UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 8 Examination in Engineering: December 2025

Module Number: EC8205 Module Name: Design and Management of Data Networks

[Three Hours]

[Answer all questions, each question carries 10 marks]

Q1 A new Faculty of Engineering building is to be integrated into the university campus network. The building will support computer laboratories, lecture halls, a library, staff offices, and wireless access. The network must deliver data, voice, video, and internet services with high availability, security, and scalability. The network is designed using Enterprise Network Architecture principles.

a) i) Identify a suitable enterprise network architecture model for this scenario.

[1.0 Mark]

ii) Justify your choice with respect to modularity, scalability, and service integration.

[2.0 Marks]

b) i) In a hierarchical network, how do you select Layer 2 switches, Layer 3 switches, and routers for the Access, Distribution, and Core layers?

[1.0 Mark]

ii) What are the key reasons behind your selection for each layer?

[1.0 Mark]

c) Using the selected enterprise architecture: Identify the major architectural modules required to support the building network.

[1.0 Mark]

d) i) Propose design techniques used in enterprise architecture to ensure high network availability.

[1.0 Mark]

ii) Explain how multiple services (data, VoIP, video, and wireless) are supported and prioritized within the enterprise network.

[1.0 Mark]

e) Draw a clear and well-labeled enterprise network architecture diagram showing:

- Architectural modules.
- Hierarchical layers.
- Major services and redundancy.

[2.0 Marks]

Q2 a) A small office LAN consists of four computers (PC1–PC4) connected through two Ethernet switches (S1 and S2) as shown in **Figure Q2**:

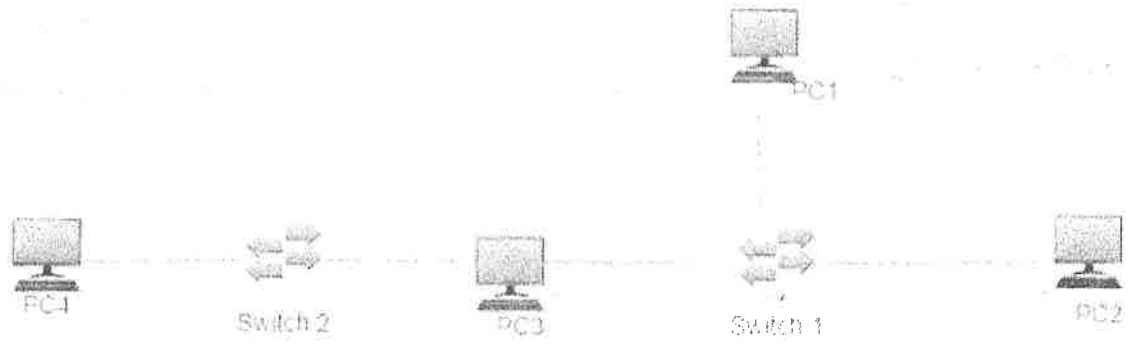

Figure: Q2

- Ethernet cable length between each device: 100 m
- Signal propagation speed in Ethernet cable: 2×10^8 m/s
- Data rate of Ethernet links: 100 Mbps
- Frame size transmitted by PC1: 1500 bytes
- Switches operate in store-and-forward mode
- Processing delay at each switch: 5 μs
- Queuing delay is negligible

i) Calculate the transmission delay for the 1500-byte Ethernet frame. [1.0 Mark]

ii) Calculate the total end-to-end delay experienced by the frame sent from PC1 to PC4, considering: Transmission delay, Propagation delay and Switch processing delay. Clearly show all steps.

[2.0 Marks]

iii) Assume PC4 sends an immediate acknowledgement frame of the same size back to PC1 along the same path. Calculate the total round-trip delay, including transmission and processing delays.

[1.0 Mark]

iv) If the Ethernet link speed is upgraded to 1 Gbps while all other network parameters remain unchanged, recalculate the transmission delay for the link. Based on your calculation, comment on whether transmission delay or propagation delay dominates the total end-to-end delay, giving a brief justification.

[2.0 Marks]

b) An organization currently uses:

- IPsec site-to-site VPNs for branch connectivity.
- Remote Access VPN for employees.

The organization plans to migrate to SD-WAN.

i) Identify the limitations of the current VPN-based architecture.

[1.0 Mark]

ii) Propose a step-by-step migration strategy to SD-WAN.

[1.0 Mark]

iii) Discuss security, cost, and performance trade-offs during migration.

[1.0 Mark]

iv) Explain how cloud applications (SaaS/IaaS) influence SD-WAN adoption.

[1.0 Mark]

Q3 a) A router in your network has the following connected subnets:

- 10.10.8.0/24 - Sales
- 10.10.9.0/24 - Marketing
- 10.10.10.0/24 - HR
- 10.10.12.0/24 - Finance
- 10.10.13.0/24 - IT

You are tasked with configuring summary routes on this router for redistribution into OSPF to reduce routing table entries in the rest of the network.

i) Propose the summary routes you would configure on the router, including the subnet mask for each.

[2.0 Marks]

ii) Explain why some subnets must be summarized separately instead of using a single summary route.

[1.0 Mark]

iii) Describe **two potential problems** that could occur if discontiguous networks are summarized incorrectly.

[0.5 Marks]

b) A network uses an OpenFlow-enabled switch controlled by an SDN controller. Explain how the switch can implement L2 switching, L3 routing, firewall packet filtering, and NAT using the match-action paradigm, giving one example of a match field and an action for each function.

[3.0 Marks]

c) i) How does OSPF prevent routing loops, and how is this different from distance-vector protocols?

[1.5 Marks]

ii) A network runs OSPF internally and is connected to the Internet via BGP. Explain how the router will choose between an OSPF-learned route and a BGP-learned route?

[2.0 Marks]

Q4 The Faculty of Engineering, University of Ruhuna network has experienced unauthorized access attempts on the LMS server. Therefore, the Senior Network Engineer has decided to apply new security policies on the Core Router (R1).

The Assignment: You are the Junior Network Engineer. You must configure Access Control Lists (ACLs) to isolate student traffic and secure the Admin subnet. However, per Faculty policy, you cannot touch the router until you submit a Method of Procedure (MOP) document.

The network follows a **Router-on-a-Stick topology**, where all inter-VLAN traffic is routed through the sub-interfaces of R1. The topology related details are summarized in Table Q4.

a) Draw a clearly labeled diagram illustrating the network topology.

[2.0 Marks]

b) Write the Access Control Entries (ACEs) to permit HTTP and HTTPS traffic from the Student Labs to the LMS Server.

[2.0 Marks]

c) Which interface should the above ACL be applied to, and in which direction?

[1.0 Mark]

d) If you were writing the ACEs in Q4(b) as a numbered ACL, which ACL number would you assign?

[1.0 Mark]

e) The Guest Wi-Fi subnet must be prevented from accessing the Faculty Admin VLAN. The following configuration was proposed in the MOP.

```
R1(config)#access-list 99 deny 172.16.0.0 0.0.255.255
R1(config)#access-list 99 permit any
R1(config)#interface gigabitEthernet 0/1
R1(config-if)#ip access-group 99 in
```

After reviewing the MOP, the Senior Network Engineer rejected the proposal.

i) Explain the reason for rejecting this configuration.

[1.0 Mark]

ii) Update the provided Cisco IOS configuration code to correctly implement the ACL and achieve the intended traffic restriction.

[1.0 Mark]

f) Why is it necessary to document the "**Risk Analysis/Impact**" of this change in a MOP before working on a live University network?

[1.0 Mark]

g) Why is a "**Rollback Plan**" the most important part of a MOP for a live university network?

[1.0 Mark]

Q5 You are a Network Engineer at a financial firm. Currently, the company uses a legacy Python script given in Figure Q5 to configure VLANs on 50 switches. The script reads IP addresses from a file called *"my_devices"* and creates 99 VLANs on each device (excluding the default vlan).

Management has issued a new mandate on Infrastructure as Code (IaC). The team wants to move toward configuration management tools, such as Ansible, to improve scalability and reduce the complexity of maintaining Python scripts.

a) In the current script, why is the ***.encode('ascii')*** method required when sending strings to the switch?

[1.0 Mark]

b) Identify **one** line in the script where a synchronization error might occur if the switch responds slowly.

[1.0 Mark]

c) Rewrite the script so that it creates only **even-numbered** VLANs (2, 4, ... 100) and names them ***EV_VLAN_[number]***.

[2.0 Marks]

d) The company is considering replacing telnetlib with an SSH-based library. In an environment where network devices may present different CLI prompts (> or #), explain **one** reason why Netmiko would be more reliable than Paramiko.

[1.0 Mark]

e) From a security standpoint, why is moving from telnetlib to an SSH-based library like Netmiko mandatory for a financial firm?

[1.0 Mark]

f) In a Python script, VLANs are created using a loop that runs commands step by step. In Ansible, VLANs are defined declaratively. Explain **one** key difference in how an administrator specifies VLAN creation in Ansible compared to a Python script.

[2.0 Marks]

g) List **four** key features of Ansible.

[2.0 Marks]

Table Q4

VLAN	VLAN NAME	SUBNET	R1 INTERFACE	SECURITY POLICY
10	Faculty Admin	192.168.10.0/24	G0/0.10	Full Access to All Subnets
20	Student Labs	192.168.20.0/24	G0/0.20	Only Web access to LMS.
30	Server Room	10.1.1.0/24	G0/0.30	Hosts LMS at 10.1.1.50/32
40	Guest Wi-Fi	172.16.0.0/16	G0/1	Blocked from Admin Subnet.

```
1  import getpass
2  import telnetlib
3
4  user = input("Enter your telnet username: ")
5  password = getpass.getpass()
6
7  devices = open("my_devices")
8
9  for IP in devices:
10     IP = IP.strip()
11     tn = telnetlib.Telnet(IP)
12
13     tn.read_until(b"Username: ")
14     tn.write(user.encode('ascii') + b"\n")
15     if password:
16         tn.read_until(b"Password: ")
17         tn.write(password.encode('ascii') + b"\n")
18
19     tn.write(b"enable\n")
20     tn.write(b"cisco\n")
21     tn.write(b"conf t\n")
22
23     for i in range(2, 101):
24         tn.write(f"vlan {i}\n".encode('ascii'))
25         tn.write(f"name PYVLAN-{i}\n".encode('ascii'))
26
27     tn.write(b"end\n")
28     tn.write(b"exit\n")
29     print(tn.read_all().decode('ascii'))
```

Figure Q5