Approval: 9th Senate Meeting

Course Name: Computer Networks

Course Number: CS406

Credits: 3-1-0-4

Prerequisites: CS-304 - Communicating Distributed Processes or the instructor's consent

Intended for: UG.

Distribution: Elective for CS and EE

Semester: 7th or 8th

Preamble: The course intends to provide students a complete understanding of theoretical and practical aspects of modern computer networks. This course builds on the top of CS discipline core course: Communicating Distributed Processes, where an introduction to basic computer network concepts and protocols is provided. The discussion about each layer, its responsibility, and related issues is important to design and manage the operation of modern real time networks. In order to make the course more effective, several coding and simulation based assignments are required along with some project work for each student. A few optional topics are suggested which can be taken up depending on background and interest of the students and time available.

Objectives: On completion of the course, students should be able to design a complete computer network and customize it according to the requirement. They should understand the issues, the solutions, and critically evaluate the performance of the proposed solutions.

Syllabus:

1. **Introduction to Networking and Physical layer: (4 contact hours)**

   [a] Signals and Data – Basic Properties, Fourier Transform, Transmission (noise, attenuation, distortion), Effective Bandwidth.

   [b] Digital to Digital Transmission – Line coding, Block coding and Scrambling.

   [c] Multiplexing - Frequency-Division Multiplexing (FDM), Wavelength-Division Multiplexing (WDM), Time-division Multiplexing (TDM).

   [d] Types of Switching – Circuit Switching, Packet Switching, Message Switching, QoS for Circuit Switching.

2. **Data Link Layer: (7 contact hours)**

   [a] Link-Layer Addressing – Types of addresses, Address Resolution Protocol (ARP).

   [b] Error Detection and Correction – Block Coding, Cyclic Codes (Cyclic Redundancy Check, Polynomials, GF2) and Checksum.

[c] Logical Link Control (LLC) Sublayer: LLC Services – Framing, Flow and Error Control. **Protocols –** Stop-and-Wait, Piggybacking, High-Level Data Link Control (HDLC), Point-to-Point Protocol (PPP).

[d] Media Access Control (MAC) Sublayer: Random Access – ALOHA, Carrier Sense Multiple Access (CSMA), Collision Detection (CSMA/CD), Collision Avoidance (CSMA/CA).

3. Network Layer: (10 contact hours)

[a] Network Layer Services – Packeting, Routing, and Forwarding.

[b] Packet Switching – Datagram Approach (connectionless Service), Virtual Circuit Approach (connection- oriented Service).

[c] QoS of Packet Switching – Delay, Throughput, Packet Loss, and Congestion Control.

[d] IP Addressing – IPv4 and IPv6, Dynamic Host Configuration Protocol (DHCP), Network Address Translation (NAT).

[e] Routing Algorithms:

1. **UNICAST Routing:** Max Flow-Min Cut theorem and Ford Fulkerson Algorithm, Bellman Ford and Dijkstra's Algorithms, Shortest Path Routing, Distance-Vector Routing, Link -State Routing and Path Vector Routing, Hierarchical Routing, Routing Information Protocol (RIP), Open Shortest Path First (OSPF).

2. **MULTICAST Routing:** Flooding, Multicast Distance Vector (DVMRP), Protocol Independent Multicast (PIM) and Multicast Link State (MOSPF).

4. Transport Layer: (10 contact hours)

[a] Protocols – Stop-and-Wait, Go-Back-N, Selective-Repeat, User Datagram Protocol (UDP): services and applications, Transmission Control Protocol (TCP): services, flow, and congestion control.

[b] TCP implementation techniques – Slow start, congestion avoidance, fast retransmit and fast recovery.

[c] Optional Topics: TCP Variants: TCP Tahoe, TCP Reno, TCP Vegas, TCP SACK and TCP Westwood, STCP.

5. Application Layer: (6 contact hours)

[a] Services and Protocols – Application protocols, such as Hypertext Transfer Protocol (HTTP), Simple Mail Transfer Protocol (SMTP), File Transfer Protocol (FTP), Internet Mail Access Protocol (IMAP), Post Office Protocol (POP), Simple Network Management

Protocol (SNMP).

[b] Optional Topics: Secure Shell (SSH), Domain Name System (DNS), Lightweight Directory Access Protocol (LDAP), Network Time Protocol (NTP), Remote Procedure Call (RPC) and Secure Socket Layer (SSL).

6. **Advanced Topics: (5 contact hours)**

[a] Service Models – Resource Reservation Protocol **(**RSVP), Integrated and Differentiated.

[b] Flow Control – Scheduling, Traffic Modellers, Multi Protocol Label Switching (MPLS).

[c] Peer to Peer Paradigm – Distributed Hash Table (DHT), CHORD, PASTRY, KADEMILA.

Textbooks:

1. B. A. Forouzan, *Data Communications and Networking*, 5/e, McGraw Hill, 2013.

Suggested Reference Books:

1. A. S. Tanenbaum and D. J. Wetherall, *Computer Networks*, 5/e. Prentice Hall, 2011.
2. D. P. Bertsekas and R. G. Gallager, Data Networks, 2/e, Prentice Hall, 1992.
3. S. Keshav, *An Engineering Approach to Computer Networking: ATM Networks, the Internet, and the telephone network*, Addison Wesley Longman, 1997.
4. R. Perlman, *Interconnections: Bridges, Routers, Switches and Internetworking Protocols*, 2/e, Addison Wesley, 1999.
5. L. L. Peterson and B. S. Davie, *Computer Networks: A Systems Approach*, 5/e, Morgan Kaufmann, Elsevier, 2011.
6. W. Stallings, *Data and Computer Communications*, 10/e, Pearson, 2013.
7. G. B. White, E. A. Fisch, and U. W. Pooch, *Computer System and Network Security*, CRC Press, 1995.