/Tutorial sheets tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	    - Ask questions
	    - Highlight the applications of each of the layer of Model
	    - Briefly introduce the topic and outline the objectives of the lesson.
	
	2. **Development** (30 minutes)
	    a. **Functions and Protocols of Each Layer**
	      -Provide more detailed explanations of the functions and protocols associated with each layer.
	      - Use examples and scenarios to illustrate how each layer operates and interacts with others.
	    b. **Importance of the OSI Model**
	      - Discuss how the OSI model helps in troubleshooting and designing network systems.
	      - Explain its role in facilitating communication between different hardware and software systems.
	
	3. Exercise (5 minutes) –
	    - Summarize the key points of the lesson.
	    - Encourage students to think about and share examples of how they use different layers of the OSI model in their daily network interactions.

Closure	1. Recap the main points covered: overview of the OSI model, the seven layers, their functions, and associated protocols. 2. Allow students to ask questions and discuss any doubts or thoughts they have.
Evaluation	1. Assess student comprehension through informal checks during the lesson, such as questioning and observation. 2. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 3. Encourage active participation and provide feedback.

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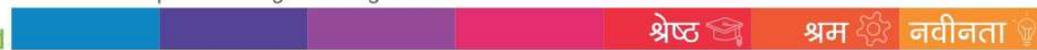| Lesson Plan No. 1.9	Course Name: Computer Networks Topic: TCP/IP Reference Model	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	  a. Explain what the TCP/IP Reference Model is and its significance in networking.
	  b. Identify and describe the layers of the TCP/IP model.
	  c. Understand the functions and protocols associated with each layer.

Teaching Aids (if any)	a. Presentation slides.
	  b. Projector
	  c. You Tube NPTEL videos
	  d. Use of Nearpod/Tutorial sheets tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	  - Begin with a brainstorming session. Ask students: Have they heard of the TCP/IP model? What do they know about it?
	  - Briefly introduce the topic and outline the objectives of the lesson.
	
	2. **Development** (30 minutes)
	  a. **Overview of the TCP/IP Reference Model**
	    - Define the TCP/IP (Transmission Control Protocol/Internet Protocol) model.
	    - Explain its importance in standardizing internet communications and ensuring interoperability between different systems.
	    - Present a diagram of the TCP/IP model with its four layers.
	  b. **Application Layer**
	    - Describe how it provides network services directly to end-users.
	    - Mention common protocols like HTTP, FTP, SMTP, DNS.
	  c. **Transport Layer**
	    - Explain how it ensures reliable data transfer and error recovery.
	    - Mention protocols like TCP and UDP.
	  d. **Internet Layer**
	    - Describe how it handles logical addressing and routing.
	    - Mention protocols like IP, ICMP, ARP.
	  e. **Network Interface Layer (Link Layer)**
	    - Explain its role in physical addressing and framing.
	    - Mention technologies like Ethernet, Wi-Fi, and point-to-point protocol.
	
	3. Exercise (5 minutes) –
	  - Summarize the key points of the lesson.
	  - Encourage students to think about and share examples of how they use different layers of the TCP/IP model in their daily network interactions.

Closure	1. Recap the main points covered: overview of the TCP/IP model, its layers, their functions, and associated protocols. 2. Allow students to ask questions and discuss any doubts or thoughts they have.

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Model Institute of Engineering
& Technology (Autonomous)
Lesson Plan

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Evaluation	1. Assess student comprehension through informal checks during the lesson, such as questioning and observation.
	2. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
	3. Encourage active participation and provide feedback.

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Lesson Plan No. 1.10	Course Name: Computer Networks Topic: TCP/IP Reference Model	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	   a. Explain what the TCP/IP Reference Model is and its significance in networking.
	   b. Identify and describe the layers of the TCP/IP model.
	   c. Understand the functions and protocols associated with each layer.

Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube NPTEL videos d. Use of Nearpod/Tutorial sheets tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	   - Ask questions
	   - Highlight the applications of each of the layer of Model
	   - Briefly introduce the topic and outline the objectives of the lesson
	
	2. **Development** (30 minutes)
	   a. Functions and Protocols of Each Layer
	   - Provide more detailed explanations of the functions and protocols associated with each layer.
	   - Use examples and scenarios to illustrate how each layer operates and interacts with others.
	   b. Comparison with OSI Model
	   - Compare the TCP/IP model with the OSI model, highlighting similarities and differences.
	   - Discuss the practical usage and widespread adoption of the TCP/IP model in real-world networking.
	   c. Importance of the TCP/IP Model
	   - Discuss how the TCP/IP model helps in the design, implementation, and management of networks, especially the Internet.
	   - Explain its role in facilitating communication between different hardware and software systems.
	
	3. Exercise (5 minutes) –
	   - Summarize the key points of the lesson.
	   - Encourage students to think about and share examples of how they use different layers of the TCP/IP model in their daily network interactions.

Closure	1. Recap the main points covered: overview of the TCP/IP model, its layers, their functions, and associated protocols. 2. Allow students to ask questions and discuss any doubts or thoughts they have.
Evaluation	1. Assess student comprehension through informal checks during the lesson, such as questioning and observation. 2. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 3. Encourage active participation and provide feedback.

Lesson Plan No. 1.11	Course Name: Computer Networks Topic: Network Topologies	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Explain what network topologies are. b. Identify different types of network topologies. c. Discuss the advantages, disadvantages, and applications of each topology.
Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube NPTEL videos d. Use of Nearpod/Tutorial sheets tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	- Begin with a brainstorming session. Ask students: What do they think network topology means? Can they name any types of network topologies?
	- Briefly introduce the topic and outline the objectives of the lesson
	
	2. **Development** (30 minutes)
	  a. **Definition of Network Topology**
	  - Define network topology as the arrangement of various elements (links, nodes, etc.) in a computer network.
	  - Explain the importance of choosing the right topology for network performance and efficiency.
	  - Explain the different types of topologies.
	  b. **Bus Topology**
	  - Explain the structure: a single central cable to which all network devices are connected.
	  - Discuss its advantages (e.g., easy to install, inexpensive) and disadvantages (e.g., difficult to troubleshoot, limited cable length and number of stations).
	  - Provide examples of where bus topology might be used.
	  c. **Star Topology**
	  - Explain the structure: all devices are connected to a central hub.
	  - Discuss its advantages (e.g., easy to manage, better performance) and disadvantages (e.g., if the central hub fails, the whole network is affected).
	  - Provide examples of where star topology might be used.
	  d. **Ring Topology**
	  - Explain the structure: each device is connected to two other devices, forming a ring.
	  - Discuss its advantages (e.g., data packets travel in one direction, reduced chances of data collision) and disadvantages (e.g., a failure in any cable or device breaks the loop).
	  - Provide examples of where ring topology might be used.
	  e. **Mesh Topology**
	  - Explain the structure: every device is connected to every other device.

	- Discuss its advantages (e.g., high redundancy, reliable) and disadvantages (e.g., expensive, complex to set up and maintain). - Provide examples of where mesh topology might be used. 3. Exercise (5 minutes) – - Summarize the key points of the lesson. - Encourage students to think about and share examples of different network topologies they have encountered or used.
Closure	1. Recap the main points covered: definition of network topology, types of network topologies, their advantages and disadvantages, and applications. 2. Allow students to ask questions and discuss any doubts or thoughts they have.
Evaluation	1. Assess student comprehension through informal checks during the lesson, such as questioning and observation. 2. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 3. Encourage active participation and provide feedback.

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Lesson Plan No. 1.12	Course Name: Computer Networks Topic: Network Topologies	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Explain what network topologies are. b. Identify different types of network topologies. c. Discuss the advantages, disadvantages, and applications of each topology.
Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube NPTEL videos d. Use of Nearpod/Tutorial sheets tool for online quiz
Teaching Development	1. **Introduction** (5 minutes) - Ask questions - Highlight the various network topologies. - Briefly introduce the topic and outline the objectives of the lesson. 2. **Development** (30 minutes) a. **Tree Topology** - Explain the structure: a combination of star and bus topologies. - Discuss its advantages (e.g., scalable, easy to manage) and disadvantages (e.g., if the backbone line breaks, the entire network segment goes down). - Provide examples of where tree topology might be used. b. **Hybrid Topology** - Explain the structure: a combination of two or more different types of topologies. - Discuss its advantages (e.g., flexible, scalable) and disadvantages (e.g., complex design and maintenance). - Provide examples of where hybrid topology might be used. c. **Comparison of Network Topologies** - Compare different types of topologies in terms of cost, performance, reliability, and scalability. - Use diagrams and real-world examples to illustrate the differences. d. **Applications of Network Topologies** - Discuss practical applications of different topologies in various environments such as homes, offices, data centers, and large enterprises. 3. Exercise (5 minutes) – - Summarize the key points of the lesson. - Encourage students to think about and share examples of different network topologies they have encountered or used.
Closure	1. Recap the main points covered: definition of network topology, types of network topologies, their advantages and disadvantages, and applications. 2. Allow students to ask questions and discuss any doubts or thoughts they have.

Evaluation	1. Assess student comprehension through informal checks during the lesson, such as questioning and observation.
	2. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
	3. Encourage active participation and provide feedback.

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Lesson Plan No. 2.1	Course Name: Computer Networks Topic: Concept of physical Layers	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Articulate the concept of the physical layer in the OSI Model. b. Appreciate the function of the physical layer. c. Understand basic concepts of data transmission.
Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube NPTEL videos d. White Board e. Use of Nearpod/Tutorial sheets tool for online quiz

Teaching Development	a. **Introduction to Physical Layer (10 minutes):**
	● Concept of Physical Layer:
	  o Explain what the physical layer is and its role in the OSI model.
	  o Use PowerPoint slides to illustrate the position of the physical layer within the OSI model and its interactions with other layers.
	● Working/Functionality of Physical Layer:
	  o Explain how the physical layer transmits raw bitstreams over a physical medium.
	  o Discuss bit-level transmission, modulation, and signal processing using real-world examples (e.g., Ethernet cables, fiber optics).
	  o Use diagrams and animations to show signal conversion and transmission processes.
	b. Introduction to Signalling Concept in Networking (10 minutes):
	● Concept of Periodic Signals:
	  o Define periodic signals and their role in data transmission.
	  o Show NPTEL video on periodic signals for a visual explanation.
	● Types of Signals:
	  o Differentiate between analog and digital signals.
	  o Discuss modulation techniques (AM, FM, PM) and their applications.
	  o Use visual aids and simulations to demonstrate how modulation affects signal transmission.
	c. Introduction to Frequency Spectrum (10 minutes):
	● Frequency Spectrum and Bandwidth:
	  o Define frequency spectrum and bandwidth, and explain their importance in data transmission.
	  o Illustrate these concepts using diagrams and the whiteboard.
	  o Explain how bandwidth affects data transfer rates and network performance.
	3. Exercise (10 minutes)
	● Summary:
	  o Briefly summarize the key points of the lesson.
	● Class Discussion:
	  o Encourage students to think about and share examples of data communication systems they encounter daily.
	● Activity: "What's in Your Wallet (Network Edition)":

	o Rules:
	1. Set a timer for 30 seconds. Instruct students to identify and display 5 or more internet-connected devices from their home or classroom.
	2. Students should show these items on their cameras or list them in class.
	3. Points are awarded for each device shown, with wireless printers or desktops counted as half points.
	4. Discuss the prevalence of network-connected devices and their dependence on the physical layer for connectivity.
Closure	• Recap (5 mins):
	Recap the main points covered: the concept of the physical layer, its functionality, and key concepts in data transmission.
	• Q&A:
	Allow students to ask questions and discuss any doubts or thoughts they have.
	• Suggested Reading:
	Link: Physical Layer in OSI Model
	• Homework:
	Students list and define the devices they presented during the activity for the next session.
Evaluation	(5 minutes)
	Reflective Questions:
	1. What is the physical layer and its role in the OSI model?
	2. Why is the physical layer important for data communication?
	3. Who are the key players involved in a communication system?
	• Student Discussion:
	Allow students to answer and discuss these questions to evaluate their understanding of the lesson.

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Lesson Plan No. 2.2	Course Name: Computer Networks Topic: Digital to Digital Conversion and Line Coding Scheme	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	   a. Appreciate the Concept of Digital-to-Digital Conversion
	   b. Identify Different Digital-to-Digital Conversion Techniques
	   c. Describe the Purpose and Importance of Line Coding

Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube NPTEL videos d. White Board e. Use of Nearpod/Tutorial sheets tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	• Ask Questions:
	   - What do you know about digital signals?
	   - Have you heard about line coding schemes before?
	• Set the Scene:
	   - Briefly introduce the concept of digital-to-digital conversion and line coding.
	2. **Development** (35 minutes)
	   a. Digital to Digital Conversion:
	      ● Explain the concept of digital signals.
	      ● Discuss the importance of digital-to-digital conversion.
	      ● Visual Aid: Use PPTs to show examples of digital-to-digital conversion.
	   b. Line Coding Schemes:
	      ● Define line coding and its purpose.
	      ● Discuss various line coding schemes: Unipolar, Polar, Bipolar, and Manchester coding.
	      ● Example Demonstration: Illustrate each coding scheme on the green board.
	3. **Exercise (5 minutes)**
	   Class Discussion:
	● Ask students to give examples of where digital to digital conversion is used in real life.
	   Activity**:**
	● Quick quiz on Nearpod to identify different line coding schemes.

Closure	• Recap: Summarize the key points of digital-to-digital conversion and line coding schemes. • Q&A: Address any questions from students.
Evaluation	1. Assess student comprehension through informal checks during the lesson, such as questioning and observation.

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	2. Use reflective questions (What, Why, Who?) to allow students to answer and discuss: ● What: What are the different line coding schemes? ● Why: Why is line coding necessary in digital communication? ● Who: Who might use these digital conversion techniques and coding schemes in their daily work or studies?

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Lesson Plan No. 2.3	Course Name: Computer Networks Topic - Transmission Media	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Identify and Describe Types of Transmission Media b. Compare and Contrast Transmission Media c. Select Appropriate Transmission Media d. Identify and discuss recent advancements and future trends in transmission media technologies
Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube NPTEL videos d. White Board e. Use of Nearpod/Tutorial sheets tool for online quiz
Teaching Development	1. **Introduction** (5 minutes) • Ask Questions: Can you name different types of transmission media? • Set the Scene: Briefly introduce the types of transmission media. 2. **Development** (35 minutes) a) **Wired Media:** ● Discuss different types of wired media: Twisted pair cables, Coaxial cables, and Fiber optics. ● **Visual Aid:** Use PPTs to show images and diagrams of each type. b) **Wireless Media:** ● Explain various wireless media: Radio waves, Microwaves, and Infrared. ● **Example Demonstration:** Illustrate how wireless transmission works using the green board. **Real-Time Examples** Show a video on 3. **Exercise (5 minutes) –** ● **Class Discussion:** o Ask students to list devices that use different transmission media. ● **Activity:** o Quick quiz on Nearpod to match transmission media with their uses.
Closure	**Recap:** Summarize the types of transmission media discussed. **Q&A:** Address any questions from students.
Evaluation	1. Assess student comprehension through informal checks during the lesson, such as questioning and observation. 2. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. ● What: What are the different types of transmission media?

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	● Why: Why is it important to choose the right transmission media? ● Who: Who might be involved in deciding which transmission media to use in different scenarios?

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Lesson Plan No. 2.4	Course Name: Computer Networks Topic: RS-232 Interface	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	   a. Understand RS-232 Basics
	   b. Identify RS-232 Pinout and Signals
	   c. Compare RS-232 with Other Serial Interfaces

Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube NPTEL videos d. White Board e. Use of Nearpod/Tutorial sheets tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	   - Ask students: Have you encountered the RS-232 interface in any devices?
	   - Set the Scene: Briefly introduce the RS-232 interface and its applications.
	
	2. **Development** (35 minutes)
	   a. RS-232 Interface:
	      ● Define RS-232 and its role in data communication.
	      ● Discuss the pin configuration and signal description.
	      ● Visual Aid: Use PPTs to show the RS-232 connector and its pin configuration.
	   b. Applications:
	      ● Explain where RS-232 is used in real life.
	      ● Example Demonstration: Show examples of devices that use RS-232.
	      ● Discuss different types of media: wired (e.g., twisted pair, coaxial cable, fiber optics) and wireless (e.g., radio waves, microwaves, infrared).
	   3. **Exercise** (5 minutes) –
	Class Discussion: - Ask students to identify devices they know that use RS-232.
	
	Activity:
	
	   ● Quick quiz on Nearpod to label the RS-232 pin configuration.

Closure	• Recap:
	   Summarize the key points of the RS-232 interface.
	• Q&A:
	   Address any questions from students.

Evaluation	1. Assess student comprehension through informal checks during the lesson, such as questioning and observation. 2. Use reflective questions (What, Why, Who?) to allow students to answer and discuss: 3. **What:** What are the key features of the RS-232 interface?

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	4. **Why:** Why is RS-232 still used in certain applications despite the availability of newer interfaces? 5. **Who:** Who might need to use or understand RS-232 in their field of work?

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Lesson Plan No. 2.5	Course Name: Computer Networks Topic: Switching Mechanisms and Comparison	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	   a. Identify and Differentiate Switching Techniques
	   b. Understand Switching in Modern Networks

Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube NPTEL videos d. White Board e. Use of Nearpod/Tutorial sheets tool for online quiz

Teaching Development	● **Introduction** (5 minutes)
	● Ask students: What do you know about data switching?
	● Briefly introduce the different switching mechanisms.
	● **Development** (30 minutes)
	● **Circuit Switching:**
	● Explain the concept of circuit switching.
	● Use PPTs to show examples of circuit switching.
	● **Packet Switching:**
	● Define packet switching and its importance in modern networks.
	       - Data is divided into packets that are routed independently.
	       - More efficient use of network resources compared to circuit switching
	● **Example Demonstration:** Illustrate packet switching on the whiteboard, showing how packets travel through the network and are reassembled at the destination.
	
	● **Message Switching:**
	● Discuss the concept of message switching:
	       - Entire messages are routed and stored at intermediate nodes until the path to the destination is available.
	       -Used in telegraphy and some early computer networks.
	● Compare message switching with circuit and packet switching.
	● Visual Aid: Use PPTs to show examples and diagrams of message switching.
	
	     3. **Exercise (5 minutes)** –
	Class Discussion:
	
	● Ask students to compare the pros and cons of each switching mechanism.
	      o **Circuit Switching:** Reliable and predictable, but inefficient use of resources.
	      o **Packet Switching:** Efficient and scalable, but potential for delays and packet loss.

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	o **Message Switching:** Flexible and stores complete messages, but can introduce significant delays. **- Activity:** ● Quick quiz on Nearpod to match switching mechanisms with their definitions.
Closure	☷ **Recap:** Summarize the different switching mechanisms and their comparisons. ☷ **Q&A:** Address any questions from students.
Evaluation	1. Assess student comprehension through informal checks during the lesson, such as questioning and observation. 2. Use reflective questions (What, Why, Who?) to allow students to answer and discuss: 　● What are the different switching mechanisms? 　● Why are different switching mechanisms used in different contexts? 　● Who might be involved in choosing a switching mechanism for a network?

Lesson Plan No. 2.6	Course Name: Computer Networks Topic: Modems and Their Types	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	    a. Describe and Classify Modem Types
	    b. Compare Modem Technologies
	    c. Discuss the Evolution of Modems

Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube NPTEL videos d. White Board e. Use of Nearpod/Tutorial sheets tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	    • **Brainstorming Session:**
	    - Ask students: What do you know about modems?
	    - Gather responses to gauge their prior knowledge and set the stage for the lesson.
	    • **Brief Introduction:**
	    - Introduce the concept of modems and their significance in data communication.
	2. **Development** (30 minutes)
	    Modems:
	    ● Define modems and their role in data communication.
	    ● Discuss the basic working principle of modems.
	    ● **Visual Aid:** Use PPTs to show images of modems
	    Types of Modems:
	    ● Explain different types of modems: Dial-up, DSL, Cable, and Fiber optic modems.
	    ● **Example Demonstration:** Illustrate the working of each type of modem on the green board.
	
	3. Exercise (5 minutes) –
	    - **Class Discussion:**
	    ● Ask students to list the types of modems they have used or encountered.
	    - **Activity:**
	    ● Quick quiz on Nearpod to identify the types of modems from given descriptions.

Closure	🎬 Recap**:** Summarize the key points about modems and their types. 🎬 Q&A**:** Address any questions from students.

Evaluation	1. Assess student comprehension through informal checks during the lesson, such as questioning and observation.
	2. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
	    ● What are the different types of modems?
	    ● Why have modem technologies evolved over time?

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	● Who might need to use or understand different modem types in their field of work?

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Lesson Plan No. 3.1	Course Name: Computer Networks Topic: Data Link Layer	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Understand the basic concepts of the Data Link Layer. b. Identify the functions and services provided by the Data Link Layer. c. Explain the importance of error detection and correction. d. Recognize various protocols used at the Data Link Layer.
Teaching Aids (if any)	a. Presentation slides. b. Projector c. You Tube NPTEL videos d. Use of Nearpod/Tutorial sheets tool for online quiz
Teaching Development	**1. Introduction (5 minutes)** - Ask students: • What do you know about the Data Link Layer in networking? • Can you name some functions that the Data Link Layer performs? Explain the relevance of the Data Link Layer in the OSI model and its role in network communication. **2. Development (30 minutes)** a. **What is the Data Link Layer?** **Definition:** • Explain the Data Link Layer as the second layer in the OSI model responsible for node-to-node data transfer. • Emphasize its role in establishing, maintaining, and terminating a connection between two physically connected devices. Importance: • Discuss how the Data Link Layer ensures error-free data transfer between devices. • Mention its critical role in local area networks (LANs) and wide area networks (WANs). **2. Functions of the Data Link Layer** -Framing: • Explain the process of dividing the data stream into manageable frames. • Error Control: • Discuss techniques like Cyclic Redundancy Check (CRC) and Parity Check. • Flow Control: • Explain how flow control manages the pace of data transmission between sender and receiver.

	• MAC Addressing:
	• Describe how MAC addresses are used for hardware addressing in a network.
	3. **Protocols in the Data Link Layer**
	  Common Protocols:
	  • Discuss protocols like Ethernet, PPP (Point-to-Point Protocol), and HDLC (High-Level Data Link Control).
	  Real-World Example:
	  • Illustrate the use of Ethernet in a typical office LAN.
	4. **Applications of the Data Link Layer**
	  Real-World Applications:
	  • Discuss examples such as local area networks (LANs) and wireless communication.
	  Case Study:
	  • Walk through a scenario of data transfer in a LAN identifying components and protocols involved.
	  YouTube Video:
	
	Exercise (5 minutes)
	Ask students to summarize the key functions of the Data Link Layer.
	 Discuss the answers with the class.

Closure	Summarize the lesson learning outcomes and confirm understanding with the students. Suggested Reading: • 'Data and Computer Communications' by William Stallings Chapter 7 pp. 150-180. • 'Computer Networking: A Top-Down Approach' by James Kurose and Keith Ross Chapter 6 pp. 400-420. **Homework** Write a short essay on the importance of error detection and correction at the Data Link Layer and upload it on the course portal.
Evaluation	1. Reflective Questions (What, Why, Who?): 2. How would you define the Data Link Layer in your own words? 3. What are the basic functions of the Data Link Layer?

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Lesson Plan No. 3.2	Course Name: Computer Networks Topic: Error Detection and Correction	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	   a. Understand the basic concepts of error detection and correction.
	   b. Identify different types of errors in data communication.
	   c. Explain various error detection techniques.
	   d. Understand and apply error correction methods.

Teaching Aids (if any)	a. Presentation slides.
	   b. Projector
	   c. You Tube NPTEL videos
	   d. Use of Nearpod/Tutorial sheets tool for online quiz

Teaching Development	**1. Introduction (5 minutes)**
	
	- Ask questions.
	What do you understand by the term "error detection and correction"?
	Have you ever experienced data errors in your communication devices?
	Explain the importance of error detection and correction in reliable communication.
	
	2. Development (30 minutes)
	   a. What is Error Detection and Correction?
	
	   - Explain error detection as identifying errors in the transmitted data and error correction as the process of correcting these errors to retrieve the original data.
	
	   - Discuss the necessity of these processes to ensure reliable data transmission and communication integrity.
	
	Types of Errors in Data Communication
	   - Single-Bit Errors:
	   - Explain how single-bit errors affect only one bit of the data unit.
	   - Burst Errors:
	   - Describe burst errors as affecting multiple bits within a data unit.
	
	   ● **Error Detection Techniques**
	   Parity Check:
	   - Explain how parity bits are used to detect errors.
	   Cyclic Redundancy Check (CRC):

	- Describe CRC and its use in detecting errors through polynomial division. *Checksum:* - Discuss the use of checksums in detecting errors by summing up data segments. ● **Error Correction Methods** *Automatic Repeat Request (ARQ):* - Explain ARQ as a method where the sender retransmits data upon detecting errors. *Forward Error Correction (FEC):* - Describe FEC as a method that adds redundant data to correct errors without retransmission. *Hamming Code:* - Explain the Hamming code and its ability to detect and correct single-bit errors. ● **Applications of Error Detection and Correction** - Discuss real-world applications such as in internet communication, satellite transmission, and data storage. **Exercise (5 minutes)** - Ask students to list and describe various error detection techniques. - Discuss the answers with the class.

Closure	Summarize the lesson learning outcomes and get affirmation from students on these.
	 Suggested Reading:
	  - "Data and Computer Communications" by William Stallings, Chapter 6, pp. 150-175.
	  - "Computer Networking: A Top-Down Approach" by James Kurose and Keith Ross, Chapter 3, pp. 123-145.
	 Homework
	
	 Write a short essay on the importance of error correction in data communication and upload it on the Camu.

Evaluation	Reflective Questions (What, Why, How). Allow students to answer and discuss.
	- How would you define error detection in your own words?
	- What are the basic error detection techniques?
	- Why is error correction necessary?
	Spend 5 minutes to wrap up and consolidate the learnings.

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Lesson Plan No. 3.3	Course Name: Computer Networks Topic: Flow Control - Elements of Data Link Protocol	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	  a. Understand the concept of flow control in data link protocols.
	  b. Identify different flow control mechanisms.
	  c. Explain the importance of flow control in network communication.
	  d. Recognize the practical applications of flow control in data communication.

Teaching Aids (if any)	a. Presentation slides.
	  b. Projector
	  c. You Tube NPTEL videos
	  d. Use of Nearpod/Tutorial sheets tool for online quiz

Teaching Development	**Introduction (5 minutes)** ● Ask students: - What do you understand by the term "flow control" in the context of data communication? - Can you think of a situation where managing the flow of data is critical? - Explain the relevance of flow control in ensuring efficient and reliable communication in networks. **Development (30 minutes)** ● **What is Flow Control?** - Definition: - Explain flow control as the process of managing the rate of data transmission between two nodes to prevent a fast sender from overwhelming a slow receiver. - Importance: - Discuss how flow control ensures data integrity and prevents data loss by managing buffer capacities. ● **Basic Flow Control Mechanisms** ● **Stop-and-Wait Protocol:** - Describe the mechanism where the sender stops and waits for an acknowledgment for each data frame before sending the next one. - Advantages and Disadvantages: - Discuss simplicity and reliability vs. inefficiency and low utilization of bandwidth. ● **Sliding Window Protocol:** - Explain the mechanism allowing the sender to send multiple frames before needing an acknowledgment, with a sliding window controlling the flow. - Advantages and Disadvantages: - Discuss improved efficiency and better bandwidth utilization vs. increased complexity.

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	● **Flow Control in Action**
	● **Real-world Examples:**
	- Discuss the use of flow control in protocols like TCP (Transmission Control Protocol) and its role in preventing network congestion.
	● **Case Study:**
	- Walk through a scenario of file transfer between two devices, highlighting the role of flow control mechanisms.
	● **YouTube Video:**
	Exercise (5 minutes)
	Ask students to summarize the main flow control mechanisms and their roles. Discuss the answers with the class.
Closure	Summarize the lesson learning outcomes and get affirmation from students on these.
	Suggested Reading:
	"Data and Computer Communications" by William Stallings, Chapter 7, pp. 230-260.
	"Computer Networking: A Top-Down Approach" by James Kurose and Keith Ross, Chapter 3, pp. 150-185.
	Homework:
	Write a short essay on the differences between stop-and-wait and sliding window protocols and upload it on the learning management system (LMS).
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
	2. How would you define flow control in your own words?
	3. What are the basic flow control mechanisms?
	4. Why is flow control necessary in data communication?

Lesson Plan No. 3.4	Course Name: Computer Networks Topic: Sliding Window Protocol	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	   a. Understand the basic concepts of the Sliding Window Protocol.
	   b. Explain how the Sliding Window Protocol manages data transmission.
	   c. Identify the advantages and limitations of using the Sliding Window Protocol.
	   d. Implement the Sliding Window Protocol in a simulated environment.

Teaching Aids (if any)	a. Presentation slides.
	   b. Projector
	   c. You Tube video

Teaching Development	**Introduction (5 minutes)**
	   ● Ask students:
	   ● What do you understand by the term "Sliding Window Protocol"?
	   ● Have you ever experienced data transmission errors in your daily internet usage?
	   ● Explain the relevance of reliable data communication and how the Sliding Window Protocol helps in achieving this.
	
	Development (30 minutes)
	What is the Sliding Window Protocol?
	   ● Definition:
	   ● Explain the Sliding Window Protocol as a method for reliable and sequential data transmission.
	   ● Emphasize its role in various applications such as TCP/IP.
	Importance:
	   ● Discuss how the Sliding Window Protocol ensures efficient and error-free data transmission.
	   ● Highlight the benefits of using this protocol in terms of network performance and reliability.
	Types of Sliding Window Protocols:
	Stop-and-Wait ARQ:
	   ● Explain the basic mechanism.
	   ● Discuss its advantages and limitations.
	Go-Back-N ARQ:
	   ● Explain how it differs from Stop-and-Wait ARQ.
	   ● Discuss its working mechanism and efficiency.
	Selective Repeat ARQ:
	   ● Explain its advanced features.
	   ● Discuss how it improves upon the limitations of Go-Back-N ARQ.
	Components of the Sliding Window Protocol:
	Window Size:
	   ● Explain the concept of window size in the protocol.
	   ● Discuss how it affects the flow control and efficiency.
	Acknowledgment:
	   ● Explain the role of acknowledgments in ensuring data integrity.
	Sequence Numbers:
	   ● Discuss the importance of sequence numbers in maintaining the order of data packets.
	Real-World Application:

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	Example:
	● Walk through a scenario of a file download from a server, identifying how the Sliding Window Protocol ensures reliable transmission.
	YouTube Video:
	Exercise (5 minutes)
	Ask students to summarize the types of Sliding Window Protocols and their roles. Discuss the answers with the class to reinforce the learning.
Closure	Summarize the Lesson Learning Outcomes and get affirmation from students.
	Suggested Reading:
	"Data and Computer Communications" by William Stallings, Chapter 7, pp. 230-255.
	"Computer Networking: A Top-Down Approach" by James Kurose and Keith Ross, Chapter 3, pp. 145-175.
	Homework:
	Write a short essay on the importance of the Sliding Window Protocol in reliable data communication and upload it on Camu.
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
	2. How would you define the Sliding Window Protocol in your own words?
	3. What are the different types of Sliding Window Protocols?
	4. Why is the Sliding Window Protocol necessary?
	Spend 5 minutes to wrap up and consolidate the learnings.

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Lesson Plan No. 3.5	Course Name: Computer Networks Topic: Example of Data Link Protocol (HDLC)	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	   a. Understand the basic concepts of the HDLC protocol.
	   b. Explain how HDLC manages data transmission.
	   c. Identify the advantages and limitations of using HDLC.
	   d. Implement the HDLC protocol in a simulated environment.

Teaching Aids (if any)	a. Presentation slides.
	   b. Projector
	   c. You Tube video

Teaching Development	**Introduction (5 minutes)**
	
	● **Ask students:**
	    ○ What do you understand by the term "HDLC"?
	    ○ Have you ever wondered how data frames are managed in data communication systems?
	    ○ Explain the relevance of reliable data communication and how HDLC helps in achieving this.
	
	Development (30 minutes)
	
	What is HDLC?
	
	● **Definition:**
	    ○ Explain HDLC (High-Level Data Link Control) as a bit-oriented synchronous data link layer protocol.
	    ○ Emphasize its role in reliable and efficient data transmission.
	
	Importance:
	
	● Discuss how HDLC ensures efficient and error-free data transmission.
	● Highlight the benefits of using HDLC in terms of network performance and reliability.
	
	Modes of HDLC:
	
	● **Normal Response Mode (NRM):**
	    ○ Explain the basic mechanism and its typical use in point-to-multipoint links.
	● **Asynchronous Balanced Mode (ABM):**
	    ○ Explain how it differs from NRM and its use in point-to-point links.
	● **Asynchronous Response Mode (ARM):**
	    ○ Describe its features and typical use scenarios.
	
	Components of HDLC:

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	● **Frame Structure:**
	  ○ Explain the structure of an HDLC frame, including fields like Flag, Address, Control, Information, and FCS (Frame Check Sequence).
	● **Frame Types:**
	  ○ Discuss the three main types of HDLC frames: Information (I-frames), Supervisory (S-frames), and Unnumbered (U-frames).
	● **Error Detection and Control:**
	  ○ Explain the mechanisms HDLC uses for error detection and flow control.
	
	Real-World Application:
	
	● **Example:**
	  ○ Walk through a scenario of a data transmission between two devices, identifying how HDLC ensures reliable communication.
	● **YouTube Video:**
	
	Exercise (5 minutes)
	
	● Ask students to summarize the different modes of HDLC and their roles.
	● Discuss the answers with the class to reinforce the learning.

Closure	Summarize the Lesson Learning Outcomes and get affirmation from students on these. Suggested Reading: "Data and Computer Communications" by William Stallings Chapter 2 pp. 50-70. "Computer Networking: A Top-Down Approach" by James Kurose and Keith Ross Chapter 2 pp. 45-65.
Evaluation	Reflective Questions (What Why Who?). Allow students to answer and discuss. ● How would you define data communication in your own words? ● What are the basic components of data communication? ● Why are protocols necessary? Spend 5 minutes to wrap up and consolidate the learnings.

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Lesson Plan No. 3.6	Course Name: Computer Networks Topic: Channel Allocation Problems	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	    a. Define channel allocation and its significance in communication networks.
	    b. Identify different types of channel allocation methods (Fixed, Dynamic, Hybrid).
	    c. Analyze the challenges of channel allocation in wireless and mobile networks.
	    d. Explore solutions to mitigate channel allocation problems in modern networks.

Teaching Aids (if any)	a. Presentation slides. b. Projector

Teaching Development	**Introduction (5 minutes)**
	
	● **Ask students:**
	    ○ How does your phone or Wi-Fi connect to the internet without interference from other devices?
	    ○ Explain briefly what channel allocation is and its relevance in everyday communication (Wi-Fi, cellular networks).
	
	Development (40 minutes)
	
	A. Channel Allocation Methods (15 minutes)
	
	a. Fixed Allocation (7 minutes)
	
	● **Definition:** Explain how fixed allocation assigns specific channels to specific users or cells.
	● **Example:** Analog cellular systems, traditional FM radio stations.
	● **Discussion:** Ask, "What are the potential inefficiencies of fixed allocation?" (e.g., underutilized channels during low demand).
	● **Real-World Example:** Discuss the use of frequency division multiple access (FDMA) in early cell phone systems.
	
	b. Dynamic Allocation (8 minutes)
	
	● **Definition**: Explain how dynamic allocation allows channels to be assigned on-demand.
	● **Example**: GSM cellular networks dynamically allocate channels based on user demand.
	● **Discussion**: "How does this method adapt to varying traffic loads in mobile networks?"
	● **Real-World Example**: Explore how modern 4G/5G networks use dynamic allocation to improve spectrum efficiency.

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	B. Challenges of Channel Allocation (10 minutes) ● **Interference**: Explain how multiple users can interfere with each other, leading to performance degradation. ● **Scarcity of Spectrum**: Discuss the limited availability of frequencies and the need for efficient allocation. ● **Real-World Problem**: "How do cities with high population densities (like New York) manage spectrum to support millions of cellular users?" **C. Solutions to Channel Allocation Problems (5 minutes)** ● **Hybrid Systems**: Explain how hybrid systems combine fixed and dynamic allocation to balance efficiency and flexibility. ● **Techniques**: Briefly introduce frequency reuse and spectrum sharing in modern wireless networks. **Exercise (10 minutes)** ● **Case Study**: "Imagine you are a network engineer tasked with allocating channels for a new 5G network in a dense urban area. What factors would you consider?" ● Break students into small groups (2-3) to brainstorm solutions. ● Allow each group to present their thoughts, then provide feedback. ● Discuss spectrum auctions as a real-world mechanism for managing limited spectrum resources.
Closure	Summarize the three main types of channel allocation methods (Fixed, Dynamic, Hybrid). Reiterate the importance of solving channel allocation problems to improve communication networks. **Suggested Reading:** "Data and Computer Communications" by William Stallings, Chapter 6, pp. 180-210 (explains channel allocation techniques in-depth).
Evaluation	Reflective Questions (What Why Who?). Allow students to answer and discuss. ● What are the advantages of dynamic channel allocation over fixed? ● How does channel allocation affect user experience in crowded environments? **Homework Assignment**: Write a 500-word essay on how 5G networks address the challenges of channel allocation. Spend 5 minutes to wrap up and consolidate the learnings.

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Lesson Plan No. 3.7	Course Name: Computer Networks	Course No.: COM-502
	Topic: Multiple Access Protocol-ALOHA	

Objectives	At the end of the lesson the student shall be able to: a. Understand the concept of multiple access in communication networks. b. Explain the ALOHA protocol and its variants (Pure ALOHA and Slotted ALOHA). c. Identify real-world applications of the ALOHA protocol. d. Analyze the efficiency and limitations of ALOHA. e. Relate ALOHA's principles to modern network protocols like Wi-Fi.
Teaching Aids (if any)	a. Presentation slides. b. Projector c. Charts showing packet collisions and time slots in ALOHA.

Teaching Development	**Introduction (5 minutes)**
	
	● **Ask students:**
	   ○ Have you ever experienced delays or slowdowns in your Wi-Fi connection when many devices are connected at once? Why do you think this happens?"
	   ○ Introduce the concept of multiple access: multiple devices trying to communicate over a shared channel.
	   ○ Briefly explain the historical context of ALOHA developed for wireless communication between remote stations in Hawaii.
	
	Development (30 minutes)
	
	A. Multiple Access & ALOHA Protocol (15 minutes)
	
	● **Definition of Multiple Access:** Explain how multiple devices use a shared communication channel, which can lead to collisions.
	● **Introduction to ALOHA:** Explain the basic idea of ALOHA, developed by Norman Abramson for wireless networks.
	   ○ **Pure ALOHA:**
	      ■ **How it works:** Devices transmit whenever they have data, leading to potential collisions.
	      ■ **Real-time example:** Imagine students raising their hands to answer questions in a class simultaneously, leading to confusion.
	      ■ **Formula:** Efficiency = 18.4%. (Discuss that about 18.4% of time is used successfully without collisions).
	   ○ **Slotted ALOHA:**
	      ■ **How it works:** Transmission is divided into time slots, reducing collisions.
	      ■ **Example:** Think of students being allowed to raise their hands only at the start of a teacher-determined time.
	      ■ **Efficiency:** 36.8%. Explain how time-slotted communication leads to fewer collisions.

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	B. Performance and Efficiency (10 minutes) ● Compare the efficiency of Pure ALOHA and Slotted ALOHA. Explain why Slotted ALOHA performs better. ● **Graphical Representation:** Show a graph comparing collision rates in Pure and Slotted ALOHA (this can be visualized in the PPT). ● Discuss how modern technologies like Ethernet and Wi-Fi have evolved based on these concepts. **C. Real-World Applications & Limitations (5 minutes)** ● **Application:** Explain that ALOHA is used in satellite communication, RFID tags, and even in the early development of Wi-Fi. ● **Discussion:** "Why do you think a simple protocol like ALOHA is not widely used in high-demand environments today?" Discuss the limitations, including low efficiency in large networks**.** **Exercise (10 minutes)** ● **Scenario:** "Imagine you are managing a network for a remote island, and you need a simple solution to manage communication between sensors. Would you use Pure ALOHA or Slotted ALOHA? Why?" ● Divide students into small groups (2-3) and let them discuss which ALOHA variant is more suitable and why. ● After 5 minutes of group work, ask a representative from each group to share their thoughts. Discuss the pros and cons of each solution.
Closure	Summarize the key points: what multiple access means, how ALOHA handles it, the differences between Pure and Slotted ALOHA, and the importance of collision management in networks. "How do you think ALOHA's principles apply to your Wi-Fi connection at home?" **Suggested Reading:** "Data and Computer Communications" by William Stallings, Chapter 12, pp. 415-420 (explains the ALOHA protocol in detail). "Computer Networks: A Systems Approach" by Larry L. Peterson, Chapter 5, pp. 280-295 (discusses multiple access protocols, including ALOHA).
Evaluation	Reflective Questions (What Why Who?). Allow students to answer and discuss. ● What is the difference between Pure ALOHA and Slotted ALOHA? ● Why is the efficiency of Slotted ALOHA higher than Pure ALOHA? ● Can you think of a situation where using ALOHA would be more practical than a more complex protocol? Spend 5 minutes to wrap up and consolidate the learnings.

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Lesson Plan No. 3.8	Course Name: Computer Networks Topic: Carrier Sense Multiple Access Protocols	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Understand the concept of multiple access and how CSMA reduces collisions. b. Explain the different types of CSMA protocols (CSMA/CD, CSMA/CA). c. Identify real-world applications of CSMA. d. Analyze the efficiency and limitations of CSMA in wired and wireless networks. e. Relate the principles of CSMA to modern network technologies such as Ethernet and Wi-Fi.
Teaching Aids (if any)	a. Presentation slides. b. Projector c. Diagrams to show packet collisions and how CSMA handles them.
Teaching Development	**Introduction (5 minutes)** ● **Ask students:** ○ Have you ever noticed a slow network when many people are connected to the same Wi-Fi? Why do you think this happens?" ○ Introduce the concept of multiple access and how shared channels can lead to data collisions. ○ Introduce the need for protocols like CSMA to manage channel access efficiently and reduce collisions. **Development (30 minutes)** **A. What is Carrier Sense Multiple Access (CSMA)? (10 minutes)** ● **Definition:** Explain CSMA as a protocol that listens to the carrier (network channel) before attempting to transmit data. ● **Analogy:** Compare this to people in a conversation: "You wait until others stop speaking before you begin, to avoid interruptions." ● **Types of CSMA Protocols:** ○ **CSMA/CD (Collision Detection):** Used in wired networks like Ethernet. ■ **Example:** Imagine two cars approaching a one-lane bridge and both stop, check, then proceed if the road is clear. ■ **Real-World Application:** Early Ethernet used CSMA/CD to manage data transmission. ○ **CSMA/CA (Collision Avoidance):** Used in wireless networks like Wi-Fi. ■ **Example:** Imagine cars approaching an intersection and taking turns to avoid crashing.

■ **Real-World Application:** Wi-Fi uses CSMA/CA because wireless networks can't detect collisions directly.

B. Efficiency and Limitations of CSMA (10 minutes)

- **Graphical Representation:** Show a diagram of how CSMA/CD and CSMA/CA handle collisions.
- **Discussion:** Why does CSMA work better in wired networks compared to wireless? Explore the hidden node problem in Wi-Fi networks.
- **Efficiency:** Discuss the limitations of CSMA as network load increases and how collisions still occur under heavy traffic.

C. Real-World Applications of CSMA (10 minutes)

- **Ethernet:** Explain how modern Ethernet networks evolved from CSMA/CD and why it's still relevant today in wired LANs.
- **Wi-Fi:** Discuss how CSMA/CA is used in Wi-Fi, and why avoiding collisions in wireless communication is essential.
- **Example:** "Why do you think public Wi-Fi (like at cafes or airports) often feels slower than your home Wi-Fi? What role does CSMA play?"

Exercise (10 minutes)

- "Imagine you are tasked with setting up a Wi-Fi network in a large office building. What challenges related to multiple access would you face, and how would CSMA/CA help?"
- Break students into small groups (2-3) and let them brainstorm how CSMA/CA can be used to improve the performance of Wi-Fi in crowded areas.
- After 5 minutes, each group presents their solution, followed by a discussion on the effectiveness of CSMA in different environments.

Closure	Recap the key points: multiple access, how CSMA/CD and CSMA/CA manage collisions, and the differences between wired and wireless applications. "Which version of CSMA (CD or CA) do you think will continue to be relevant in the future, and why?" **Suggested Reading:** "Data and Computer Communications" by William Stallings, Chapter 12, pp. 421-425 (explains CSMA/CD and CSMA/CA in detail). "Computer Networks: A Systems Approach" by Larry L. Peterson, Chapter 5, pp. 296-310 (discusses the evolution of Ethernet and CSMA protocols).
Evaluation	Reflective Questions (What Why Who?). Allow students to answer and discuss. ● How does CSMA/CD differ from CSMA/CA? ● Why is CSMA/CA preferred in wireless networks over CSMA/CD? ● Can you think of a scenario where CSMA/CD might still be used today? Spend 5 minutes to wrap up and consolidate the learnings.

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Lesson Plan No. 3.9	Course Name: Computer Networks Topic: Collision Free Protocols	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	   a. Define collision-free protocols and explain their significance in network communication.
	   b. Identify key collision-free protocols like TDMA (Time Division Multiple Access) and Token Passing.
	   c. Understand the advantages and limitations of collision-free protocols.
	   d. Discuss real-world examples of collision-free protocols in modern networks.
	   e. Engage in a discussion about the applicability of these protocols in various networking scenarios.

Teaching Aids (if any)	a. Presentation slides. b. Projector c. Diagrams to illustrate time-slotting and token passing mechanisms.

Teaching Development	**Introduction (5 minutes)**
	
	● **Ask students:**
	   ○ "Have you ever noticed delays or data loss when too many people try to access the same network at once?"
	   ○ Introduce the concept of collision-free protocols and why avoiding collisions is critical for smooth network operations.
	   ○ Provide a brief overview of why these protocols are crucial in environments where collisions would drastically reduce network performance, such as in real-time communication systems.
	
	Development (30 minutes)
	
	A. What are Collision-Free Protocols? (10 minutes)
	
	● **Definition:** Explain that collision-free protocols ensure that data transmission happens without conflicts or collisions by reserving transmission opportunities for each device.
	● **Why Needed:** Discuss how traditional multiple access protocols like CSMA can result in collisions and why collision-free protocols are required for time-sensitive or high-traffic environments.
	
	B. Types of Collision-Free Protocols (15 minutes)
	
	● **Time Division Multiple Access (TDMA) (7 minutes)**
	   ○ **How it works:** Explain how TDMA divides the channel into time slots, with each device assigned its own time slot to avoid collisions.
	   ○ **Analogy:** Compare it to taking turns speaking in a meeting, where each participant is allotted a specific time to speak.
	   ○ **Real-World Example:** Show how TDMA is used in cellular networks (2G, 4G) to allow multiple users to share the same frequency band without interference.

	○ **Illustration:** Use a diagram to show how time slots are allocated to different users.
	● **Token Passing Protocol (8 minutes)**
	    ○ **How it works:** Explain the token-passing method, where a token circulates within the network, and only the device holding the token is allowed to transmit data.
	    ○ **Example:** Compare this to a classroom where a "talking stick" is passed around, and only the person holding the stick can speak.
	    ○ **Real-World Application:** Discuss how Token Ring networks used token passing to avoid collisions, and how modern industrial networks like PROFIBUS use similar mechanisms.
	    ○ **Illustration:** Use a diagram to show how the token circulates and controls access in the network.
	
	C. Advantages and Limitations of Collision-Free Protocols (5 minutes)
	
	● **Advantages:** High efficiency in networks with real-time communication needs, reduced collisions, and better use of network resources.
	● **Limitations:** Discuss the complexity of managing tokens in large networks and the overhead introduced by time-slotting in TDMA.
	● **Discussion:** Ask students, "In which situations would collision-free protocols be preferred over CSMA-based protocols?"
	
	Exercise (10 minutes)
	
	● "You are setting up a network for a manufacturing plant with machines that must communicate in real-time. Which collision-free protocol would you use, and why?"
	● Divide students into small groups (2-3) and let them discuss the application of TDMA or Token Passing in various real-world scenarios, such as industrial automation or mobile communications.
	● After 5 minutes of discussion, have each group present their thoughts on the best collision-free protocol for their scenario.

Closure	Summarize the key points: what collision-free protocols are, the two main types (TDMA and Token Passing), and their real-world applications. **Suggested Reading:** "Data and Computer Communications" by William Stallings, Chapter 13, pp. 450-460 (discusses collision-free protocols in detail). "Computer Networking: A Top-Down Approach" by James Kurose and Keith Ross, Chapter 4, pp. 190-200 (covers the advantages and limitations of TDMA and Token Ring networks).
Evaluation	Reflective Questions (What Why Who?). Allow students to answer and discuss. ● How does TDMA differ from Token Passing in terms of managing collisions? ● What are the key advantages of using a collision-free protocol in time-sensitive networks like industrial automation? ● Can you think of other protocols that also aim to minimize collisions? Spend 5 minutes to wrap up and consolidate the learnings.

Lesson Plan No. 3.10	Course Name: Computer Networks Topic: IEEE standards-802.3, 802.4, 802.5	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Understand the key IEEE standards (802.3, 802.4, and 802.5) and their significance in network communication. b. Compare the characteristics, advantages, and limitations of each standard. c. Identify real-world applications of these standards and their relevance in modern networking. d. Engage in a discussion on the evolution of these protocols and why some have become obsolete while others remain in use.
Teaching Aids (if any)	a. Presentation slides. b. Projector c. Diagrams to illustrate the difference between Ethernet, Token Bus, and Token Ring.

Teaching Development	**Introduction (5 minutes)**
	
	● **Ask students:**
	    ○ "How do the devices on your home or office network communicate with each other without interference?"
	    ○ Introduce the IEEE standards that define the rules for wired network communication: 802.3 (Ethernet), 802.4 (Token Bus), and 802.5 (Token Ring).
	    ○ Briefly explain that these standards ensure efficient data transmission in local area networks (LANs).
	
	Development (30 minutes)
	
	A. IEEE 802.3: Ethernet (10 minutes)
	
	● **Definition:** Explain IEEE 802.3 as the Ethernet standard, which governs the most widely used LAN technology.
	● **How it works:** Use CSMA/CD (Carrier Sense Multiple Access/Collision Detection) to manage communication between devices.
	● **Real-World Example:** Discuss how Ethernet is used in most home, office, and industrial networks today.
	● **Advantages:** Simple, cost-effective, scalable.
	● **Limitations:** Inefficiencies under high traffic due to collisions in legacy systems.
	● **Illustration:** Show a diagram of an Ethernet network setup.
	
	B. IEEE 802.4: Token Bus (10 minutes)
	
	● **Definition:** Explain IEEE 802.4 as a standard for Token Bus networks, a now largely obsolete protocol.
	● **How it works:** Describe how devices are arranged in a logical bus but pass a token to control access to the network.

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	● **Real-World Application:** Token Bus was used in industrial environments such as factory automation where deterministic access was important. ● **Advantages:** Predictable network access, collision-free communication. ● **Limitations:** Complexity in implementation, limited scalability. ● **Illustration:** Use a diagram to show the token-passing mechanism in a bus topology. **C. IEEE 802.5: Token Ring (10 minutes)** ● **Definition:** Explain IEEE 802.5, the standard for Token Ring networks. ● **How it works:** Devices are arranged in a physical ring, and a token is passed around the ring to control who can transmit data. ● **Real-World Application:** Token Ring was used in IBM networks during the 1980s and 1990s. ● **Advantages:** Collision-free, fair access to network resources. ● **Limitations:** Slower than Ethernet, more expensive to implement, difficult to troubleshoot. ● **Illustration:** Show a diagram of a Token Ring network setup. **Exercise (10 minutes)** ● "If you were setting up a network for a large office building in the 1980s, which protocol would you have chosen and why?" ● Divide students into small groups (2-3) to discuss the benefits and drawbacks of Ethernet, Token Bus, and Token Ring in different networking environments (e.g., office, factory, home). ● After 5 minutes, have each group present their thoughts on which protocol they would have chosen and why.
Closure	Recap the key points: what IEEE 802.3, 802.4, and 802.5 are, and how they differ in terms of structure, performance, and use cases. **Suggested Reading:** ● "Data and Computer Communications" by William Stallings, Chapter 13, pp. 460-475 (discusses IEEE 802 standards in detail). ● "Computer Networking: A Top-Down Approach" by James Kurose and Keith Ross, Chapter 5, pp. 200-210 (covers Ethernet and Token Ring standards).
Evaluation	Reflective Questions (What Why Who?). Allow students to answer and discuss. ● What are the major differences between IEEE 802.3, 802.4, and 802.5? ● Why is Ethernet more scalable compared to Token Bus and Token Ring? ● What are the use cases where Token Bus or Token Ring might still be useful today? Spend 5 minutes to wrap up and consolidate the learnings.

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Lesson Plan No. 1	Course Name: Computer Networks Topic: Network Layer: Design Issues, Routing Algorithms: The Optimality Principle	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Explain the design issues of the network layer. b. Describe various routing algorithms. c. Understand the optimality principle in routing. d. Apply routing algorithms to real-world scenarios.
Teaching Aids (if any)	a. PowerPoint slides b. Use of Nearpod tool for online quiz c. Videos demonstrating routing in networks
Teaching Development	1. **Introduction** (5 minutes) - Ask questions. How do messages find their way from your phone to your friend's phone? What happens if a network path is busy or broken? Can you think of real-world systems that require optimal routing? - Introduction to Network Layer - Explain how GPS systems find the shortest route in real-time. 2. **Development** (30 minutes) a. Design Issues in Network Layer - Discuss the key design issues: scalability, error handling, routing, and congestion control. - Example: Compare small local networks to large-scale networks like the internet. b. Distance Vector Routing - Explain the algorithm and how routers share information. - Example: Explain how the Bellman-Ford algorithm works in a simplified network. c. Link State Routing - Explain the concept and how routers use a complete map of the network. - Example: Demonstrate the Dijkstra's algorithm using a real-world map analogy. d. Hybrid Routing - Discuss a combination of distance vector and link state algorithms. - Example: Highlight the usage in large networks like ISPs. e. The Optimality Principle - Define the principle: a route is optimal if all of its sub-paths are optimal.

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	- Provide mathematical backing and theoretical examples.
	- Real-world example: Discuss how delivery services optimize routes for multiple deliveries.
	
	3. Exercise (5 minutes) –
	   - Provide scenarios where students must choose and justify the use of a particular routing algorithm.
	   - Students will use simulation tools to configure routing protocols and observe their behaviour.
	
	Use Nearpod to collect responses and discuss the answers.

Closure	1. Recap the design issues of the network layer. 2. Highlight the differences between distance vector and link state routing algorithms. 3. Homework - Use Cisco Packet Tracer to create a small network and configure it using both distance vector and link state routing protocols. Spend 5 minutes to wrap up and consolidate the learnings

Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
	   - What are the main challenges in designing the network layer?
	   - How do distance vector and link state routing algorithms differ in their approach?
	   - Why is the optimality principle crucial for efficient routing?
	2. Conduct a quiz using an online platform like Kahoot! covering the key concepts discussed.
	
	Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 4.2	Course Name: Computer Networks Topic: Hierarchical Routing, Broadcast Routing, Multicast Routing	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	   a. Explain the concept of shortest path routing and its significance in networking.
	   b. Illustrate the mechanism of flooding and its uses in various network protocols.
	   c. Understand distance vector routing and demonstrate its working through real-world scenarios.
	   d. Analyze the link state routing process and compare it with distance vector routing.

Teaching Aids (if any)	a. PowerPoint slides
	   b. Use of Nearpod tool for online quiz
	   c. Real-time network simulation using tools like Cisco Packet Tracer

Teaching Development	1. **Introduction** (5 minutes)
	   - Ask questions.
	   - Begin by asking students how they would navigate from one place to another in a city without a map (introduce shortest path routing).
	   - Use a real-world analogy, such as Google Maps, to introduce the concept of finding the shortest route.
	   - Briefly introduce flooding, distance vector, and link state routing, linking them to real-world applications like GPS and traffic routing.
	
	2. **Development** (30 minutes)
	   a. Shortest Path Routing
	   - Define the shortest path routing and explain its importance in networking.
	   - Introduce Dijkstra's algorithm and demonstrate how it calculates the shortest path in a network using a graph.
	   Example: Compare it to finding the shortest route in a road network, where nodes represent intersections, and edges represent roads.
	   b. Flooding
	   - Explain the concept of flooding where data is sent to all nodes indiscriminately.
	   - Discuss its use in certain network discovery protocols.
	   - Example: In a network where no routing information exists, flooding ensures that packets reach all possible destinations.
	
	   c. Distance Vector Routing

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- Define distance vector routing and explain how routers share information with neighbors about the distance to each network.
- Use an example where each router has a vector of distances to other routers.
- Illustrate how the Bellman-Ford algorithm is used to update these vectors.
- Example: Routing Information Protocol (RIP) in networks.

    d. Link State Routing
- Define link state routing and explain how routers know the complete topology of the network.
- Use an example where each router builds a map of the network and calculates the shortest paths to all nodes.
- Introduce OSPF (Open Shortest Path First) as a practical example of link state routing.
- Compare the efficiency of link state routing with distance vector routing, discussing the advantages and disadvantages.

3. Exercise (5 minutes) –
   - Group Activity: Divide students into groups. Each group will be assigned a specific routing algorithm (Shortest Path, Flooding, Distance Vector, or Link State) and asked to simulate a network scenario where this algorithm would be the most appropriate.

Use Nearpod to collect responses and discuss the answers.

Closure	1. Recap the key points of each routing method. 2. Highlight the differences and similarities between distance vector and link state routing. 3. Assign homework where students simulate a network with both distance vector and link state routing to compare their efficiencies. Spend 5 minutes to wrap up and consolidate the learnings

Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
	   - Why is shortest path routing crucial for real-time applications?
	   - What are the limitations of flooding?
	   - How does link state routing ensure more accurate routing compared to distance vector routing?
	
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Lesson Plan No. 4.3	Course Name: Computer Networks Topic: Hierarchical Routing, Broadcast Routing, Multicast Routing	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	   a. Explain the concept of hierarchical routing and its importance in large networks.
	   b. Illustrate the mechanism of broadcast routing with practical examples.
	   c. Understand and demonstrate multicast routing and its applications.
	   d. Compare and contrast hierarchical, broadcast, and multicast routing methods.

Teaching Aids (if any)	a. PowerPoint slides
	   b. Real-world examples (e.g., content delivery networks, live streaming services)
	   c. Use of Nearpod tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	   - Ask questions.
	     Begin by asking students how they think data is routed on the internet.
	     Use an analogy of postal mail sorting centers to explain hierarchical routing.
	     Example: Local post offices handle local mail, while regional centers handle inter-city mail.
	   - Introduce Broadcast Routing: Explain broadcast routing by comparing it to sending a group message to all contacts in a messaging app.
	   - Introduce Multicast Routing: Use the example of a live sports streaming service broadcasting to multiple subscribers.
	
	2. **Development** (30 minutes)
	   a. Hierarchical Routing
	     - Define hierarchical routing and explain its layered structure (e.g., local, regional, and global).
	     - Discuss the benefits: scalability, manageability, and reduced routing table size.
	     - Explain how the Internet uses hierarchical routing with ISPs, regional networks
	   b. Broadcast Routing
	     - Define broadcast routing and its purpose in networks.
	     - Discuss different methods of broadcast routing (e.g., flooding, spanning tree).
	     - Explain how ARP (Address Resolution Protocol) uses broadcast to find the MAC address of a device in a local network.

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	c. Multicast Routing
	   - Define multicast routing and its benefits over broadcast routing.
	   - Use a diagram to show how multicast routing conserves bandwidth compared to broadcast routing.
	 d. Examples from Day-to-Day Life
	   - Hierarchical Routing: Routing in large corporations with multiple branch offices.
	   - Broadcast Routing: Sending emergency alerts via SMS to all mobile users in a region.
	   - Multicast Routing: Online gaming where game updates are sent to multiple players simultaneously.
	
	 3. Exercise (5 minutes) –
	   - Group Activity: Split students into groups and give them different routing scenarios. Each group will choose the appropriate routing method and justify their choice.
	
	 Use Nearpod to collect responses and discuss the answers.

Closure	1. Recap the key points of hierarchical, broadcast, and multicast routing. 2. Homework - Set up a network simulation demonstrating hierarchical routing Spend 5 minutes to wrap up and consolidate the learnings

Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
	   - What are the advantages of hierarchical routing in large networks?
	   - Why is broadcast routing not suitable for all scenarios?
	   - How does multicast routing optimize bandwidth usage?
	 2. Conduct a quiz using an online platform like Kahoot! covering the key concepts discussed.
	
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Lesson Plan No. 4.4	Course Name: Computer Networks Topic: Congestion Control Algorithms: Approaches to Congestion Control	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	  a. Understand the causes of network congestion and its impact on data transmission.
	  b. Explain various congestion control algorithms and their effectiveness in different network environments.
	  c. Compare and contrast different approaches to congestion control.
	  d. Demonstrate how congestion control algorithms are implemented in protocols like TCP.

Teaching Aids (if any)	a. PowerPoint slides
	  b. Use of Nearpod tool for online quiz
	  c. Real-time network simulation using tools like Cisco Packet Tracer

Teaching Development	1. **Introduction** (5 minutes)
	  - Ask questions.
	  - Ask students to describe situations where they've experienced network slowdowns (e.g., while streaming videos or downloading large files).
	  - Use this to introduce the concept of network congestion, drawing parallels to traffic jams on highways.
	  - Briefly introduce the importance of congestion control in maintaining network performance and explain that different algorithms address this issue in various ways.
	
	2. **Development** (30 minutes)
	  a. Causes and Impact of Network Congestion
	  - Define network congestion and discuss its causes, such as high traffic volume, insufficient bandwidth, and packet collisions.
	  - Explain the impact of congestion on throughput, latency, and packet loss.
	  - Use an analogy of traffic congestion on roads to explain how data packets queue up in routers during congestion.
	  b. Approaches to Congestion Control
	  - Define open-loop control and explain how it prevents congestion before it occurs.
	  Discuss techniques such as traffic shaping, leaky bucket, and token bucket algorithms.
	  - Define closed-loop control and explain how it responds to congestion after it occurs.

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	c. Congestion Control in TCP - Discuss TCP congestion control mechanisms like slow start, congestion avoidance, fast retransmit, and fast recovery. - Example: Explain how TCP uses packet loss as a signal of congestion and adjusts the transmission window. - Use a diagram to demonstrate the TCP congestion window behavior during slow start and congestion avoidance phases. 3. Exercise (5 minutes) – - Group Activity: Divide students into groups. Each group will simulate a network scenario (using a tool like Cisco Packet Tracer) where congestion occurs. They will apply different congestion control algorithms (e.g., TCP, RED, token bucket) to manage the congestion and compare the results. Use Nearpod to collect responses and discuss the answers.
Closure	1. Summarize the key points covered: the causes of network congestion, the difference between open-loop and closed-loop control, and the main congestion control algorithms. 2. Reinforce the importance of congestion control for maintaining a high-quality network experience, particularly for real-time applications like video streaming and online gaming. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. - What is the key difference between open-loop and closed-loop congestion control? - How does TCP adjust its behavior when it detects congestion? - Why is Random Early Detection (RED) considered an improvement over traditional queue management techniques? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 4.5	Course Name: Computer Networks **Topic:** Congestion Prevention Policies, Congestion Control in Virtual-Circuit and Datagram Subnets	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Understand various congestion prevention policies and their importance in avoiding network congestion. b. Explain the mechanisms of congestion control in both virtual-circuit and datagram subnets. c. Compare the differences in congestion management between virtual-circuit and datagram-based networks. d. Apply congestion control strategies to maintain efficient network performance.
Teaching Aids (if any)	a. PowerPoint slides b. Use of Nearpod tool for online quiz c. Real-time network simulation using tools like Cisco Packet Tracer
Teaching Development	1. **Introduction** (5 minutes) - Ask questions. - Begin by asking students if they have ever experienced network delays during video calls or gaming. - Introduce the concept of network congestion and explain how congestion prevention policies help avoid congestion before it occurs. - Briefly introduce the difference between virtual-circuit and datagram subnets, explaining that each has its own methods for congestion control. 2. **Development** (30 minutes) a. Congestion Prevention Policies - Define congestion prevention and explain its proactive nature. - Example: Demonstrate how traffic shaping controls the rate of packet transmission to prevent overwhelming the network. - Use visual aids to show how these techniques apply to real-world networks, such as streaming services or large corporate networks. b. Congestion Control in Virtual-Circuit Subnets - Define **virtual-circuit subnets**, where a fixed path is established for a session (e.g., ATM, Frame Relay, MPLS). Explain how congestion is controlled by reserving resources along the path for the duration of the communication session. - Example: Show how a network using MPLS (Multiprotocol Label Switching) can ensure a stable connection with resource reservation.

- Highlight how virtual-circuit subnets typically perform better with congestion control because of their fixed paths and resource guarantees.

   c. Congestion Control in Datagram Subnets
   - Define **datagram subnets**, where each packet is routed independently, and paths can change dynamically (e.g., the Internet, IP networks).
   - Explain how congestion control is more challenging in datagram networks due to the lack of fixed routes.
   - Example: Show how TCP/IP networks use feedback loops to manage congestion, adjusting transmission rates based on packet loss.
   - Compare datagram subnets with virtual-circuit subnets, discussing their advantages and limitations in handling congestion.

3. Exercise (5 minutes) –
   - Group Activity: Assign students different network scenarios where they must choose the appropriate congestion prevention policies or control mechanisms based on whether they are working with a virtual-circuit or datagram subnet

Use Nearpod to collect responses and discuss the answers.

Closure	1. Recap the key points on congestion prevention policies and the differences in congestion control for virtual-circuit and datagram subnets. 2. Highlight the significance of choosing the right strategy based on the network type. Spend 5 minutes to wrap up and consolidate the learnings

Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
	  - What are the key differences between congestion prevention and congestion control?
	  - How does congestion control differ in virtual-circuit networks compared to datagram networks?
	  - Why is traffic shaping an important tool in preventing congestion?
	
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Lesson Plan No. 4.6	Course Name: Computer Networks	Course No.: COM-502
	Topic: Load Shedding, Jitter Control	

Objectives	At the end of the lesson the student shall be able to: a. Explain the concept of load shedding and its importance in preventing network congestion. b. Understand how jitter affects real-time communications and the methods used to control it. c. Differentiate between different jitter control mechanisms. d. Apply load shedding and jitter control strategies to improve network performance in real-time applications.
Teaching Aids (if any)	a. PowerPoint slides b. Use of Nearpod tool for online quiz c. Real-time network simulation using tools like Cisco Packet Tracer
Teaching Development	1. **Introduction** (5 minutes) - Ask questions. - Ask students to share their experiences with video buffering or delays in online calls. - Introduce the topic by explaining how network congestion and jitter can affect real-time communications, particularly in voice and video streaming. - Briefly explain the concepts of **load shedding** and **jitter control**, and how they are used to manage network traffic and ensure smooth data transmission. 2. **Development** (30 minutes) a. Load Shedding - **Definition**: Explain that load shedding refers to selectively discarding packets or data to prevent network overload and maintain overall system performance. - Discuss when and why load shedding is needed, such as during periods of high traffic where it's better to drop non-essential data than allow the entire system to degrade. - Example: Use a video streaming service during high-traffic hours. When the server is overloaded, it drops lower-resolution frames to ensure the stream continues without interruption. - Explain how load shedding is commonly used in **data streams** like real-time analytics or in web services during peak loads. - **Algorithms**: Discuss basic algorithms that decide which packets to drop, such as Random Early Detection (RED) or priority-based shedding.

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	- **Real-World Example**: Netflix or YouTube may degrade video quality to shed load during network congestion, ensuring smooth playback.
	
	  b. Jitter Control
	- **Definition**: Explain jitter as the variation in packet arrival times in a data stream, especially in real-time applications like VoIP and video conferencing.
	- Discuss how jitter impacts the quality of voice and video communications, leading to stuttering, delays, or poor synchronization.
	- **Causes of Jitter**: Varying network paths, congestion, and differing processing speeds at nodes.
	- Example: Use a VoIP call or live streaming as an example. Show how delays or variations in packet delivery can distort the voice or video quality.
	- Explain how jitter control mechanisms are used in real-world applications like Zoom or Skype to improve the user experience.
	
	3. Exercise (5 minutes) –
	  - Group Activity: Split students into groups and give them a scenario where network congestion is affecting video streaming quality due to jitter and high load.
	
	Use Nearpod to collect responses and discuss the answers.

Closure	1. Recap the key points about load shedding and its importance in maintaining network performance under high traffic conditions. 2. Reinforce how jitter control helps maintain the quality of real-time communications by minimizing variations in packet arrival times. Spend 5 minutes to wrap up and consolidate the learnings

Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
	  - How does load shedding help in preventing network congestion?
	  - What role does jitter control play in ensuring smooth voice and video communications?
	  - Why is selective load shedding often preferred over aggressive load shedding?
	
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Lesson Plan No. 4.7	Course Name: Computer Networks **Topic:** Traffic Shaping Algorithm - Leaky Bucket Algorithm, Token Bucket Algorithm	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Understand the concept of traffic shaping and its role in controlling the flow of data in networks. b. Explain the leaky bucket and token bucket algorithms and how they regulate network traffic. c. Compare the differences between the leaky bucket and token bucket algorithms. d. Demonstrate how traffic shaping algorithms help in managing network congestion and maintaining QoS (Quality of Service).
Teaching Aids (if any)	a. PowerPoint slides b. Use of Nearpod tool for online quiz c. Real-time network simulation using tools like Cisco Packet Tracer

Teaching Development	1. **Introduction** (5 minutes)
	- Ask questions.
	- Start with an analogy of how traffic flows on roads are regulated by traffic lights to maintain order. Relate this to how data flows in a network and why it needs control.
	- Introduce the concept of **traffic shaping** as a way to regulate the rate at which data packets are sent into the network.
	- Briefly mention that leaky bucket and token bucket algorithms are two popular methods used for this purpose and will be discussed in detail.
	
	2. **Development** (30 minutes)
	  a. Traffic Shaping Overview
	    - Define traffic shaping and explain its significance in controlling congestion, ensuring network stability, and maintaining QoS.
	    - Example: Discuss how traffic shaping is essential for applications like video streaming and VoIP to ensure smooth performance.
	    - Briefly introduce the two algorithms: leaky bucket and token bucket, highlighting that they help smooth out traffic bursts and regulate data flow rates.
	
	  b. Leaky Bucket Algorithm
	    - **Definition**: Explain the leaky bucket algorithm as a method where data is sent into the network at a constant rate, similar to how water leaks from a bucket with a hole at a steady rate.
	    - **Working Principle**:
	      -Packets accumulate in a buffer (the "bucket").

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-Packets are transmitted at a fixed rate, regardless of the burstiness of incoming traffic.
- If the bucket overflows, packets are discarded (similar to how excess water spills out).
- Example: Show a scenario where bursty traffic is smoothed out by the leaky bucket, which forces a constant output rate.
- **Real-World Application**: Explain how the leaky bucket algorithm is used in network devices to regulate traffic and prevent bursts from overwhelming routers.
- Visual Aid: Show a diagram of how packets are regulated by the leaky bucket algorithm.

c. Token Bucket Algorithm
- **Definition**: Explain the token bucket algorithm, where tokens accumulate in a bucket and allow for sending packets. If there are enough tokens, packets can be sent at the full rate, but if tokens are depleted, traffic slows down.
- **Working Principle**:
    - Tokens are generated at a steady rate.
    - To send a packet, a token is consumed.
    - If there are sufficient tokens, bursty traffic can be transmitted at a higher rate, allowing for flexibility.
    - If tokens run out, packets must wait until new tokens are generated.
- Example: Use an analogy of a car passing through a toll booth with tokens. If the car has tokens, it can pass through quickly, but if not, it must wait.
- **Real-World Application**: Discuss how the token bucket algorithm is more flexible than the leaky bucket, allowing bursts of traffic while still controlling the overall rate, making it useful in networks requiring bursty data transmission like streaming services.

d. Comparison of Leaky Bucket and Token Bucket Algorithms
- **Leaky Bucket**: Fixed rate, discards excess traffic, ensures constant flow but does not allow bursts.
- **Token Bucket**: Flexible rate, allows bursts when tokens are available, but limits flow when tokens run out.
- Discuss the **key differences** between the two algorithms

3. Exercise (5 minutes) –
- Students will observe how each algorithm shapes the traffic in different scenarios (e.g., constant-rate versus bursty traffic).
- Discuss the results of each group

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Closure	1. Recap the concepts of traffic shaping and the importance of regulating data flow to prevent congestion. 2. Highlight the key differences between the leaky bucket and token bucket algorithms and their practical applications in real-world networks. 3. Assign homework for students to research how modern ISPs use these algorithms to manage traffic for applications like video conferencing and gaming. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. - How does the leaky bucket algorithm help maintain a constant data flow? - What makes the token bucket algorithm more flexible for handling bursty traffic? - Why is traffic shaping essential for ensuring Quality of Service (QoS) in networks? Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 4.8	Course Name: Computer Networks Topic: Quality of Service (QoS), IP Addresses	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	  a. Understand the concept of Quality of Service (QoS) and its role in ensuring network performance.
	  b. Explain the different QoS parameters like bandwidth, latency, jitter, and packet loss.
	  c. Understand the structure of IP addresses (IPv4 and IPv6), including their formats and classes.
	  d. Explain the significance of IP addressing in routing and data transmission across the internet.

Teaching Aids (if any)	a. PowerPoint slides
	  b. Use of Nearpod tool for online quiz
	  c. Real-time network simulation using tools like Cisco Packet Tracer

Teaching Development	1. **Introduction** (5 minutes)
	  - Ask questions.
	  - Ask students to recall any situation where they faced delays or low-quality connections during online gaming, video streaming, or video calls.
	  - Use this to introduce the concept of **Quality of Service (QoS)** and how networks manage data transmission to meet specific performance criteria.
	  - Introduce the concept of **IP addresses** and explain that every device on the internet needs an IP address for identification and communication.
	
	2. **Development** (30 minutes)
	  a. Quality of Service (QoS)
	  - **Definition**: Define QoS as the ability of a network to provide different priority levels to various applications, users, or data flows to ensure optimal performance.
	  - **QoS Parameters**:
	    - **Bandwidth**: The maximum rate at which data can be transferred.
	    - **Latency**: The delay in data transmission.
	    - **Jitter**: The variation in packet arrival time.
	    - **Packet Loss**: The percentage of packets lost during transmission.
	  - Example: Use a video streaming service like Netflix as an example to explain how QoS ensures that video streaming traffic gets higher priority compared to file downloads.
	  - **Mechanisms for Implementing QoS**:

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- **Traffic Shaping**: Limiting data transfer rates to ensure network stability.
- **Prioritization**: Assigning different priority levels to different types of traffic.
- **Congestion Management**: Using algorithms like Weighted Fair Queuing (WFQ) to manage congestion.
- **Real-World Application**: Explain how Internet Service Providers (ISPs) use QoS to offer premium users higher priority for real-time applications like VoIP and video conferencing.

b. IP Addresses
- **Definition**: Define an IP address as a unique identifier assigned to each device connected to a network, enabling communication.
- **IPv4 Addresses**:
  - Explain the 32-bit structure of IPv4 addresses and how they are divided into four octets.
  - Discuss the classification of IPv4 addresses (Class A, B, C, D, E) and their ranges.
  - Example: Show how an IPv4 address looks (e.g., 192.168.1.1) and explain its breakdown.
- **IPv6 Addresses**:
  - Introduce IPv6 as the 128-bit successor to IPv4, designed to address the shortage of IP addresses.
  - Explain the format of IPv6 and how it solves the address exhaustion problem.
  - Example: Show an IPv6 address (e.g., 2001:0db8:85a3:0000:0000:8a2e:0370:7334) and break it down for students to understand.
- **IP Address Allocation**: Explain how IP addresses are allocated by the Internet Assigned Numbers Authority (IANA) and regional internet registries.
- **Subnetting and CIDR**: Briefly introduce subnetting and CIDR (Classless Inter-Domain Routing) as methods to efficiently allocate IP addresses.
- **Real-World Application**: Explain how routers and computers use IP addresses to find the best path for data to travel across the internet.

3. Exercise (5 minutes) –
   - Group Activity: Split students into groups and give them different scenarios related to QoS and IP addresses
   - Each group will present their solutions, and the class will discuss the effectiveness of their approaches.

Use Nearpod to collect responses and discuss the answers.

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Closure	1. Recap the importance of QoS in managing network performance and maintaining high-quality communication.
	2. Highlight the significance of IP addresses in routing and data transmission across the internet.
	3. Assign homework for students to configure a network in a simulation tool where they apply QoS to prioritize traffic and assign IPv4 and IPv6 addresses.
	Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
	- What are the key parameters of QoS, and why is each important for maintaining network performance?
	- How does IPv6 address the limitations of IPv4, and what are the advantages of adopting IPv6?
	- How is an IP address used in routing to deliver data to its intended destination?
	Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 4.9	Course Name: Computer Networks Topic: Introduction to IPv6, IPv4 vs. IPv6	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	   a. Understand the basics of IPv6 and how it differs from IPv4.
	   b. Explain the limitations of IPv4 that led to the development of IPv6.
	   c. Identify the key features and benefits of IPv6 over IPv4.
	   d. Discuss real-world scenarios where IPv6 is essential for modern networks.
	   e. Compare IPv4 and IPv6 in terms of address space, header format, security, and performance.

Teaching Aids (if any)	a. Presentation slides.
	   b. Projector and whiteboard for interactive discussions.
	   c. Diagrams comparing IPv4 and IPv6 address formats and headers.

Teaching Development	**Introduction (5 minutes)**
	
	● **Ask students:**
	   ○ "How many devices do you think are connected to the internet today, and how do they all get unique addresses?"
	   ○ Introduce the concept of IP addressing and how the explosive growth of internet-connected devices (IoT, smartphones) has led to the exhaustion of IPv4 addresses.
	   ○ Explain that IPv6 was developed to overcome the limitations of IPv4 and support the future growth of the internet.
	
	Development (30 minutes)
	A. What is IPv6? (10 minutes)
	● **Definition:** Explain that IPv6 (Internet Protocol version 6) is the latest version of the Internet Protocol, designed to replace IPv4 (which uses a 32-bit address space).
	● **Address Format:**
	   ○ IPv6 uses 128-bit addresses, allowing for a vastly larger address space (2^{128}).
	   ○ Example: Show an example of an IPv6 address (e.g., 2001:0db8:85a3:0000:0000:8a2e:0370:7334) and compare it to an IPv4 address (e.g., 192.168.1.1).
	   ○ Real-World Example: Discuss the role of IPv6 in large-scale networks like ISPs and cloud providers where address exhaustion is critical.
	● **Need for IPv6:** Explain that IPv4, with only about 4.3 billion addresses, cannot accommodate the increasing number of devices connected to the internet.
	   ○ **Illustration:** Use a chart to show IPv4 exhaustion and the projected growth of devices.
	
	B. Key Features and Benefits of IPv6 (10 minutes)
	● **Larger Address Space:** IPv6 provides an enormous address pool, solving the address exhaustion issue.
	● **Simplified Header Structure:** IPv6 headers are more efficient, leading to faster routing and processing.

	- **Built-in Security:** IPv6 has IPsec (Internet Protocol Security) built-in, offering better security for modern networks.
	  - **Example:** Discuss how IPv6 handles end-to-end encryption more efficiently than IPv4.
	- **Auto-configuration:** IPv6 allows for automatic IP address configuration using Stateless Address Autoconfiguration (SLAAC).
	  - **Real-World Example:** Explain how auto-configuration simplifies network management in large enterprise networks and smart cities.
	
	C. IPv4 vs. IPv6: Key Differences (10 minutes)
	- **Address Space:** IPv4 uses 32-bit addresses, while IPv6 uses 128-bit addresses, offering a near-infinite number of unique IPs.
	  - **Example:** Illustrate with a side-by-side comparison of address formats and the total number of addresses possible with IPv4 vs. IPv6.
	- **Header Format:** IPv6 headers are simpler, reducing the burden on routers.
	  - **Diagram:** Use a diagram to compare the IPv4 and IPv6 header formats.
	- **NAT vs. No NAT:** Explain how IPv4 relies heavily on Network Address Translation (NAT) to conserve IP addresses, while IPv6 eliminates the need for NAT.
	- **Security:** IPv6 mandates IPsec support for improved security, whereas it's optional in IPv4.
	- **Real-World Example:** Discuss how major tech companies (like Google and Facebook) are adopting IPv6 to improve scalability and security.
	
	Exercise (10 minutes)
	
	- "Imagine you're an IT manager tasked with upgrading a company's network to support IoT devices. Would you recommend staying with IPv4 or transitioning to IPv6? Why?"
	- Divide students into small groups (2-3) to discuss the advantages of moving to IPv6 in terms of scalability, security, and network management.
	- After 5 minutes, ask each group to present their thoughts, followed by a class discussion on the practical challenges and benefits of IPv6 adoption.

Closure	Recap the key points: What IPv6 is, why it was developed, and the major differences between IPv4 and IPv6. **Suggested Reading:** - "Data and Computer Communications" by William Stallings, Chapter 19, pp. 610-620 (covers the technical details of IPv6 and its advantages over IPv4). - "Computer Networking: A Top-Down Approach" by James Kurose and Keith Ross, Chapter 4, pp. 270-290 (explains the transition from IPv4 to IPv6 and the role of IP in networking).

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Evaluation	Reflective Questions (What Why Who?). Allow students to answer and discuss.
	• What are the main advantages of IPv6 over IPv4, and why is it necessary for the future of the internet?
	• How does the IPv6 address format improve scalability for future internet growth?
	• What challenges do you foresee in transitioning from IPv4 to IPv6, particularly for businesses?
	Spend 5 minutes to wrap up and consolidate the learnings.

Lesson Plan No. 4.10	Course Name: Computer Networks Topic: Internetworking devices –concept of Internetworking	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	   a. Define internetworking and explain why it's essential in networking.
	   b. Understand the functions of various internetworking devices (Repeaters, Hub, Bridges, Switches, Routers, Gateways).
	   c. Identify real-world scenarios where each device is used.
	   d. Compare the devices in terms of their capabilities and network layer functionality.
	   e. Discuss best practices for using these devices in building robust and scalable networks.

Teaching Aids (if any)	a. Presentation slides. b. Projector and whiteboard for interactive discussions. c. Diagrams illustrating network setups using different devices.

Teaching Development	**Introduction (5 minutes)**
	
	● **Ask students:**
	   ○ "Have you ever connected multiple devices in your home, school, or office network? What do you think allows them to communicate seamlessly?"
	   ○ Introduce the concept of internetworking, where different networks are connected using networking devices to form a larger, integrated network.
	   ○ Briefly explain why internetworking is essential for scalability and efficient communication across networks.
	
	Development (30 minutes)
	
	A. Repeaters and Hubs (10 minutes)
	● **Repeaters:**
	   ○ **Definition:** Explain that repeaters are simple devices used to regenerate and amplify signals to extend the distance a signal can travel without degradation.
	   ○ **Example:** Mention how repeaters are used in large buildings to extend the range of Wi-Fi or Ethernet connections.
	● **Hub:**
	   ○ **Definition:** A hub is a basic networking device that connects multiple computers in a network. It operates at Layer 1 (Physical Layer) of the OSI model.
	   ○ **How it works:** Data sent to the hub is broadcast to all devices connected to it, causing inefficiency in larger networks.
	   ○ **Real-World Example:** Early Ethernet networks used hubs before being replaced by more efficient devices like switches.
	
	B. Bridges and Switches (10 minutes)
	
	● **Bridges:**

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- **Definition:** A bridge connects two or more network segments at Layer 2 (Data Link Layer). It filters traffic between the segments, forwarding data only to the intended recipient.
- **Example:** A bridge might be used to connect a wired and wireless segment of a home network.
- **Real-Time Example:** Show how a bridge divides collision domains, reducing congestion in large networks.
- **Switches:**
  - **Definition:** A switch is an advanced version of a hub that operates at Layer 2 but forwards data only to the device that needs it, not to all devices.
  - **How it works:** Explain that switches use MAC addresses to forward data to the correct device, making them more efficient than hubs.
  - **Real-World Example:** Discuss how modern LANs rely on switches for fast, efficient communication.
  - **Diagram:** Show a network diagram with switches efficiently routing traffic.

C. Routers and Gateways (10 minutes)

- **Routers:**
  - **Definition:** Routers operate at Layer 3 (Network Layer) and are responsible for forwarding data between different networks based on IP addresses.
  - **How it works:** Explain that routers use routing tables to determine the best path for data to travel between networks.
  - **Real-World Example:** Discuss how routers are used in homes to connect to the internet and in businesses to manage multiple subnets.
- **Gateways:**
  - **Definition:** Gateways operate at multiple layers of the OSI model, often at the Transport Layer or Application Layer. They act as translators between different protocols or networks.
  - **Real-Time Example:** A gateway could connect a corporate network running one protocol with another using a different protocol (e.g., IPv4 to IPv6 translation).
  - **Real-World Example:** Cloud providers often use gateways to manage communication between different services or between internal and external networks.

Exercise (10 minutes)

- "Imagine you are setting up a network for a small company. They need to connect different departments, ensure data security, and access the internet. Which devices would you choose, and why?"
- Divide students into small groups (2-3) to discuss how they would design a network for the company using the devices discussed (repeaters, switches, routers, gateways).
- After 5 minutes, ask each group to present their network setup and explain why they chose each device. Discuss the pros and cons of each design, focusing on scalability, efficiency, and security.

Closure	Recap the key points: the functions of repeaters, hubs, bridges, switches, routers, and gateways, and how these devices fit into network design.
	Suggested Reading:
	● "Data and Computer Communications" by William Stallings, Chapter 10, pp. 340-355 (covers internetworking devices and their roles in networking).
	● "Computer Networking: A Top-Down Approach" by James Kurose and Keith Ross, Chapter 5, pp. 240-255 (discusses the functions of switches, routers, and other devices in modern networks).
Evaluation	Reflective Questions (What Why Who?). Allow students to answer and discuss.
	• What are the differences between a hub and a switch, and why are switches preferred in modern networks?
	• How does a router differ from a bridge, and when would you use each device?
	• What role does a gateway play in connecting networks that use different protocols?
	Spend 5 minutes to wrap up and consolidate the learnings.

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Lesson Plan No. 5.1	Course Name: Computer Networks Topic: Transport, Session, Presentation, and Application Layer	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Understand the roles of the Transport, Session, Presentation, and Application layers in the OSI Model. b. Explain the functionality of each layer and how they interact with each other. c. Recognize the key protocols associated with each layer and their importance in network communication. d. Demonstrate the flow of data across these upper layers during communication between devices.
Teaching Aids (if any)	a. PowerPoint slides b. Real-world examples (e.g., content delivery networks, live streaming services) c. Use of Nearpod tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	 - Ask questions.
	 - Begin by revisiting the OSI Model's lower layers (Physical, Data Link, and Network layers) discussed in previous lessons.
	 - Explain that today's lesson will focus on the **upper layers**: Transport, Session, Presentation, and Application, which handle data flow from application processes to network services.
	 - Briefly introduce the significance of these layers in enabling end-to-end communication across different network protocols and applications
	
	 2. **Development** (30 minutes)
	 a. Transport Layer
	 - **Definition**: Explain that the Transport layer ensures end-to-end data transmission, reliability, and error recovery.
	 - **Key Functions**:
	     - **Segmentation and Reassembly**: Dividing large messages into smaller segments for transmission and reassembling them at the destination.
	     - **Flow Control**: Ensuring the sender does not overwhelm the receiver with too much data (e.g., TCP sliding window).
	     - **Error Detection and Recovery**: Detecting and retransmitting lost or corrupted segments.
	     - **Multiplexing**: Handling multiple communications simultaneously using ports.
	 - **Protocols**:

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- **TCP (Transmission Control Protocol)**: Reliable, connection-oriented protocol.
- **UDP (User Datagram Protocol)**: Connectionless, lightweight protocol for fast transmissions.
- Example: Compare TCP (reliable, with error correction) to UDP (faster but less reliable, used in applications like gaming and video streaming).

   b. Session Layer
- **Definition**: The Session layer manages and controls the connections (sessions) between two computers.
- **Key Functions**:
    - **Session Establishment, Maintenance, and Termination**: Initiating, managing, and terminating sessions between applications.
    - **Synchronization**: Managing data exchange checkpoints to ensure data integrity across long sessions.
    - **Dialog Control**: Managing full-duplex and half-duplex communications.
- Example: Explain how the Session layer maintains a session during a video conference, ensuring the connection is maintained throughout the call.

   c. Presentation Layer
- **Definition**: The Presentation layer is responsible for translating data between the application and the network format.
- **Key Functions**:
    - **Data Translation**: Ensuring the data from the application is in a format that the receiving system can understand (e.g., ASCII, EBCDIC).
    - **Data Encryption/Decryption**: Ensuring data security during transmission by encrypting data before sending and decrypting it at the destination.
    - **Data Compression**: Reducing the size of data to make it faster to transmit across the network.
- Example: Show how the Presentation layer might encode a video file to a standard format (e.g., MP4) before sending it.

3. Exercise (5 minutes) –
   - Group Activity: Have students simulate data flow in a network using tools like Cisco Packet Tracer or Wireshark. Each group will analyze how the Transport, Session, Presentation, and Application layers work during a web page request.

Use Nearpod to collect responses and discuss the answers.

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Closure	1. Recap the roles and responsibilities of the Transport, Session, Presentation, and Application layers in the OSI Model. 2. Emphasize the importance of understanding these layers for troubleshooting network issues and configuring network applications. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. - What are the key responsibilities of the Transport layer, and how does it ensure reliable communication? - How does the Session layer maintain long-lasting connections, and why is this important? - How does the Presentation layer ensure data is in a readable format for the receiving device? - How does the Application layer interact with end-user applications to provide network services? 2. Conduct a quiz using an online platform like Kahoot! covering the key concepts discussed. Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 5.2	Course Name: Computer Networks Topic: Transport Services: Transport Service Primitives	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Understand the concept of transport services and how they provide end-to-end communication. b. Explain the role of **Transport Service Primitives** in managing communication between hosts. c. Identify and describe the key primitives used in transport services (e.g., CONNECT, LISTEN, SEND, RECEIVE). d. Demonstrate how transport service primitives are used in connection-oriented and connectionless services.
Teaching Aids (if any)	a. PowerPoint slides b. Real-world examples (e.g., content delivery networks, live streaming services) c. Use of Nearpod tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	- Ask questions.
	- Begin by asking students how devices on a network communicate with each other and what is needed for successful data transfer.
	- Introduce the concept of **transport services**, explaining that these services provide the necessary functions to ensure data is transferred reliably between devices across a network.
	- Briefly introduce **transport service primitives** as the set of operations that allow applications to interact with the transport layer to establish communication.
	
	2. **Development** (30 minutes)
	a. Overview of Transport Services
	- **Definition**: Explain that the transport layer in the OSI model provides end-to-end communication services for applications across a network.
	- **Types of Transport Services**:
	  - **Connection-Oriented Service (TCP)**: A reliable service where a connection is established before data is transferred.
	  - **Connectionless Service (UDP)**: A service where data is sent without establishing a connection, often used for faster, less reliable communications.
	- **Functions of the Transport Layer**:
	  - **Data segmentation and reassembly**.
	  -**Error control and flow control**.

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- **Multiplexing and de-multiplexing** for handling multiple connections.

    b. Transport Service Primitives

- **Definition**: Explain that transport service primitives are basic operations or commands that allow the interaction between the application layer and the transport layer. These primitives enable the setup, management, and termination of connections.

- Key Transport Service Primitives:

- **LISTEN**: A primitive that prepares the transport layer to accept incoming connection requests (used in TCP).
- **CONNECT**: A primitive used to establish a connection with a remote host.
- **SEND**: A primitive used to send data to the connected host.
- **RECEIVE**: A primitive used to receive data from a connected host.
- **DISCONNECT**: A primitive used to terminate a connection.

- Primitives in Connection-Oriented Services (TCP):

- Explain how primitives like LISTEN, CONNECT, SEND, RECEIVE, and DISCONNECT work together to manage a TCP connection.
- Example: Show how a web browser initiates a connection to a server using CONNECT, how data is exchanged using SEND/RECEIVE, and how the connection is closed using DISCONNECT.

- Primitives in Connectionless Services (UDP):

- Explain that in UDP, only SEND and RECEIVE are typically used, as there is no need for LISTEN, CONNECT, or DISCONNECT.
- Example: Describe how a DNS query (UDP-based) sends data using SEND and receives a response using RECEIVE without establishing a formal connection.

3. Exercise (5 minutes) –
   - Group Activity: Split students into pairs and ask them to simulate a simple client-server connection using primitives in a simulated environment like Cisco Packet Tracer.
   - One student will simulate the server (using LISTEN and RECEIVE), and the other will simulate the client (using CONNECT and SEND).

Use Nearpod to collect responses and discuss the answers.

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Closure	1. Recap the importance of transport services and transport service primitives in managing network communication.
	2. Emphasize the differences between connection-oriented and connectionless transport services, highlighting the use of specific primitives in each.
	Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
	- What is the role of the transport layer in network communication?
	- How do transport service primitives enable communication between hosts in a network?
	- What are the key differences in the primitives used for connection-oriented and connectionless services?
	2. Conduct a quiz using an online platform like Kahoot! covering the key concepts discussed.
	Spend 5 minutes to evaluate student assimilation of the lesson contents

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| Lesson Plan No. 5.3 | Course Name: Computer Networks
Topic: Elements of Transport Protocol,
Issues | Course No.: COM-502 |

Objectives	At the end of the lesson, the student shall be able to: a. Understand the elements of transport protocols and their significance in network communication. b. Identify key issues related to transport protocols. c. Analyze how transport protocols ensure reliable data transmission across networks. d. Explain various challenges such as congestion, flow control, and error control within transport protocols.
Teaching Aids (if any)	a. PowerPoint slides b. Use of Nearpod tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	- Begin with questions about the role of transport protocols in ensuring end-to-end data transmission.
	- Introduce the core elements of transport protocols, explaining that they provide essential services like error recovery, flow control, and congestion management.
	
	2. **Development** (30 minutes)
	a. Elements of Transport Protocol
	- **Definition and Purpose**: Explain that transport protocols are responsible for delivering data between hosts in a reliable manner, ensuring that the data is properly sequenced and error-free.
	- **Key Elements:**
	  - **Error Detection and Correction**: How transport protocols like TCP use mechanisms such as checksums to detect errors and retransmit data if necessary.
	  - **Flow Control**: Techniques (e.g., sliding window) used by transport protocols to prevent a sender from overwhelming a receiver.
	  - **Congestion Control**: Algorithms (like TCP's congestion window) to manage data flow across the network and prevent congestion collapse.
	  - **Segmentation and Reassembly**: How large messages are divided into smaller segments and reassembled at the destination.
	  - **Connection Management**: Handling the setup and teardown of connections between hosts, as in TCP.
	
	b. Issues in Transport Protocols

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- **Congestion Control**: How network congestion occurs and the methods (like additive increase/multiplicative decrease) transport protocols use to control it.
- Discuss examples like slow start and congestion avoidance in TCP.
- **Flow Control Issues**: Explain what happens when the sender's data overwhelms the receiver, and how protocols like TCP prevent this with sliding windows.
- **Error Control Problems**: Explore the challenges of ensuring data integrity, particularly with unreliable transmission channels, and how retransmission mechanisms can increase overhead.
- **Sequence Number Wrapping**: Address issues when sequence numbers wrap around and how protocols mitigate the resulting problems.
- **Latency and Throughput**: Examine how network delays affect transport protocols and ways to optimize throughput without sacrificing reliability.

3. Exercise (5 minutes) –
   - Group Activity: Assign students into pairs. One simulates a client and the other a server in a TCP connection. Ask them to simulate a scenario where congestion control and error control mechanisms come into play.
   - Use Nearpod to collect their responses and discuss the outcomes.

Use Nearpod to collect responses and discuss the answers.

Closure	1. Recap the significance of transport protocols in ensuring reliable data communication. 2. Highlight key issues and how protocols address them, emphasizing error recovery, flow, and congestion control. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. - What are the core elements of transport protocols, and why are they important? - How do congestion control and flow control mechanisms improve network performance? - What are the key issues transport protocols face, and how are they mitigated? 2. Conduct a quiz using an online platform like Kahoot! covering the key concepts discussed.

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	Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 5.4	Course Name: Computer Networks Topic: Introduction to TCP and UDP	Course No.: COM-502

Objectives	At the end of the lesson, the student shall be able to:
	  a. Understand the core concepts of TCP and UDP.
	  b. Differentiate between connection-oriented and connectionless transport services.
	  c. Identify the key features of TCP (Transmission Control Protocol) and UDP (User Datagram Protocol).
	  d. Analyze the use cases where TCP or UDP is preferred based on network requirements.

Teaching Aids (if any)	a. PowerPoint slides b. Use of Nearpod tool for online quiz

Teaching Development	1. **Introduction** (5 minutes)
	  - Ask students: "How do applications ensure that data is sent and received correctly across the network?"
	  - Introduce TCP and UDP as two primary transport layer protocols responsible for data transmission. Explain that TCP is connection-oriented and reliable, whereas UDP is connectionless and faster but less reliable.
	
	2. **Development** (30 minutes)
	  a. Transmission Control Protocol (TCP)
	    - **Definition and Purpose**: Explain that TCP provides reliable, ordered, and error-checked delivery of data.
	    - **Connection-Oriented Communication**: Describe how TCP establishes a connection through a three-way handshake (SYN, SYN-ACK, ACK) before data transmission begins.
	    - **Reliable Delivery**: Discuss how TCP ensures that all segments of data are received and in the correct order, using acknowledgments and retransmissions.
	    - **Flow Control**: Introduce TCP's sliding window mechanism to manage the rate of data flow and prevent the receiver from being overwhelmed.
	    - **Congestion Control**: Explain how TCP handles network congestion through techniques such as slow start, congestion avoidance, and fast recovery.
	    - **Use Case**: Real-world applications of TCP (e.g., web browsing, file transfers, emails) where reliability is essential.
	
	  b. User Datagram Protocol (UDP)
	    - Definition and Purpose: Explain that UDP is a simpler, connectionless protocol that sends data without establishing a prior connection.

	- Connectionless Communication: Discuss how UDP does not require handshaking, making it faster but less reliable than TCP.
	- Unreliable Delivery: Highlight that UDP does not guarantee the order of delivery, error checking, or retransmission, making it suitable for applications where speed is more important than reliability.
	- Low Overhead: Mention that UDP has less overhead compared to TCP, making it efficient for time-sensitive applications.
	- Use Case: Real-world applications of UDP (e.g., DNS, video streaming, VoIP) where low latency is more critical than perfect reliability.
	
	3. Exercise (5 minutes) –
	  - Pair students and assign them to simulate a TCP connection (client-server) and a UDP data transmission using tools like Cisco Packet Tracer or Wireshark.
	  - Use Nearpod to collect responses and discuss differences between TCP and UDP observed during the exercise.

Closure	1. Recap the fundamental differences between TCP and UDP. 2. Highlight key points like reliability, connection establishment, flow control, and congestion control in TCP, versus the speed and low overhead of UDP. 3. Encourage students to think about the trade-offs between speed and reliability when choosing between TCP and UDP for network applications. Spend 5 minutes to wrap up and consolidate the learnings

Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss.
	  - What are the key differences between TCP and UDP?
	  - Why is TCP considered more reliable than UDP?
	  - In what situations would you choose UDP over TCP, and why?
	
	2. Conduct a quiz using an online platform like Kahoot! covering the key concepts discussed.
	
	Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 5.5	Course Name: Computer Networks Topic: FTP	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	   a. Define FTP and understand its purpose in network communication.
	   b. Explain how FTP works, including active and passive modes.
	   c. Identify the structure of FTP commands and responses.
	   d. Discuss real-world examples of FTP use and its limitations.
	   e. Understand the differences between FTP and other file transfer methods (SFTP, FTPS).

Teaching Aids (if any)	a. Presentation slides.
	   b. Projector and whiteboard for interactive discussions.
	   c. Diagrams to illustrate active and passive FTP modes.

Teaching Development	**Introduction (5 minutes)**
	
	● **Ask students:**
	   ○ "Have you ever downloaded or uploaded files to a website? How do you think large files are transferred between servers and computers?"
	
	   ○ Briefly introduce FTP as one of the earliest methods for transferring files across a network.
	
	   ○ Explain how FTP allows users to upload, download, and manage files remotely using a client-server model.
	
	Development (30 minutes)
	
	A. What is FTP? (10 minutes)
	
	● **Definition:** Explain that FTP (File Transfer Protocol) is a standard network protocol used to transfer files from one host to another over a TCP-based network, like the internet.
	
	● **How it works:** Discuss the client-server model in FTP, where the FTP client connects to the FTP server to upload or download files.
	
	   o **Example:** Transferring files from your local computer to a web server for hosting a website.
	
	● **History:** Briefly discuss the historical development of FTP, highlighting its origins in the early ARPANET.
	
	B. FTP Commands and Responses (10 minutes)
	
	● **Basic Commands**: Introduce the basic commands used in FTP, such as USER, PASS, GET, PUT, QUIT.

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  - o **Real-Time Example:** Show how these commands are used via a command-line interface (CLI) with an FTP server (provide a demo using PowerPoint screenshots or a short YouTube clip).

  - **Response Codes:** Explain how FTP servers respond with numerical codes (e.g., 200 for success, 530 for login failure).

    - o **Example:** Discuss what happens when a user tries to log in with incorrect credentials.

  C. Active vs. Passive FTP (10 minutes)

  - **Active Mode:** Explain how in active mode, the client opens a random port and waits for the server to connect back to it. This mode can cause issues with firewalls.

    - o **Illustration:** Use a diagram to show the process of an active FTP session.

  - **Passive Mode:** Explain how passive mode resolves firewall issues by having the client initiate both data and command connections.

    - o **Example:** Mention why passive mode is often preferred in modern networks.

    - o **Illustration:** Use a diagram to show the difference between active and passive mode.

  Exercise (10 minutes)

  - "Imagine you are running an online store and need to regularly transfer large amounts of product data between your local server and a cloud server. Would you use FTP, or another protocol like SFTP? Why?"
  - Divide students into small groups (2-3) to discuss the pros and cons of using FTP for file transfers in different situations.
  - After 5 minutes, ask each group to present their thoughts. Engage the class by discussing other modern alternatives like SFTP (Secure FTP) and FTPS (FTP Secure).

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<tr><td>**Closure**</td><td colspan="2">

  Recap the key points: what FTP is, the main commands, active vs. passive FTP, and real-world uses.

  Suggested Reading:

  - "Data and Computer Communications" by William Stallings, Chapter 15, pp. 500-510 (covers FTP and related file transfer protocols).

  - "TCP/IP Protocol Suite" by Behrouz A. Forouzan, Chapter 22, pp. 675-680 (discusses FTP and its role in the TCP/IP suite).

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<tr><td>**Evaluation**</td><td colspan="2">

  Reflective Questions (What Why Who?). Allow students to answer and discuss.

  - What are the key differences between active and passive FTP?
  - Why is FTP not considered secure by modern standards?

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| | ● What advantages do SFTP and FTPS offer over FTP? |
| | Spend 5 minutes to wrap up and consolidate the learnings. |

Lesson Plan No. 5.6	Course Name: Computer Networks Topic: DNS	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to: a. Define DNS and explain its purpose in internet communication. b. Describe how DNS works, including its hierarchical structure and the role of DNS servers. c. Understand different DNS record types and their functions. d. Discuss real-world examples of DNS, including how domain names are resolved. e. Analyze the potential security threats to DNS, such as DNS spoofing and attacks.
Teaching Aids (if any)	a. Presentation slides. b. Projector and whiteboard for interactive discussions. c. Diagrams illustrating the DNS hierarchy and resolution process.
Teaching Development	**Introduction (5 minutes)** ● **Ask students:** ○ "Have you ever wondered how typing 'www.google.com' in your browser leads you to the Google website? What's happening behind the scenes?" ○ Briefly introduce DNS as the "phonebook of the internet" that maps domain names to IP addresses. ○ Explain why DNS is critical for making the internet user-friendly by allowing domain name resolution instead of requiring users to remember IP addresses. **Development (30 minutes)** **A. What is DNS? (10 minutes)** ● **Definition:** Explain that DNS (Domain Name System) is a protocol used to translate human-friendly domain names (like www.example.com) into machine-readable IP addresses (like 192.168.1.1). ● **DNS Hierarchy:** Describe the hierarchical structure of DNS, including: o **Root Servers:** The starting point of DNS resolution. o **Top-Level Domains (TLDs):** Like .com, .org, .edu. o **Second-Level Domains:** The specific domain names (e.g., google.com). ● **Real-World Example:** Walk through an example of how typing a URL in a browser initiates the DNS lookup process. **B. DNS Query Types (10 minutes)**

- **Recursive and Iterative Queries:** Explain the difference between recursive queries (where a DNS server queries other servers on behalf of the client) and iterative queries (where the client receives referrals to other DNS servers).

- **Real-Time Example:** Show a breakdown of a DNS query through a packet capture tool (e.g., Wireshark), highlighting the recursive query process.

- **DNS Record Types:**

  o **A Record:** Maps a domain name to an IP address.

  o **MX Record:** Used for email routing.

  o **CNAME Record:** Alias for a domain name.

  o **NS Record:** Points to the authoritative DNS server for a domain.

  o **Example:** Show how www.google.com is mapped to an IP address via an A record in the DNS system.

C. DNS Resolution Process (10 minutes)

- **How DNS Works:** Walk through the DNS resolution process step-by-step, from the client query to the DNS server, root server, and authoritative server.

  o **Illustration:** Use a flowchart to show the process of resolving a domain name to an IP address, starting from a client's request to loading a webpage**.**

  o **Real-World Example:** Explain how the DNS caching system speeds up the resolution process for frequently visited websites.

Exercise (10 minutes)

- "Imagine you're managing a website and notice that your site is unreachable for many users. How could DNS be causing the problem? What steps would you take to diagnose and fix the issue?"
- Break students into small groups (2-3) to discuss common DNS issues like propagation delays, misconfigured DNS records, and DNS server outages.
- After 5 minutes, ask each group to present their thoughts and proposed solutions, followed by a class discussion on DNS troubleshooting.

Closure	Recap the key points: what DNS is, how DNS resolution works, the importance of DNS in modern networking, and the potential security risks associated with DNS.

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	Suggested Reading: ● "Data and Computer Communications" by William Stallings, Chapter 14, pp. 530-540 (discusses DNS in detail, including query types and security issues). ● "Computer Networking: A Top-Down Approach" by James Kurose and Keith Ross, Chapter 2, pp. 110-125 (covers DNS and its role in the internet infrastructure).
Evaluation	Reflective Questions (What Why Who?). Allow students to answer and discuss. ● What are the main components of DNS, and how do they work together to resolve a domain name? ● How do DNS caching and TTL (Time To Live) affect the performance of DNS resolution? ● What security measures can be used to protect DNS from attacks? Spend 5 minutes to wrap up and consolidate the learnings.

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Lesson Plan No. 5.7	Course Name: Computer Networks Topic: E-mail	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	    a. Understand the basic structure and components of an email system.
	    b. Explain how email works, including the role of protocols like SMTP, POP3, and IMAP.
	    c. Discuss the lifecycle of an email from composition to delivery and storage.
	    d. Analyze the benefits and limitations of email communication in modern networking.
	    e. Identify common security issues related to email and how to prevent them.

Teaching Aids (if any)	a. Presentation slides.
	    b. Projector and whiteboard for interactive discussions.
	    c. Diagrams illustrating the flow of an email from sender to recipient.

Teaching Development	**Introduction (5 minutes)**
	
	● **Ask students:**
	    ○ "How many emails do you send and receive daily? Have you ever thought about what happens behind the scenes when you click 'Send'?"
	    ○ Briefly introduce email as a fundamental communication tool in both personal and professional life.
	    ○ Explain that while email seems simple on the surface, it involves multiple components working together to deliver messages reliably.
	
	Development (30 minutes)
	
	A. How E-mail Works (10 minutes)
	
	● **Definition**: Email is an electronic messaging system used for exchanging messages between users over a network.
	
	● **Basic Components**:
	
	    o **Email Client**: Software that allows users to compose, send, and receive emails (e.g., Gmail, Outlook).
	
	    o **Mail Server**: Stores and forwards emails (e.g., Google's Gmail servers).
	
	    o **Protocols**: Define how emails are sent and received.
	
	        ▪ **SMTP** (Simple Mail Transfer Protocol): Used for sending emails.

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▪ **POP3** (Post Office Protocol): Used for retrieving emails from a server to a local device.

▪ **IMAP** (Internet Message Access Protocol): Used for retrieving emails while keeping them stored on the server.

● **Real-World Example**: Walk through an example of sending an email from a Gmail account to an Outlook account, explaining how SMTP, POP3, and IMAP come into play.

B. Lifecycle of an Email (10 minutes)

● **Composition**: The user writes an email using an email client.

● **Transmission**:

o **SMTP**: The client sends the email to the SMTP server, which forwards it to the recipient's mail server.

o **Example**: A student sending an email to their professor using their university account.

● **Storage & Retrieval**:

o **POP3**: The email is downloaded from the server and stored locally.

o **IMAP**: The email remains on the server and is synchronized across multiple devices.

● **Real-Time Example**: Use a diagram to show the flow of an email from the sender's client, through the SMTP server, to the recipient's inbox.

C. Email Protocols and Their Differences (10 minutes)

● **SMTP**: Explain that SMTP is responsible for sending emails. It works over TCP and ensures reliable delivery.

o **Example**: Compare SMTP to a postal service ensuring that a letter reaches its destination.

● **POP3 vs. IMAP**:

o **POP3**: Retrieves the email and deletes it from the server, making it ideal for users with limited storage.

o **IMAP**: Synchronizes emails across multiple devices, making it the preferred option for modern users with smartphones, tablets, and laptops.

	o **Example**: A student accessing the same email account on their phone and laptop via IMAP.

Exercise (10 minutes)

- "Imagine you're running a small business and you need to set up email accounts for your employees. Would you choose POP3 or IMAP, and why?"
- Divide students into small groups (2-3) to discuss which protocol (POP3 or IMAP) would be better for different scenarios (e.g., large enterprise vs. small business).
- After 5 minutes, have each group present their solution, followed by a discussion on the pros and cons of each protocol. |
| **Closure** | Recap the key points: how email works, the role of SMTP, POP3, and IMAP, and the lifecycle of an email from composition to retrieval.

Suggested Reading:

- "Data and Computer Communications" by William Stallings, Chapter 16, pp. 510-525 (covers email systems and protocols in detail).

- "Computer Networking: A Top-Down Approach" by James Kurose and Keith Ross, Chapter 2, pp. 80-90 (discusses email protocols and their functions). |
| **Evaluation** | Reflective Questions (What Why Who?). Allow students to answer and discuss.
- What are the main differences between POP3 and IMAP, and when would you choose one over the other?
- Why is SMTP necessary for email transmission, and how does it ensure reliable delivery?
- What are some common email security issues, and how can they be addressed?

Spend 5 minutes to wrap up and consolidate the learnings. |

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Lesson Plan No. 5.8	Course Name: Computer Networks Topic: Introduction to WWW	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	  a. Define the World Wide Web (WWW) and explain its significance in modern communication.
	  b. Understand how the web operates, including the roles of web browsers, servers, and URLs.
	  c. Describe key technologies behind the web: HTML, HTTP, and DNS.
	  d. Identify real-world examples of how the WWW is used.
	  e. Discuss the evolution of the web from Web 1.0 to Web 3.0 and beyond.

Teaching Aids (if any)	a. Presentation slides. b. Projector and whiteboard for interactive discussions. c. Diagrams showing the relationship between web clients, servers, and URLs.

Teaching Development	**Introduction (5 minutes)**
	
	● **Ask students:**
	  ○ "When you visit a website, how do you think the information gets from the server to your browser?"
	  ○ Provide a brief history of the World Wide Web, invented by Tim Berners-Lee in 1989 to facilitate information sharing between universities and research institutions.
	  ○ Explain that the web is an information system that operates over the internet, making it easier to access and share data through websites.
	
	Development (30 minutes)
	
	A. What is the World Wide Web? (10 minutes)
	
	● **Definition**: Explain that the WWW is a system of interlinked hypertext documents accessible via the internet. It uses web browsers to access these documents.
	
	  o **Example**: When you enter "www.example.com" in a browser, you are accessing a specific document or webpage stored on a web server.
	
	● **Components of the Web**:
	
	  o **Web Browsers**: Software applications used to retrieve and display web pages (e.g., Chrome, Firefox).
	
	  o **Web Servers**: Store web pages and respond to requests from web browsers.

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- o **URLs**: Uniform Resource Locators, the addresses used to access resources on the web.

- o **Example**: Break down a URL like "https://www.google.com/search?q=example" into its components (protocol, domain, path, query).

B. How the Web Works: HTTP, HTML, DNS (10 minutes)

- **HTTP (Hypertext Transfer Protocol)**: The protocol used by the web to communicate between clients and servers.

  - o **Example**: When you request a webpage, your browser uses HTTP to ask the server to send the page's HTML.

- **HTML (Hypertext Markup Language)**: The language used to create and format web pages.

  - o **Real-Time Example**: Show a simple HTML code snippet and explain how it is rendered in the browser.

- **DNS (Domain Name System)**: Translates domain names (like www.google.com) into IP addresses that browsers use to locate the server hosting the website.

  - o **Example**: Explain the process of typing a website address, using DNS to find the server, and HTTP to retrieve the web page.

  - o **Illustration**: Use a flowchart to show how a web request is processed, from entering a URL to receiving a web page.

C. Evolution of the Web: Web 1.0 to Web 3.0 (10 minutes)

- **Web 1.0 (Static Web)**: Introduce Web 1.0 as the "read-only" web, where websites were static, and user interaction was limited.

  - o **Example**: Early websites like informational portals or business pages.

- **Web 2.0 (Dynamic Web)**: Discuss the transition to Web 2.0, which is user-generated content, interactivity, and social media (e.g., blogs, Facebook).

  - o **Example**: Wikipedia, where users can edit content, and YouTube, where users upload and share videos.

- **Web 3.0 (Semantic Web)**: Mention Web 3.0 as the next step, focusing on AI, machine learning, and blockchain, where the web becomes more intelligent and data-driven.

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	o **Real-World Example**: Personalized search results using AI in platforms like Google and decentralized applications using blockchain technology. **Exercise (10 minutes)** ● "Imagine you're building a website for your business. What tools and technologies would you use to make it interactive and user-friendly?" ● Divide students into small groups (2-3) to brainstorm what features and technologies (HTML, HTTP, CSS, JavaScript) they would implement for their website. ● After 5 minutes, ask each group to present their ideas, encouraging a discussion on how these technologies shape modern web development.
Closure	Recap the key points: What the WWW is, how it works, the role of HTTP, HTML, and DNS, and how the web has evolved from Web 1.0 to Web 3.0. **Suggested Reading:** ● "Data and Computer Communications" by William Stallings, Chapter 27, pp. 780-790 (covers HTTP, DNS, and the architecture of the web). ● "Computer Networking: A Top-Down Approach" by James Kurose and Keith Ross, Chapter 2, pp. 90-105 (explains the web's operation, focusing on URLs, DNS, and HTTP).
Evaluation	Reflective Questions (What Why Who?). Allow students to answer and discuss. ● What are the main components that allow the World Wide Web to function? ● How has the web evolved from a static system (Web 1.0) to an interactive one (Web 2.0 and beyond)? ● What are some challenges or potential improvements you foresee for Web 3.0? Spend 5 minutes to wrap up and consolidate the learnings.

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Lesson Plan No. 5.9	Course Name: Computer Networks Topic: Firewalls	Course No.: COM-502

Objectives	At the end of the lesson the student shall be able to:
	  a. Define what a firewall is and explain its purpose in network security.
	  b. Understand how firewalls work, including packet filtering, stateful inspection, and proxy firewalls.
	  c. Discuss the differences between hardware and software firewalls.
	  d. Analyze real-world examples of how firewalls protect networks from attacks.
	  e. Identify common firewall configurations and best practices.

Teaching Aids (if any)	a. Presentation slides.
	  b. Projector and whiteboard for interactive discussions.
	  c. Diagrams showing different types of firewalls (packet filtering, stateful, proxy).

Teaching Development	**Introduction (5 minutes)**
	
	● **Ask students:**
	  ○ "Have you ever wondered how your computer or office network is protected from outside attacks while you're browsing the web?"
	  ○ Briefly introduce firewalls as the first line of defense in network security, explaining how they monitor and control incoming and outgoing network traffic based on predetermined security rules.
	  ○ Mention the growing importance of firewalls in protecting personal, corporate, and government networks.
	
	Development (30 minutes)
	
	A. What is the World Wide Web? (10 minutes)
	
	● **Definition**: Explain that the WWW is a system of interlinked hypertext documents accessible via the internet. It uses web browsers to access these documents.
	
	  o **Example**: When you enter "www.example.com" in a browser, you are accessing a specific document or webpage stored on a web server.
	
	● **Components of the Web**:
	
	  o **Web Browsers**: Software applications used to retrieve and display web pages (e.g., Chrome, Firefox).
	
	  o **Web Servers**: Store web pages and respond to requests from web browsers.

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o **URLs**: Uniform Resource Locators, the addresses used to access resources on the web.

o **Example**: Break down a URL like "https://www.google.com/search?q=example" into its components (protocol, domain, path, query).

B. How the Web Works: HTTP, HTML, DNS (10 minutes)

- **HTTP (Hypertext Transfer Protocol)**: The protocol used by the web to communicate between clients and servers.

  o **Example**: When you request a webpage, your browser uses HTTP to ask the server to send the page's HTML.

- **HTML (Hypertext Markup Language)**: The language used to create and format web pages.

  o **Real-Time Example**: Show a simple HTML code snippet and explain how it is rendered in the browser.

- **DNS (Domain Name System)**: Translates domain names (like www.google.com) into IP addresses that browsers use to locate the server hosting the website.

  o **Example**: Explain the process of typing a website address, using DNS to find the server, and HTTP to retrieve the web page.

  o **Illustration**: Use a flowchart to show how a web request is processed, from entering a URL to receiving a web page.

C. Evolution of the Web: Web 1.0 to Web 3.0 (10 minutes)

- **Web 1.0 (Static Web)**: Introduce Web 1.0 as the "read-only" web, where websites were static, and user interaction was limited.

  o **Example**: Early websites like informational portals or business pages.

- **Web 2.0 (Dynamic Web)**: Discuss the transition to Web 2.0, which is user-generated content, interactivity, and social media (e.g., blogs, Facebook).

  o **Example**: Wikipedia, where users can edit content, and YouTube, where users upload and share videos.

- **Web 3.0 (Semantic Web)**: Mention Web 3.0 as the next step, focusing on AI, machine learning, and blockchain, where the web becomes more intelligent and data-driven.

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	o **Real-World Example**: Personalized search results using AI in platforms like Google and decentralized applications using blockchain technology. **Exercise (10 minutes)** ● "Imagine you are setting up a network for a small business. What type of firewall would you choose, and how would you configure it to protect the business from cyberattacks?" ● Divide students into small groups (2-3) to discuss the pros and cons of different firewalls (hardware vs. software, packet filtering vs. stateful inspection). ● After 5 minutes, ask each group to present their chosen firewall and configuration, followed by a class discussion on why that configuration would be effective.
Closure	Recap the key points: what firewalls are, how they work, and their importance in protecting networks from external threats. **Suggested Reading:** ● "Data and Computer Communications" by William Stallings, Chapter 20, pp. 640-650 (discusses firewalls and intrusion detection systems). ● "Network Security Essentials: Applications and Standards" by William Stallings, Chapter 8, pp. 300-320 (covers firewall types and configurations).
Evaluation	Reflective Questions (What Why Who?). Allow students to answer and discuss. ● What are the main differences between a packet-filtering firewall and a stateful firewall? ● Why might a business choose a proxy firewall over other types? ● How does a hardware firewall differ from a software firewall, and when would you choose one over the other? Spend 5 minutes to wrap up and consolidate the learnings.

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