COMPUTER NETWORKS

ENCT 304

Lecture : 3 **Year : III**
Tutorial : 1 **Part : I**
Practical : 3

Course Objectives:
The objective of this course is to provide fundamental concepts and principles of computer networks. It focuses on various network architectures, protocols, standards, and the networking device functionalities. The course also aims to equip students with the skills to design, implement, test and troubleshoot basic network configurations.

1 Introduction (5 hours)

1.1 Computer network, importance and applications
1.2 Types of computer networks
1.3 Network topologies
1.4 Client/server and P2P networks
1.5 Protocols and standards, need of standardization
1.6 Layered network architecture, OSI and TCP/IP reference models
1.7 Addressing at different layers
1.8 Networking devices: Repeater, hub, bridge, switch, router, gateway

2 Physical Layer (5 hours)

2.1 Network monitoring: Bandwidth, throughput, delay, round-trip-time
2.2 Multiplexing - FDM, TDM, WDM
2.3 Switching - circuit switching, packet switching, datagram and virtual circuit switching
2.4 Transmission media - Guided (twisted pair, coaxial, optical fiber) and unguided media (radio waves, microwaves, infrared)
2.5 Ethernet cable standards (twisted pair and optical fiber)
2.6 Data encoding: Manchester, NRZ-I, MLT3, 4B/5B

3 Data Link Layer (8 hours)

3.1 Data link layer functions - Framing, error control, flow control, access control
3.2 Error control codes: Parity, checksum, CRC
3.3 Data link protocols: PPP, HDLC
3.4 Logical link control (LLC) and media access control (MAC) sublayers
3.5 Random access protocols: ALOHA, CSMA, CSMA/CD, CSMA/CA

3.6 Token based protocols: Token bus, token ring, FDDI
3.7 Ethernet (IEEE 802.3) and its evolution, bridged and switched Ethernet
3.8 WLAN (Wi-Fi) and IEEE 802.11
3.9 VLAN and its importance
3.10 Virtual circuit switching: ATM, MPLS

4 Network Layer (12 hours)

4.1 Network layer functions and services
4.2 Connection oriented and connectionless network services
4.3 Logical addressing and its importance
4.4 IPv4 addressing and classes, private and public IP address, sub-netting and super-netting, VLSM, CIDR
4.5 Unicast, multicast and broadcast addresses
4.6 Routing and types of routing: Static and dynamic, unicast and multicast, interior and exterior, distance vector and link state
4.7 Routing protocols: RIP, OSPF, EIGRP, BGP
4.8 Network address translation (NAT)
4.9 IPv6 addressing, need and features of iPv6
4.10 Protocols: IPv4, ARP, ICMP, IPv6, ICMPv6
4.11 Transition from IPv4 to IPv6 and strategies
4.12 Traffic shaping and congestion control mechanisms

5 Transport Layer (5 hours)

5.1 Transport layer functions and services
5.2 Elements of transport layer protocols: process-to-process communication, addressing, multiplexing and de-multiplexing, segmentation and reassembly, error control, flow control
5.3 Transport protocols: TCP and UDP
5.4 TCP services: connection setup and release, reliable, stream oriented, flow-control, error-control
5.5 Introduction to socket and socket programming

6 Upper Layers and Network Design (6 hours)

6.1 Functions and services of session, presentation and application layers
6.2 Introduction to upper layer protocols: DHCP, HTTP, HTTPS, FTP, SMTP, POP, IMAP
6.3 DNS, its function and DNS queries
6.4 Network management tools and protocols (SNMP)
6.5 Basics of web, e-mail, DNS and proxy server configurations
6.6 VoIP, FoIP and IP interconnection
6.7 Network design and configuration guidelines

7 Advanced Topics (4 hours)

7.1 Introduction to software-defined networking (SDN), basic architecture, importance and applications
7.2 Network security and its importance
7.3 Overview of content delivery networks (CDNs), named data networking (NDN), intent based networking (IBN)
7.4 Quantum network, network virtualization and recent trends in networking

Tutorial (15 hours)

1. Comparison of OSI and TCP/IP models
2. Comparison of twisted-pair, coaxial, and fiber optic in terms of cost, bandwidth, applications and so on
3. Datalink layer frames and framing techniques
4. Comparison of CSMA/CD and CSMA/CA
5. IP address classes, reserved IP addresses, subnetting (FLSM and VLSM), supernetting, comparison between IPv4 and IPv6
6. Comparison of different routing protocols with their applications
7. TCP and UDP protocols, their applications
8. TCP 3-way handshake with message flow
9. Application protocols to services (HTTP → Web, SMTP → Email, FTP → File transfer, DNS → Name resolution)
10. Working of DNS

Practical (45 hours)

1. Network cabling: Preparation of network cables and their uses
2. Network commands which are very important for testing and troubleshooting
3. Basic router configurations, basic network setup: IP address, subnet mask, default gateway
4. Subnetting and supernetting
5. Configuration of static routes and default routes
6. Dynamic routing configurations: RIP, EIGRP, OSPF, BGP
7. Configuration of switch, VLAN configuration and inter-VLAN routing
8. Server configurations: DHCP, web, DNS
9. Wireless network setup and packet analysis
10. Network troubleshooting: Diagnosing and resolving network issues
11. Network design: Design a complete network on given requirements using simulators like Cisco packet tracer or GNS3 or Mininet or equivalent tool
12. Presentation and review

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	5	6
2	5	6
3	8	12
4	12	15
5	5	6
6	6	9
7	4	6
Total	**45**	**60**

* There may be minor deviations in marks distribution.

References

1. Forouzan, B. A. (2012). Data communications and networking. McGraw-Hill.
2. Kurose, J. F., Ross, K. W. (2017). Computer networking: A top-down approach. Pearson.
3. Tanenbaum, A.S., Feamster, N. (2021). Computer networks. Pearson.
4. Stevens, W.R., Fall, K.R. (2011). TCP/IP illustrated: The protocols. Addison-Wesley.
5. RFCs and online resources for protocol specifications.