# 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.**

ourse Content:

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

| Sl. No. | Name of the activity | No. of hours | Evaluation Criteria |
|---|---|---|---|
| 1 | Assignment writing. Numerical based assignment is preferable. | 5 assignments of 3h each. Total = 15h | Based on the assignment submitted. |

| | | | |
|---|---|---|---|
| 2 | Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software | 5 small coding-based problems of 3h each. Total = 15h | Based on the coding solution submitted. |
| 3 | Technical Video based learning related to the subject | Duration of video = 5h Report preparation & Presentation = 10h Total = 15h | Report /presentation based on the video learning outcomes. |
| 4 | Discussion on research paper based on relevant subject | 3 research paper = 15h | Summarize research paper and evaluation critical parameters |
| 5 | Poster/chart/power point preparation on technical topics | Duration = 10 h | Based on poster/chart preparation and presentation skills |
| 6 | Application/Software development | Duration = 15 h | Depending on the complexity of the Application/Software |
| 7 | Group Discussion on emerging/trending technical topics based on subject | Duration = 1 h each | Based on performance in group discussion, technical depth, knowledge etc. |
| 8 | Seminar / Presentation | Duration for study and preparation=5h Report writing=3h Presentation=2h Total=10h | Topic can be selected technical content beyond syllabus |
| 9 | Real world case studies-based learning | Duration of data collection/study = 5h Report preparation = 10h Total = 15h | Based on in-depth study, technical depth, data collected, fact finding, etc. |
| 10 | Working/non-working model on technical topics | Working = 12 h Non-working = 8 h | Based on inter department/external evaluation |
| 11 | Self-learning on-line course | Minimum duration of the course should be 15h. | Examination based assessment at the end of course. Based on the certificate produced. |
| 12 | Complex problem solving | Maximum 3 problem. Study of the problem and solution finding, Total = 15h | Based on the depth of the solution submitted. |

| 13 | Industry/Research laboratory visit | Visit = 5h, Report preparation = 5h Total = 10h | Based on report submitted. Report should contain observations and calculations based on industry/ lab data. |
|----|-----|-----|-----|
| 14 | Videos on Industrial safety aspects based on subject | Duration of video = 5h Report preparation = 5h Total = 10h | Based on quiz/report submitted |
| 15 | Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment /health/any other issue | Duration = 15 h for industrial exposure<br><br>Problem identification and tentative solution = 10 h Total = 20 h | Based on evaluation of critical problems and solutions |

Note:
- All the suggested activity should be related to the subject.
- Min 3 activities must be carried out as per the availability of faculties and 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.