University of Engineering and Technology, New Campus, Lahore
Department of Computer Science

Open Ended Lab

Course Code & Title: CSC203L Computer Networks Lab

1. Course Learning Outcome:

CLO 4: Design, configure, and test small computer networks using appropriate addressing schemes, protocols, and simulation tools.

Level of CLO: CLO3 is mapped to the 6th level, i.e., *Creation* of Bloom's taxonomy.

2. Schwab/Herron Levels of Laboratory Openness

Level	Methodology	Description	Problem	Ways & Means	Answers
2	Guided Inquiry	Students investigate a teacher presented question using student designed/selected procedures	Given	Open	Open

3. Problem Statement:

Design and implement a university Network with multiple sub-campus each campus having multiple departments using a network simulator Cisco Packet Tracer. Each campus should include at least three departments (e.g., Computer Science, Electrical Engineering, and Administration) and a server room hosting core services. The project will require configuring various network devices, implementing VLANs, establishing inter-router routing, and testing end to end connectivity.

Problem Description:

Network Design Requirements:

Network Topology:

- The network topology must be **multi-campus (at least 2 sub-campus & one main campus)**, with a **star-shaped** design connecting each sub-campus to a central core switch, but also ensuring communication between different campus locations via **border routers**.
- Each sub-campus (i.e., the departments) should have its own **border router** for connectivity between sub-campuses and the central network.
- **At least 4 border routers** should be used: one for each sub-campus for high availability and redundancy, and inter-campus communication.
- The main campus can still have the central core switch, but each sub-campus should be interconnected with **multiple border routers** to ensure there's no single point of failure in inter-campus communication.

Devices & Network Components:

Routers:

- **At least 8 routers** will be used:
  - **4 border routers**, each located at one sub-campus for inter-campus communication and to ensure redundancy.
  - **4 internal routers** (one for each sub-campus department) to handle routing between departments and internal communication.

Switches:

- 5 switches will be used, including one Layer 3 switch at each sub-campus for routing between VLANs and inter-campus routing.

End Devices:

- 10+ PCs per department, along with printers and mobile devices (e.g., Computer Science: 10 PCs, Electrical Engineering: 10 PCs, Administration: 10 PCs).
- **Mobile Devices**: Wireless devices (smartphones, laptops) will also be integrated into the network via access points at each sub-campus.

Servers:

- At least two servers per department: one for HTTP and another for Email.
- Two additional servers for public services such as a **Web Server**, **DNS server**, and **FTP server** for file sharing and storage across departments at each sub-campus.

ISP Connection:

- The network must be connected to an ISP using **4 border routers**, one for each sub-campus, ensuring multiple paths to the internet and between sub-campuses for load balancing and failover.

2. Network Configuration:

IP Addressing & Subnetting:

IPv4 Addressing:

- The network will use IPv4 addressing.
- Each sub-campus (Computer Science, Electrical Engineering, and Administration) will have its own subnet with VLSM (Variable Length Subnet Masking) for efficient use of IPs.
- Each sub-campus will have its own **public IP range** provided by the ISP for direct internet connectivity.
- The private IP range for internal network communication (192.168.0.0/16) will be used across all sub-campuses.

Private IP Addressing Scheme:

- For the internal network, private IPs from 192.168.0.0/16 will be used for subnets.
- Example:
  - **Main Campus** could use 192.168.1.0/24

    - **(Administrator in main campus**)
    - **Sub-Campus 1** (Having 3 different departments) could use 192.168.2.0/24
    - **Sub-Campus 2** (Having 3 different department) could use 192.168.3.0/24

VLAN Configuration:

- Each department within each sub-campus will be placed in a separate VLAN for isolation and performance optimization.
    - VLAN 10: Computer Science
    - VLAN 20: Electrical Engineering
    - VLAN 30: Administration
- **Wireless Devices**: Separate VLANs for wireless devices at each sub-campus to segregate traffic and improve performance.

Inter-VLAN Routing:

- The Layer 3 switches will perform inter-VLAN routing between the different VLANs within each sub-campus and between sub-campuses.

Routing Protocols:

- **OSPF (Open Shortest Path First)** will be used for internal routing between the internal routers at each sub-campus and the core network.
- The **border routers** at each sub-campus will use **BGP (Border Gateway Protocol)** for inter-campus routing, ensuring load balancing and redundancy between sub-campuses.

Server Configuration:

- **Web Server**: A server for hosting web services (HTTP) for the entire campus network.
- **Email Server**: A server for handling email services (SMTP, POP3).
- **DNS Server**: A server for handling domain name resolution.
- **FTP Server**: A server for storing and sharing files between departments across all sub-campuses securely.

Security:

- Implement **ACLs (Access Control Lists)** to restrict access between the different departments, sub-campuses, and servers.
- The **border routers** will implement basic firewall rules to block unauthorized external access between sub-campuses and from the outside world.

3. Testing & Troubleshooting:

Test Cases:

1. Inter-Unit Communication:

- **Test 1**: Ensure Computer Science (Unit A) at Sub-Campus 1 can communicate with Electrical Engineering (Unit B) at Sub-Campus 2 and Administration (Unit C) at Sub-Campus 3.
- **Test 2**: Test communication between Sub-Campus 1 and Sub-Campus 2 (e.g., Computer Science to Electrical Engineering).
- **Test 3**: Check communication between end devices within each department at each sub-campus.

2. Server Access:

- **Test 1**: Verify that Computer Science (Unit A) at Sub-Campus 1 can access the Web Server and Email Server located in the central server room.
- **Test 2**: Ensure that Electrical Engineering (Unit B) at Sub-Campus 2 can access the DNS Server at the central server room.
- **Test 3**: Administration (Unit C) at Sub-Campus 3 should only be able to access the Email Server.

3. Security:

- **Test 1**: Ensure that Administration (Unit C) at Sub-Campus 3 cannot access the Web Server in Computer Science at Sub-Campus 1.
- **Test 2**: Use ping, tracert, and show commands to troubleshoot and verify routing functionality between different sub-campuses.

Troubleshooting:

- Use the `show ip route` command to verify routing tables and ensure proper routing between VLANs and sub-campuses.
- Troubleshoot VLANs and subnetting using `show vlan brief` to check VLAN configurations at each sub-campus.

- Verify that wireless devices at each sub-campus are able to connect, obtain IP addresses via DHCP, and access network services such as FTP, DNS, and HTTP.

4. Instructions:

- This is a **group project**; each group will consist of 4 students.
- Your project will be graded according to the provided rubrics.
- Proper network labeling (device names, IP addresses, VLAN IDs, etc.) is mandatory.
- Any form of plagiarism or copying of simulation files/configurations will result in penalties as per department policy.
- Deadline to submit: 5th January 2026

5. Deliverables:

Simulation File:

- Complete **Packet Tracer file** (.pkt) with the network topology, configurations, and simulations.
- The simulation file should reflect the updated network design with multiple **border routers** for inter-campus communication and redundancy.

Documentation:

- **Network Diagram**: Clearly labelled topology diagram with IP addressing scheme, device names, and **multiple border routers** for each sub-campus.
- **VLAN Table**: List of VLAN IDs and their corresponding department names, including separate VLANs for **wireless devices**.

- **IP Addressing Table**: Detailed table of assigned IP ranges and subnets for the **main campus** and **sub-campuses** with multiple public IP ranges for each sub-campus.
- **Key Configuration Details**:
  - **Switch configurations** (e.g., trunking, VLAN assignments).
  - **Router configurations** (e.g., OSPF, BGP, RIP for inter-campus routing).
  - **Server configurations** (e.g., IP settings for **HTTP**, **Email**, **FTP**, and **DNS servers**).
- **Testing Results**:
  - Logs and screenshots from **ping** and **tracert** tests.
  - Results from server access tests, including restricted and allowed access based on **ACLs** and testing between sub-campuses.
- **Redundancy Testing**: Ensure the **border routers** for each sub-campus function correctly with failover in case of a router failure

Open Ended Lab Assessment Rubrics

Criteria	Excellent (7)	Good (5-6)	Satisfactory (3-4)	Needs Improvement (1-2)	Poor (0)
Network Design & Topology	Well-structured, clear, scalable design; appropriate choice of devices; logical separation of departments and sub-campuses; multiple border routers and inter-campus connections.	Mostly clear design; minor issues in device selection, scalability, or labeling.	Functional design but lacks clarity or scalability; some devices/links not clearly labeled.	Disorganized or unrealistic design; several missing/incorrect links or labels.	No coherent design; topology incomplete or irrelevant.
IP Addressing & VLAN Planning	Correct and efficient subnetting/VLSM; no overlaps; clear IP and VLAN tables; multiple public IPs for sub-campuses; VLANs properly defined for each department and wireless devices.	Mostly correct IP scheme; minor mistakes or inefficiencies; VLANs mostly appropriate.	Basic addressing works but may be inefficient; VLANs partially defined or not fully justified.	Major addressing or VLAN errors; connectivity only partially possible.	Addressing scheme invalid; VLANs missing or incorrect.
Configuration & Implementation	All required devices configured correctly (routers, switches, servers, border routers, wireless devices); network fully functional as per the problem statement. Includes multiple border	Most configurations correct; minor issues with some services or routing but overall network largely functional.	Core configurations done; basic connectivity present; some services or features missing/incorrect.	Incomplete configurations; several parts of the network not working.	Little or no correct configuration; network not working.

	routers for redundancy and load balancing.				
Testing & Troubleshooting	Comprehensive testing; appropriate use of commands (ping, tracert, show, etc.); issues identified and correctly resolved with clear reasoning. Includes troubleshooting between sub-campuses and verification of border routers' functionality.	Adequate set of tests; most major issues found and resolved; minor gaps in troubleshooting detail.	Basic tests performed; at least one issue identified and addressed; limited justification.	Minimal testing; issues detected but not properly analyzed or resolved.	No meaningful testing; problems left unresolved.
Documentation & Presentation	Report is well-structured and clear; includes diagrams, tables, and explanations; configurations and results are easy to follow and professional. Updated to reflect sub-campus structure and multiple border routers.	Report mostly complete and understandable; minor formatting or clarity issues; most required elements included.	Documentation present but lacks detail or organization; some required elements missing.	Poorly organized or incomplete documentation; difficult to understand; major parts missing.	No proper documentation; work cannot be evaluated.