00073

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical & Computer Engineering

Study Programme	: Bachelor of Science Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX5434 Data Communications & Networking**
Academic Year	: 2023/24
Date & Time	: 10th March 2025, 13:30 p.m. – 16:30 p.m.
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Five (5)** questions in **(5)** pages.
3. Answer all **Five (5)** questions. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. This is a **Closed Book** Examination.
6. Answers should be in clear handwriting.
7. Do not use Red colour pen.

Q1.

(a) Briefly explain why the OSI model is primarily used for theoretical reference while the TCP/IP model is widely implemented in real-world networking. (02 marks)

(b) A CCTV surveillance system transmits full HD video (1920 × 1080 resolution) at a frame rate of 60 frames per second over a dedicated network.

(i) Determine the raw data rate required to transmit the uncompressed CCTV video feed, assuming a 24-bit colour depth. Express your answer in Gbps. (03 marks)

(ii) The CCTV system transmits video over a network with a 10 MHz bandwidth and a signal-to-noise ratio (SNR) of 40 dB. Using Shannon's Capacity Theorem, calculate the maximum achievable data rate for this channel. (03 marks)

(iii) To optimize storage and bandwidth usage, the system applies H.265 (HEVC) compression with an average compression ratio of 3000:1. Calculate the effective data rate after compression and compare it with the Shannon capacity from part (ii) to determine if the network can support real-time CCTV transmission. (03 marks)

(iv) Identify two factors that could negatively impact the real-time transmission of CCTV recording, even if the compressed video data rate is within the Shannon capacity limit. (02 marks)

(c) (i) Encode the binary data sequence 10101100 and illustrate the corresponding waveform using the following encoding schemes

1. Manchester 2. Differential Manchester (04 marks)

(ii) Using the generator polynomial $G(x) = x^3 + x + 1$, calculate the transmitted codeword for the above dataword 10101100 using CRC. Show all steps. (03 marks)

Q2.

(a) (i) Clarify the importance of subnetting and how it helps ISPs to manage address allocation efficiently. (02 marks)

(ii) Discuss supernetting, its role in route aggregation, and how it reduces the size of routing tables in large networks. (02 marks)

(b) A medium sized ISP has decided to allocate the following blocks of IP addresses to a set of customers as below:

Customer A - 32 IP addresses
Customer B – 64 IP addresses
Customer C (A smaller ISP) – 512 IP addresses
Customer D – 128 IP addresses
Customer E and F – 16 IP addresses each.

(i) It has been decided to use 192.168.0.0/22 for the IP allocation of above networks. For each of the above customers, provide the usable IP address range in CIDR format, subnet mask and broadcast address. Clearly show all the steps you followed. (10 marks)

(ii) Find out how many more addresses are remaining with the main block after allocating addresses for the above networks. (02 marks)

(c) Explain the key differences between IPv4 and IPv6 in the following aspects:

(i) Addressing Capacity – Compare the address space and its impact on scalability.

(ii) Network Address Translation (NAT) – Explain the role of NAT in IPv4 and why it is not required in Ipv6. (04 marks)

Q3.

(a) Describe three common routing metrics used in determining the best path in a network. (03 marks)

(b) What is convergence in routing? Why is it a critical factor in dynamic routing protocols? (03 marks)

(c) Use Link State routing algorithm to find the shortest path from node U to the other nodes in the undirected graph below. Use the Table Q3 to show your answer. Link costs are as shown on the Figure Q3. (14 marks)

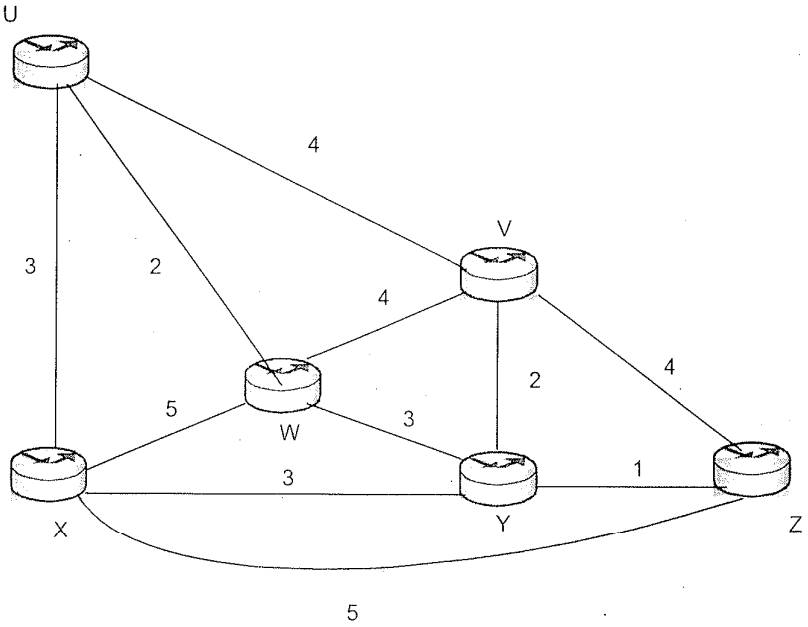

Figure Q3

Table Q3

Step	Nodes considered	Destination Node V		Destination Node W		Destination Node X		Destination Node Y		Destination Node Z	
		Cost	Path	Cost	Path	Cost	Path	Cost	Path	Cost	Path
1											
2											
:											

Q4.

(a) You are a network administrator at Axis Corporation which is a medium sized e-commerce Company and you are responsible for ensuring efficient domain resolution for the company's internal and external communication. The company has a growing network with multiple departments and an increasing number of domain requests. Recently, employees have reported slow access to external websites, and your manager suspects DNS resolution issues

(i) Assume a user of Axis Corporation is trying to access the external website, **www.hal.u-tokyo.ac.jp** . Clearly explain how it resolves the request with steps. You may use a diagram if required. (03 marks)

(ii) How does DNS caching improve network performance? (02 marks)

(iii) Give one example for potential risks of using cached DNS records, and how it can be mitigated? (02 marks)

(iv) How does Time-To-Live (TTL) impact caching? (03 marks)

(b) Assume that Axis Corporation mentioned above is planning to enhance its network security. Currently, it has a basic packet filtering firewall, but recent cyber threats and increasing customer transactions have raised concerns about security vulnerabilities. The company needs a firewall solution that provides better threat detection, application-level protection, and real-time attack prevention while balancing cost and complexity.

(i) Identify and briefly describe two types of firewalls (other than packet filtering firewalls) that could improve the company's security. (02 marks)

(ii) Which firewall type would provide the best application-level protection? Justify your answer. (02 marks)

(iii) List three key factors the company should consider when selecting a firewall. (03 marks)

(iv) Based on the given scenario, recommend the most suitable firewall type for the company. Justify your choice by considering both security and cost factors. (03 marks)

Q5.

(a) (i) Compare the advantages of using Sliding Window over Stop and Wait flow control methods in terms of latency and bandwidth utilization. (02 marks)

(ii) Explain how Selective Repeat ARQ handles lost or corrupted packets compared to Go-Back-N ARQ. (02 marks)

(ii) If a system uses the Selective Repeat ARQ method with a 2-bit sequence number, what is the maximum window size required for the sender and why? Provide calculations or timing diagrams to support your answer. (06 marks)

(b) ABC Company is a multinational company with multiple branch offices across different cities. To ensure secure and efficient communication between branches, the company has implemented VLANs within each office and a VPN to connect the remote branches over a Wide Area Network (WAN). Additionally, the company is exploring the possibility of integrating Software-Defined Networking (SDN) to enhance network automation and management.

(i) Explain how VLANs can improve network performance and security within ABC Company's branch offices. What challenges might arise in VLAN configuration and management? (03 marks)

(ii) Describe how VPNs help ABC Company to securely connect its branch offices over a WAN. Compare the benefits of using a site-to-site VPN versus a remote-access VPN for their network infrastructure. (03 marks)

(iii) If ABC Company decides to implement Software-Defined Networking (SDN) to enhance network automation, how would SDN improve the scalability and management of their VLAN and VPN infrastructure? Provide a brief explanation. (04 marks)

END