UE22EC351A: Computer Communication Networks (4-0-2-4-5)

Course Description:

This course provides an in-depth overview of the Internet as architecture and as a service model. A top-down approach is followed in understanding the Packetization of transmission digital data and the performance of end-user applications as the data is exchanged over the internet. We explore the roles of network components (e.g., LAN switches, Routers, SDN). A hands-on approach is taken to enhance the understanding of the design and analysis of protocols and algorithms. The course introduces tools such as Wireshark, GNS3 and Python socket libraries. **Knowledge of Digital Communication is required for this course**

Course Objectives:

- To provide an in-depth understanding of protocols and algorithms used in the Internet.
- To introduce the architecture and operating principles of different network components
- To enable the students to design simple computer networks.
- To provide tool based analysis for understanding packetization and data transmission
- To develop strong analytic and problem solving skills.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the protocols related to the application layer, transport layer, network layer and link layer
- Design simple computer networks and analyze packet capture
- Implement routing algorithms, and write socket programs for client-server applications
- Solve numerical problems and logical problems arising in computer network design
- Apply networking concepts to the design of applications, protocols and systems

Course Content:

Unit 1: Internet architecture and applications

(i) Internet fundamentals: Terminology (services and protocols), Network edge (Access networks and PHY), Network core (Packet switching and Interconnection of ISPs), Performance measures (Delay, Loss, Throughput), Protocol layers and their service models, (ii) Application layer: Principles of network applications, Web and HTTP, DNS, Video streaming and CDN, Electronic mail, (iii) Transport layer: Services, sockets, multiplexing and de-multiplexing, UDP

14 Hours

Unit 2: Transmission control protocol and IP

(i) Principles of reliable data transfer: Stop and wait protocols, Pipelining, (ii) Connection oriented transport: TCP Connection, TCP Segment Structure, Round-Trip Time Estimation and Timeout, Reliable Data Transfer, Flow Control, TCP Connection Management, (iii) Congestion management: Principles of congestion control, Classic TCP congestion control (including Tahoe; Reno), (iv) Internet Protocol: IPv4 datagram format, IPv4 addressing (including DHCP), NAT, IPv6 (datagram and tunnelling), ICMP

14 Hours

Unit 3: Network layer

(i) Router and its operations: Internal organization, Functions of router (destination-based forwarding, switching, processing, scheduling), Generalized forwarding and SDN data plane (Match, Action, Openflow examples, Middleboxes), (ii) Routing algorithms: Introduction, LS algorithm, DV algorithm, (iii) Routing protocols: Intra-AS routing (OSPF), Inter-AS routing (BGP), Role of BGP, Advertising BGP route information, Determining the best routes, IP anycast, Routing policy, (iv) SDN control plane: Key features of SDN architecture, SDN controller and SDN network-control applications, Data plane and control plane interactions

14 Hours

Unit 4: Link Layer, LANs and WLANs

(i) Link layer: Services and implementation, Error detection and correction techniques (Parity check and CRC), Random access protocols (Slotted Aloha, CSMA, CSMA/CD), (ii) Switched LANs and Link virtualization: Link layer addressing and ARP, Ethernet, Link layer switches, Virtual Local Area Networking, MPLS (iii) Wireless networks: Basic architecture, Wireless link and network characteristics, WiFi (802.11) architecture, IEEE 802.11 protocol, 802.11 frame format

14 Hours

List of experiments :

1. Introduction to Wireshark: Packet capture procedure, Filters, Analysis
2. Analyze the downloading of embedded objects in a web-page using Wireshark
3. Analyze the DNS query and response using Wireshark
4. Analyze TCP connection and segmentation when downloading large file from a web-server using Wireshark
5. Socket programming and Wireshark analysis over LAN: UDP sockets and TCP sockets
6. Design simple 1-hop and 2-hop networks and configure IPv4 addresses and RIP using GNS3
7. Design a 1-hop network to demonstrate dynamic addressing using GNS3 and Wireshark
8. Design a 2-hop network to demonstrate dynamic addressing using GNS3 and Wireshark
9. Configure and analyze OSPF in a multihop network using GNS3
10. Design a 2-hop network to demonstrate static and dynamic NAT configurations using GNS3 and Wireshark
11. Design a switched LAN and analyze link layer addressing and ARP in GNS3 and Wireshark
12. Socket programming over WiFi hotspot and Wireshark analysis

Text Books:

1. James F Kurose and Keith W Ross, "Computer Networking: A Top-Down Approach", Pearson Education, 8th Edition, 2022.

Reference Books:

1. William Stallings, "Data and Computer Communications", Pearson Education, 10th Edition, 2017.
2. LAB Manual, provided by the Department of ECE