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|  | **PIR MEHR ALI SHAH ARID AGRICULTURE UNIVERSITY**  **University Institute of Information Technology** |

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| **Computer Networks (CS-577)** | | | | | |
| **Credit Hours:** | 4(3-2) | **Prerequisites:** | None | | |
| **Teacher:** | Dr. Kashif Sattar | Office: Room-104 | kashif@uaar.edu.pk | | |
| **Course Learning Outcomes (CLOs)** | | | | | |
| At the end of course the students will be able to: | | | | **Domain** | **BT Level\*** |
| 1. Describe the key terminologies and technologies of computer networks | | | | C | 2 |
| 1. Explain the services and functions provided by each layer in the Internet protocol stack. | | | | C | 2 |
| 1. Identify various internetworking devices and protocols, and their functions in a network. | | | | C | 4 |
| 1. Analyze working and performance of key technologies, algorithms and protocols. | | | | C | 4 |
| 1. Build Computer Network on various Topologies. | | | | P | 3 |
| \*BT- Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A=Affective domain | | | | | |

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| **Course Contents:** |
| Introduction and protocols architecture, basic concepts of networking, network topologies, layered architecture, physical layer functionality, data link layer functionality, multiple access techniques, circuit switching and packet switching, LAN technologies, wireless networks, MAC addressing, networking devices, network layer protocols, IPv4 and IPv6, IP addressing, sub netting, CIDR, routing protocols, transport layer protocols, ports and sockets, connection establishment, flow and congestion control, application layer protocols, latest trends in computer networks. |
| **Course Objective:** |
| At the successful completion of this course, students will be able to:   * Describe the general principles of data communication. * Describe how computer networks are organized with the concept of layered approach. * Describe how signals are used to transfer data between nodes. * Implement a simple LAN with hubs, bridges and switches. * Describe how packets in the Internet are delivered. * Analyze the contents in a given Data Link layer packet, based on the layer concept. * Design logical sub-address blocks with a given address block. * Decide routing entries given a simple example of network topology * Describe what classless addressing scheme is. * Describe how routing protocols work. * Use C programming language to implement network programs. * Design and implement a network protocol. |
| **Teaching Methodology:** |
| Lectures, Written Assignments, Practical labs, Semester Project, Presentations |
| **Courses Assessment:** |
| Mid Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam |
| **Reference Materials:** |
| 1. Computer Networking: A Top-Down Approach Featuring the Internet, 7th edition   By James F. Kurose and Keith W. Ross (August 2018)   1. Computer Networks, 5th Edition by Andrew S. Tanenbaum 2. Data and Computer Communications, 10th Edition by William Stallings 3. Data Communication and Computer Networks, 5th Edition by Behrouz A. Forouzan |

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| **Week/Lecture #** | | **Theory** | **Practical** |
| Week 1 | Lecture-I | **Introduction:**   * Introduction to Computer Networks * Data Communication |  |
| Lecture-II | **Basic concepts of networking:**   * Components of network   + Source, Destination, Data, Medium, Protocol * Networks * Types of Networks   + Peer to Peer   + Centralized     - Client/Server Architecture   **Network topologies:**   * Bus, Star, Mesh, Ring |  |
| Lecture-III | **Networking Devices:**   * Devices and their working   + Hub, Bridge, Repeater, Switch , Router (Just Introduction)   Classification of Computer Networks:   * Geographical area   + LAN   + MAN   + WAN * Administrative Control   + Intranet   + Extranet   + Internet |  |
| Practical-I |  | Introduction to Networks |
| Practical-II |  | Introduction to Networks |
| Week 2 | Lecture-I | **Protocols architecture:**   * Network Models |  |
| Lecture-II | **Layered architecture:**   * OSI Reference Model   + Layers in the OSI Model   + Each layer Responsibility |  |
| Lecture-III | * TCP/IP Protocol Suit * Addressing (Physical, Logical, Port and Specific) |  |
| Practical-I |  | Lab-1 |
| Practical-II |  | Lab-1 continue. |
| Week 3 | Lecture-I | **Physical layer functionality:**   * Transmission Media   + Wired ( Topic 7.2 Frozouzan)     - Twisted pair cable     - Coaxial Cable     - Fiber Optic   + Wireless ( Topic 7.3 Frozouzan)     - Radio wave Transmission     - Microwave Transmission       * Terrestrial       * Satellite       * Infrared Transmission |  |
| Lecture-II | Physical layer functionality:   * Data and Signals (Chapter 3.1 Frozouzan) * Analog and Digital data/signal * Periodic and Non Periodic signals * Units of Period and Frequency |  |
| Lecture-III | Physical layer functionality:   * Frequency vs Amplitude vs Phase * Composite Periodic Signal * Bandwidth as a Frequency difference * Digital Signals and Levels |  |
| Practical-I |  | Lab-2 |
| Practical-II |  | Lab-2 continue. |
| Week 4 | Lecture-I | * Transmission Impairments (Ch3.4, Frozouzan) * Attenuation, Distortion, Noise, Jitter, SNR, SNRdB * Performance   + Bandwidth   + Throughput   + Delay     - Propagation time     - Transmission time   + Bandwidth-Delay Product |  |
| Lecture-II | * Data Rate Limits (Topic 3.5 Frozouzan),   + Nyquist Bit Rate   + Shannon Capacity |  |
| Lecture-III | **Data link layer functionality:**   * Multiplexing (Chapter 6.1 Frozouzan)   + Analogue (FDM / WDM)   + Digital (TDM) * Spread Spectrum   + FHSS   + DSSS |  |
| Practical-I |  | Lab-3 |
| Practical-II |  | Lab-3 continue. |
| Week 5 | Lecture-I | Data Link Control (Chapter 11, Frozouzan)   * Framing Techniques * Bit vs Byte Stuffing * Flow and Error Control |  |
| Lecture-II | Data Link Layer Protocols:   * For Noiseless Channel   + Simplest   + Stop and Wait |  |
| Lecture-III | Data Link Layer Protocols:   * For Noisy Channel   + Stop and Wait ARQ   + Go Back N ARQ   + Selective Repeat ARQ   + Design of Piggybacking in Go-Back-N ARQ |  |
| Practical-I |  | Lab-4 |
| Practical-II |  | Lab-4 continue.. |
| Week 6 | Lecture-I | **Multiple access techniques:**   * Random Access Protocols   + ALOHA/ Slotted ALOHA   + CSMA   + 1-Persistent, Non Persistent, P-Persistent   + CSMA/CD   + CSMA/CA |  |
| Lecture-II | * Controlled Access   + Reservation   + Polling   + Token Passing |  |
| Lecture-III | * Channelization Protocols   + FDMA   + TDMA   + CDMA with Example |  |
| Practical-I |  | Lab-5 |
| Practical-II |  | Lab-5 continue.. |
| Week 7 | Lecture-I | **Circuit switching and packet switching:**   * ATM Networks Basic Concept * Broadband Switching |  |
| Lecture-II | * ATM Cell Structure * ATM layer |  |
| Lecture-III | **LAN technologies:**   * Ethernet, * Token Ring and * Wireless LAN using IEEE 802.11   **Wireless networks:**   * Infrastructure mode networks * Ad-hoc mode networks * Wireless MAC, CSMA/CA |  |
| Practical-I |  | Lab-6 |
| Practical-II |  | Lab-6 continue. |
| Week 8 | Lecture-I | **MAC addressing:**  MAC Header |  |
| Lecture-II | Performance parameters (Topic 3.6, Frozouzan)  CRC |  |
| Lecture-III | Mid Revision |  |
| Practical-I |  | Lab1 to 3 Mid Revision |
| Practical-II |  | Lab4 to 6 Mid Revision |
| **Midterm Exam** | | | | |
| Week 9 | Lecture-I | **Networking devices:**   * Network Layer, * Datagram Format, * Fragmentation, * Intro. to Layer3 Switch |  |
| Lecture-II | **Network layer protocols:**   * Routing Protocol, RIP, OSPF, BGP |  |
| Lecture-III | Network layer protocols:   * Routing Algorithms, Link state, Distance Vector |  |
| Practical-I |  | **Project Allocation.**  Lab-7 |
| Practical-II |  | Lab-7 continue. |
| Week 10 | Lecture-I | **IPv4 and IPv6:**   * IPv4, IPv6 addressing |  |
| Lecture-II | **IP addressing:**   * IP addresses and Classes |  |
| Lecture-III | IP addressing:   * IP Assignment / DHCP * Public and Private IP addresses |  |
| Practical-I |  | Lab-8 |
| Practical-II |  | Lab-8 continue. |
| Week 11 | Lecture-I | **Sub netting:** |  |
| Lecture-II | **CIDR:** |  |
| Lecture-III | Routing:   * Routed Protocols * Non-routable Protocols * Network Address Translation • Domain Name System * Autonomous Systems • Assignment / Types • VLAN |  |
| Practical-I |  | Lab-9 |
| Practical-II |  | Lab-9 continue. |
| Week 12 | Lecture-I | **Routing protocols:**   * Routing Protocols   + Interior gateway routing   + Exterior gateway routing |  |
| Lecture-II | Switching o Circuit Switched Networks o Packet Switched Networks |  |
| Lecture-III | Transport layer:  Transport Layer, Connectionless, Connection Oriented |  |
| Practical-I |  | Lab-10 |
| Practical-II |  | Lab-10 continue. |
| Week 13 | Lecture-I | **Transport layer protocols:** |  |
| Lecture-II | **Ports and sockets:** |  |
| Lecture-III | **Connection establishment:**   * RTT Estimate, TCP Flow Control |  |
| Practical-I |  | Lab-11 |
|  | Practical-II |  | Lab-11 continue. |
| Week 14 | Lecture-I | TCP Connection Management |  |
| Lecture-II | **Flow control:**   * TCP Operations, * Flow Control, * Fast Retransmission Algorithm |  |
| Lecture-III | **Congestion control:**   * Congestion Control Mechanisms * TCP Slow Start, * Transport Layer Presentations |  |
| Practical-I |  | Lab-12 |
| Practical-II |  | Lab-12 continue. |
| Week 15 | Lecture-I | **Application layer protocols:**   * Introduction to Application Layer, * Application Architectures (Client-Server, P2P), * Protocols Addressing Schemes (IP, Port, MAC Addresses), * HTTP, HTTP Stateful and Stateless, Cookies, Web Cache * Email Servers, SMTP, DNS, DNS Architecture * DNS TLD and Authoritative Servers |  |
| Lecture-II | Network Performance Metrics:   * Loss, * Delay in different networks, Nodal Delay, Queuing Delay, * Network Throughput |  |
| Lecture-III | **Latest trends in computer networks:**   * Network Security, Malware, Packet Sniffing, Intruders * IoT, BAN, PAN etc. |  |
| Practical-I |  | Lab-13 |
| Practical-II |  | Lab-13 continue. |
| Week 16 | Lecture-I | **Project Demos:**   * GroupWise Project Demos and Presentations |  |
| Lecture-II | **Project Demos:**   * GroupWise Project Demos and Presentations |  |
| Lecture-III | **Final Course Revision:** |  |
| Practical-I |  | Revision of Lab7-10 |
| Practical-II |  | Revision of Lab11-13 |
| **Final term Exam** | | | | |