GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code: BE04000271
Subject Name: Computer Networks

w. e. f. Academic Year:	2024-25
Semester:	4
Category of the Course:	Professional Core Course

Prerequisite:	Basics of Computer Fundamentals including Hardware, Software and Operating Systems
Rationale:	This course builds a foundation in networking concepts and protocols. Students should understand computer fundamentals, data representation, and basic data structures and be proficient in a programming language (C, C++, Java or Python) for socket programming and practical exercises.

Course Outcomes:

Sr. No.	CO statement	Marks % Weightage
CO-1	Understand fundamentals of computer networks, topologies, OSI & TCP/IP models and network history.	15%
CO-2	Analyze physical and data link layer concepts, including signals, media, MAC protocols, Ethernet and VLANs.	25%
CO-3	Demonstrate network layer knowledge: IP addressing, packet forwarding, routing algorithms & protocols.	20%
CO-4	Evaluate transport layer protocols, including TCP/UDP services, flow, error and congestion control.	20%
CO-5	Apply application layer concepts and implement basic client-server communication using sockets.	20%

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	SL	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/ CA (I)	TW/ SL (I)	ESE (V)	
45	00	30	45	120	4	70	30	20	30	50	200

- **Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

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Course Content:

Sr. No.	Content	Total Hrs	% of Weightage
1	**Introduction to Computer Networking :** Data communication, Data flow, Network criteria, Types of connection, Physical topologies Types of networks, OSI Reference Model and TCP/IP Model , History and evolution of computer networks	5	15
2	**Physical Layer :** Analog & Digital signals, Network Performance(Bandwidth, Throughput, Latency, Jitter), Transmission media: Guided media (Twisted pair, Coaxial, Fiber optic) & Unguided media (Radio waves, Microwaves, Infrared)	5	15
3	**Data Link Layer :** Data link control: Framing, Error detection and correction (Parity Checking, CRC, Checksum, Hamming code), Media access control protocols: Random access (ALOHA, CSMA/CD, CSMA/CA), Controlled access (Reservation, Polling, Token Passing), Channelization (FDMA, TDMA, CDMA), Ethernet Standards: IEEE 802.3 (Ethernet), IEEE 802.11 (Wi-Fi), Connecting devices: Hubs, Switches, Routers, Virtual LAN (VLAN)	8	15
4	**Network Layer (IP & Routing) :** IPv4 and IPv6 addressing , IP Datagram structure, Forwarding and Switching, Types of Delay (Processing, Queuing, Transmission, Propagation), Routing Algorithms: Distance-vector, Link-state, Path-vector, Routing Protocols: (RIP, OSPF, BGP), IP Supporting Protocols(ARP, RARP, ICMP, IGMP)	10	20
5	**Transport Layer :** Process-to-process communication & port addressing Services: Flow control, Error control UDP: Features & Applications TCP: Segment, Services, Features, Connection establishment & termination, Congestion control: (Window, Detection, Policies) Multiplexing & Demultiplexing	10	20
6	**Application Layer** Client-Server paradigm, API Standard applications: WWW & HTTP, FTP, Email, DNS Basics of socket programming (TCP & UDP)	7	15

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
14	**28**	**14**	**07**	**07**	**00**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. **Data Communications and Networking with TCP/IP Protocol Suite (6th Edition)** – Behrouz A. Forouzan McGraw Hill
2. **Computer Networks (6th edition)-** Andrew S. Tanenbaum, Nick Feamster, David J. Wetherall, Pearson
3. **Computer Networking- A Top-Down approach (9th edition)-** James F. Kurose, Keith Ross, Pearson
4. **Computer Networks- A Top-Down approach-** Behrouz A. Forouzan, McGraw Hill
5. **Data and Computer Communications, (10th edition),** William Stallings**,** Pearson

Suggested MOOC Courses:

1. **Computer Networks and Internet Protocol** By Prof. Soumya Kanti Ghosh, Prof. Sandip Chakraborty, IIT Kharagpur (https://onlinecourses.nptel.ac.in/noc22_cs19/preview)

2. **Computer Networks** By Dr. Karthik N , NIT, Puducherry (https://onlinecourses.swayam2.ac.in/ntr25_ed138/preview)

List of Experiments:

Sr. No	Practical	CO
Practical Set-1: (Network Devices and Transmission Media)		**CO1,CO2**
1.1	Identify and study physical network devices: Hub, Switch and Router. Observe LED	

	indicators, ports and physical connectivity.	
1.2	Explore various transmission media: UTP, STP, Coaxial and Fiber optic cables. Perform crimping of straight-through, cross-over and rollover cables and verify functionality using a cable tester.	
1.3	Explore the Packet Tracer tool by configuring basic devices (hub, switch, router) and connecting them to end-user devices using appropriate cables (auto, straight-through, cross-over). Verify connectivity through simulation mode and validate using the ping command.	
Practical Set-2 (LAN Topologies Implementation)		**CO2**
2.1	Implement bus, ring, star and mesh topologies in Packet Tracer.	
2.2	Configure a star topology using hub and switch and compare packet flow behavior between hub and switch.	
Practical Set-3 (VLAN & Inter-VLAN Communication)		**CO3**
3.1	Configure VLANs on switches in Packet Tracer.	
3.2	Assign ports to VLANs and verify intra-VLAN communication.	
3.3	Configure inter-VLAN routing with a router or L3 switch and test connectivity across VLANs using ping and traceroute.	
Practical Set-4 (Error Detection and Correction Techniques)		**CO2**
4.1	Implement a program to generate CRC (Cyclic Redundancy Check) for error detection.	
4.2	Implement a program to apply Parity Check for error detection.	
4.3	Implement a program using the Checksum technique for error detection.	
4.4	Implement a program for Hamming Code to perform single-bit error correction.	
Practical Set-5 (IP Addressing and Static Routing)		**CO3**
5.1	Implement a program to verify whether a given IP address is valid or invalid. Additionally, display all related details, including IP Class, Default Subnet Mask, Network Address, Broadcast Address, Number of Hosts and Address Type (Private/Public/Reserved).	
5.2	Configure static routes in Packet Tracer and verify connectivity using ping and tracert commands.	
Practical Set-6 (Dynamic Routing)		**CO3**
6.1	Configure and test RIP protocol in Packet Tracer.	
6.2	Configure and test OSPF protocol in Packet Tracer.	
6.3	Compare RIP and OSPF by evaluating the number of hops, convergence speed and efficiency of routing updates and document the observed performance differences.	
Practical Set – 7 (DHCP Configuration and Network Commands)		**CO3,CO4**
7.1	Configure a DHCP server in Packet Tracer for automatic IP allocation.	
7.2	Create multiple DHCP pools and exclude reserved addresses and test client IP assignment and connectivity.	
7.3	Implement and study the output of essential network commands such as ping, ipconfig/ifconfig, nslookup and netstat using Packet Tracer.	
Practical Set – 8 (TCP and UDP Communication)		**CO4**
8.1	Configure a Web Server (TCP/HTTP) in Packet Tracer and access it from clients.	

8.2	Configure a TFTP Server (UDP) and transfer files.	
8.3	Compare TCP and UDP communication by analyzing packet flow and reliability.	
Practical Set – 9 (Packet Capture and Protocol Analysis (Wireshark))		**CO4**
9.1	Explore the Wireshark interface, study capture options and filters and perform a live packet capture on an active network interface.	
9.2	Apply display filters such as ip, tcp, udp and icmp to isolate specific traffic, and analyze the details of Ethernet, IP, TCP and UDP headers in selected packets.	
9.3	Explore protocol statistics using features like Protocol Hierarchy, Conversations and I/O Graphs, then save and export the capture file for documentation.	
9.4	Simulate and analyze packet loss and retransmission in TCP connections, for example by disconnecting/reconnecting or dropping pings and observe how TCP handles recovery.	
Practical Set – 10 (Application Layer Services – HTTP, DNS and Email)		**CO5**
10.1	Design and host a static webpage on an HTTP Web Server in Packet Tracer, configure the server with an IP address and access the webpage from a client machine using a web browser.	
10.2	Configure a DNS Server in Packet Tracer, map domain names to their corresponding IP addresses and test successful name resolution by accessing the webpage using the domain name instead of the IP address.	
10.3	Set up an Email Server with SMTP and POP3 services, create user accounts and enable email communication between client systems to send and receive messages.	

Major Equipment:

1. PCs / Laptops
2. Networking Devices (Routers, Switches[Layer 2 & Layer 3], Hubs)
3. Ethernet Cables (CAT5e / CAT6), Coaxial and fiber optic cable for demonstration
4. Cable Crimping Tool & RJ45 Connectors with Cable Tester

Open Source / Free Software for Computer Network Practicals

1. **Cisco Packet Tracer – Network Simulation Tool**
   (https://www.netacad.com/courses/packet-tracer)
2. **Wireshark – Network Protocol Analyzer**
   (https://www.wireshark.org/download.html)

List of suggested activities for Term Work / Self Learning:

Sr. No	Name of Activity	No. of Hours	Evaluation Criteria
1	Assignment Writing – Numerical / theoretical network problems such as	5 assignments × 1h each = Total = 5h	Based on completeness, correctness and submission of assignments

	IP addressing, subnetting, routing table calculations, CRC/error detection exercises			**Note:**
2	Technical Video-Based Learning – Watch online lectures/tutorials on Computer Networks, Routing, Transport protocols and Wireshark analysis	Duration = 5h, Report & Presentation = 5h; Total = 10h	Report / Presentation on key learning outcomes	
3	Seminar / Presentation – Study and present a technical topic beyond syllabus such as ● Network Security Mechanisms: (Firewalls, VPN, IDS/IPS) ● Software-Defined Networking (SDN) and OpenFlow, ● Internet of Things (IoT) Networking and Protocols ● Cloud Networking: AWS, Azure, and Google Cloud ● 5G Networks and Beyond: Architecture and Applications IPv6 Deployment and Transition Strategies ● QoS (Quality of Service) in IP Networks, ● VoIP Networking and SIP Protocol	Study/Prep = 10h, Report = 3h, Presentation = 2h; Total = 15h	Based on technical depth, quality of report and presentation skills	
4	Mini Project / Application Development – Integrate multiple features in Packet Tracer or Wireshark such as: ● Multi-Department Corporate Network ● University Campus Network ● ISP Network Simulation ● Smart City Network ● Hospital Network Simulation	Duration = 15h	Evaluation based on functionality, technical correctness, integration of protocols and documentation	

	• Smart home with IOT devices		
5	Real-World Case Study – Study campus network design, ISP setup, or data center network; prepare diagrams, IP schemes, routing policies	Data collection/study = 5h, Report prep = 5h; Total = 10h	Based on correctness, completeness and analysis of the report
6	Industry Visit– Visit networking labs or industry for hands-on exposure	Visit = 5h, Report prep = 5h; Total = 10h	Based on report containing observations, network setups and calculations
7	Self-Learning through Online MOOC Courses	Minimum duration of the course should be 15h.	Examination based assessment at the end of course. Based on the certificate produced.

- Above mentioned activities are suggestive, faculty can carry other activity related to the subject which can enhance theoretical and practical understanding of the students.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- Rubrics for the evaluation can be prepared by the faculty.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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