UNIVERSITY OF MAURITIUS
FACULTY OF SCIENCE

YEARLY/SECOND SEMESTER EXAMINATIONS

SEPTEMBER/OCTOBER 2023

PROGRAMME	BSc (Hons) Mathematics with Computer Science - Year 3 and Level 5		
MODULE NAME	Computer Networks and System Administration		
DATE	Friday 29 September 2023	MODULE CODE	ICT 3053Y(5)/ CSE 3053Y(5)
TIME	09:30 – 12:30 Hours	DURATION	3 Hours
NO. OF QUESTIONS SET	5	NO. OF QUESTIONS TO BE ATTEMPTED	4

INSTRUCTIONS TO CANDIDATES

Answer ANY FOUR (4) Questions.

Each question carries 25 marks.

Use of electronic calculator is permitted.

Question 1

(a) (i) The Improved Mobile Telephone System (IMTS) used a high-powered (200-watt) transmitter placed on top of a hill and *used two frequencies.* Account for this.

(ii) Discuss the limitations of Improved Mobile Telephone System (IMTS) that lead to its replacement by Advanced Mobile Phone System (AMPS).

(iii) Compared to IMTS, AMPS offered more system capacity and less investment in terms of equipment. Explain, giving reasons, what made these possible.

(iv) Discuss, with justifications, as to why first and second generation mobile phones cannot handle a soft handoff.

[1+3+3+2 marks]

(b) Figure 1 shows a newly booted host – Host H that broadcasts a DHCP DISCOVER packet to reach a remote DHCP server and obtain an IP address. However, the DHCP DISCOVER packet has to transit through a router, other networks and finally another router (located on the same network segment as the DHCP server) to reach the DHCP Server. Explain, with reasons, as to whether Host H will obtain an IP address from the DHCP server.

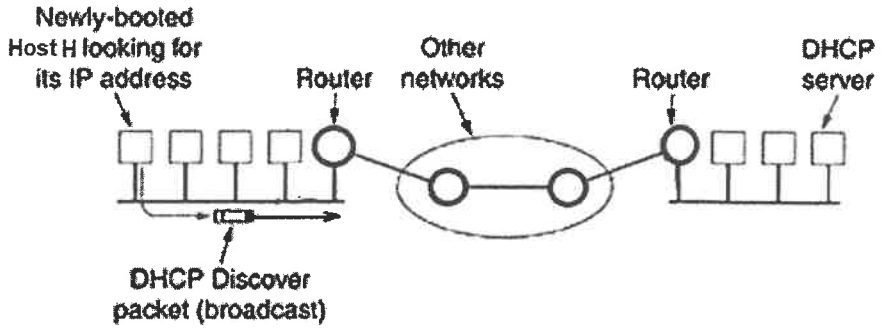

Figure 1

[4 marks]

(c) Router 1 is a new router that has been installed in a network. Figure 2 shows Router 1's connections with Routers 2, 3 and 4 which are its closest (most direct) neighbours.

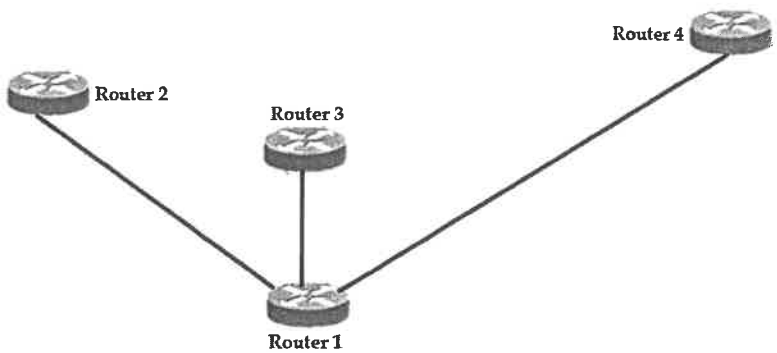

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Figure 2

(i) How will Router 1 learn about its closest (most direct) neighbours (Routers 2, 3 and 4?)

(ii) How can Router 1 have a reasonable estimate of the delay to Router 4?

[2+3 marks]

(d) (i) Figure 3 shows the leaky bucket algorithm being deployed on a router which is sending one packet per clock tick to its output line. This output line is connected to a very low-bandwidth network. The packets that the router is sending are predominantly very big in size and are consequently occupying the channel on the low-bandwidth network for a very long time. Propose a technique/mechanism to address this problem. Your solution should **exclude** "upgrade of the bandwidth of the low-bandwidth network" and/or "allowing a fixed number of bytes per tick, rather than just one packet".

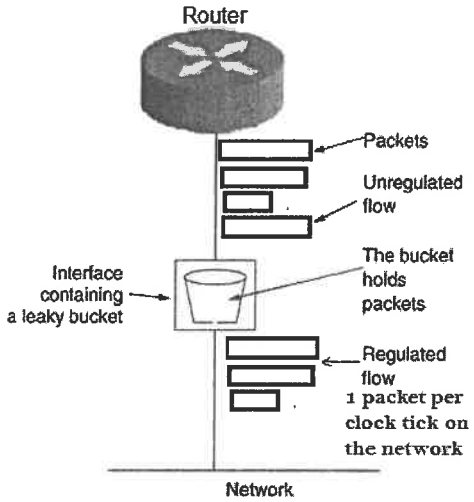

Figure 3

(ii) As it applies to the token bucket algorithm, calculate the token arrival rate (in bytes per second), given: token bucket capacity = 100 bytes, burst rate 25 bytes/second and burst length 10 seconds.

[3+2 marks]

(e) In a network, a cut-through switch was replaced by a store-and-forward switch. What difference would this change make?

[2 marks]

[Total 25 marks]

(continued next page)

Question 2

(a) Study Figure 4. Stations U, V, X and Y are within the radio range of station W. Station Z is within the radio range of Y but not within the radio range of U, V, W and X.

(i) Propose a scenario whereby the hidden station problem would occur.

(ii) Assume that W is transmitting to U. Propose a scenario whereby the exposed station problem would take place.

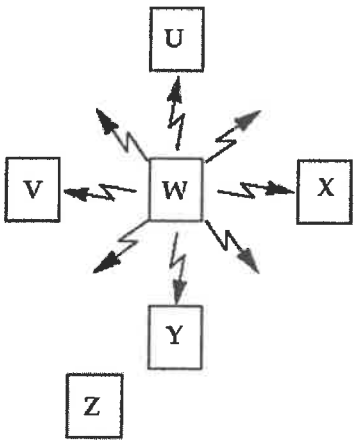

Figure 4

[3+3 marks]

(b) Provide a brief discussion of the following two design goals of routing algorithms

(i) simplicity and low overhead

(ii) rapid convergence

[2x2 marks]

(c) (i) What is the function of the **RST bit** in the TCP Segment Header?

(ii) With the help of a free-hand sketch, explain TCP's Connection Establishment given a delayed duplicate CONNECTION REQUEST appearing out of nowhere from an old connection.

[2+4 marks]

(d) What are the four primary assumptions that are made when using collision-free protocols?

[4 marks]

(e) (i) State two services offered by a Domain Name System (DNS) service.

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(ii) Write down the resource record for a mail server, given that the mail server's name is atlantis, the domain name is ocean.intnet.mu, the IP address is 40.41.42.43 and the time to live with a stable value of 5 hours.

[2+3 marks]

[Total 25 marks]

Question 3

(a) Figure 5 shows a Server Farm Model. One problem with the server farm model is that there is no longer a shared cache because each processing node has its own memory. Propose a solution to counter this performance loss.

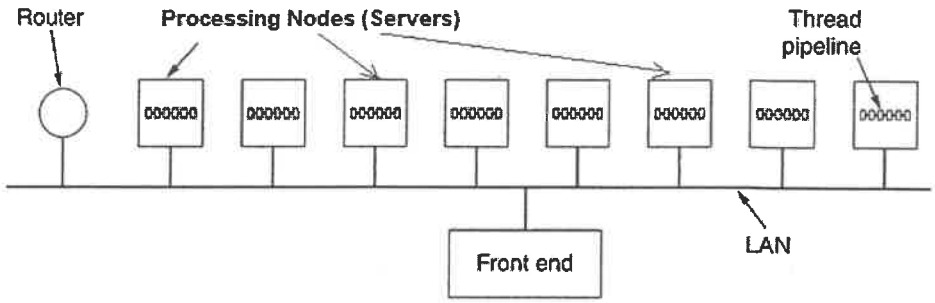

Figure 5

[2 marks]

(b) (i) Figure 6 shows frames being transmitted using the bit-map protocol in a network having 10 stations. Draw the bit-map and clearly show the contention slots.

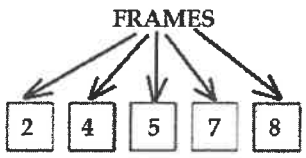

Figure 6

(ii) State two disadvantages of being the last station when using the bit-map protocol. Assume that the last station has a frame ready to be transmitted.

[2+2 marks]

(c) What is the function of the "flags field" in the IP header (IPv4 header)?

[2 marks]

(d) (i) Figure 7 shows a router performing NAT. Client 1 is located in subnet 1 and Host 3 is located in subnet 3. Subnet 1 and subnet 3 are network segments in a campus network. Client 1 has accessed the web server and Host 3 has delivered an email to the email server. Draw the complete NAT table given the above scenario.

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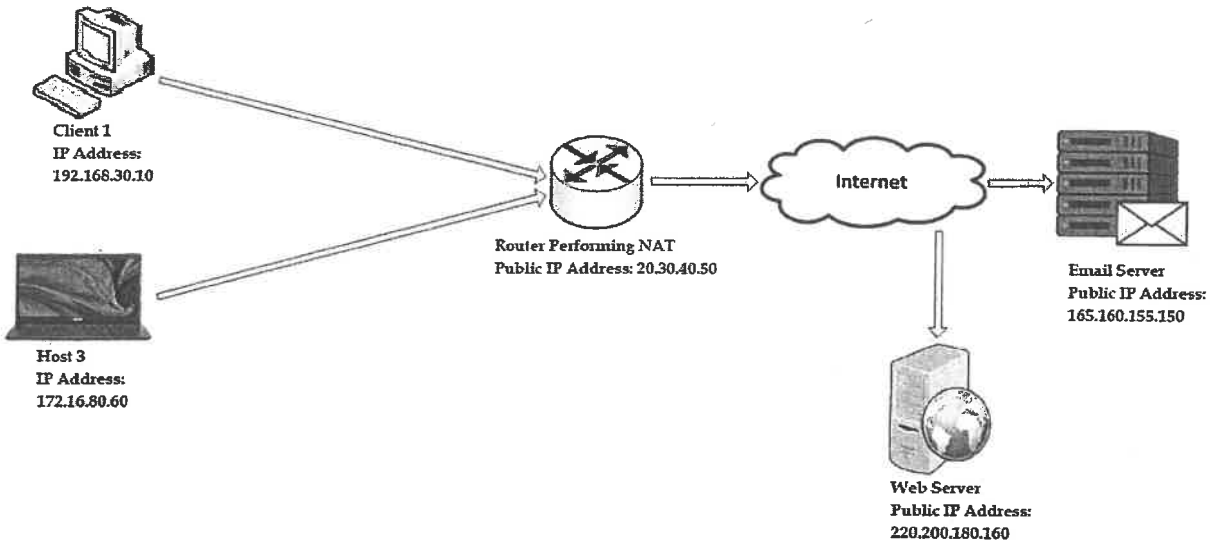

Figure 7

(ii) Discuss, giving reasons, as to whether the following extract from a white paper is valid or not. "NAT does NOT violate the architectural model of IP".

(iii) To access the web server, Client 1 establishes a TCP connection to it. Explain what will happen in the event that the router performing NAT crashes.

[3+2+2 marks]

(e) Fully explain for the following: "Due to a major limitation/disadvantage in the Reverse Address Resolution Protocol (RARP), it was replaced by a better alternative – the Bootstrap Protocol (BOOTP)".

[3 marks]

(f) Explain the following UDP Blocking Modes.

(i) Non-Blocking Communication

(ii) Communication Deadlock

[2+1 marks]

(g) Define Service Set Identifier (SSID) and briefly describe its purpose in a Wi-Fi network.

[2 marks]

(h) Provide a concrete example to validate the following.

(i) the TCP/IP model is not much of a guide for designing new networks using new technologies.

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(ii) the TCP/IP model is not at all general and is poorly suited to describing any protocol stack other than TCP/IP.

[2x1 marks]
[Total 25 marks]

Question 4

(a) POP3 and IMAP are two different email protocols and are used for retrieving emails from email servers. Write down three advantages that POP3 offers over IMAP.

[3 marks]

(b) (i) Explain the "out-of-order caching (buffering)" congestion prevention policy as it applies to the data link layer of the OSI Reference Model.

(ii) Explain the "packet lifetime management" congestion prevention policy as it applies to the network layer of the OSI Reference Model.

(iii) Consider Figure 8. Router R1 is inflicted by congestion and one of its output lines has gone into a "warning state". Assume that the hop-by-hop choke packets mechanism is being used. Choke packets are sent from Router R1 up to Router R30 to which Station P is connected. Station P is the cause of congestion and is sending very large volumes of traffic. Explain in detail how Station P would react once Router R30 starts receiving the choke packets and decreases its sending rate. Assume that all connections from Station P are using TCP only.

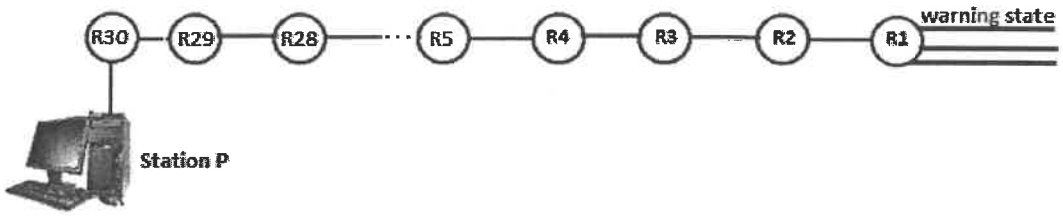

Figure 8

[2+2+3 marks]

(c) Explain, giving reasons, as to whether the Routing Information Protocol (RIP) would work in an Autonomous System where Class B and C non-default subnet masks are used and where bandwidth is used as a metric.

[2 marks]

(d) What are main functions of the Application Layer of the OSI Reference Model

[2 marks]

(e) (i) Explain why **Class D** and **Class E** IP addresses are not used on hosts in IP networks.

(ii) Given Network ID=135.130.0.0 and number of hosts per subnet=511, calculate the subnet mask and the number of subnets.

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(iii) Host M has IP Address 220.210.200.7 and Subnet Mask 255.255.255.248 and Station Y has IP Address 220.210.200.8 and Subnet Mask 255.255.255.192. Assume that Host M and Station Y are connected to the SAME subnet. Will they be able to exchange packets? Fully justify your answer.

[2+4+3 marks]

(f) Asynchronous transfer mode (ATM) is a high-speed, connection-oriented technology that offers high bandwidth (up to 10 Gbps). Still, ATM uses small fixed-size cells. Account for this.

[2 marks]

[Total 25 marks]

Question 5

(a) During the data encapsulation process, a packet is offered by the Network Layer to the Data Link Layer which turns it into a frame. Explain what additional information is added by the Data Link layer to turn the packet into a frame.

[3 marks]

(b) Figure 9 illustrates the X.25 packet-switching protocol for Wide Area Network (WAN) connectivity. Discuss the implications of removing the Packet Assembler/Disassembler (PAD) from the X.25 network.

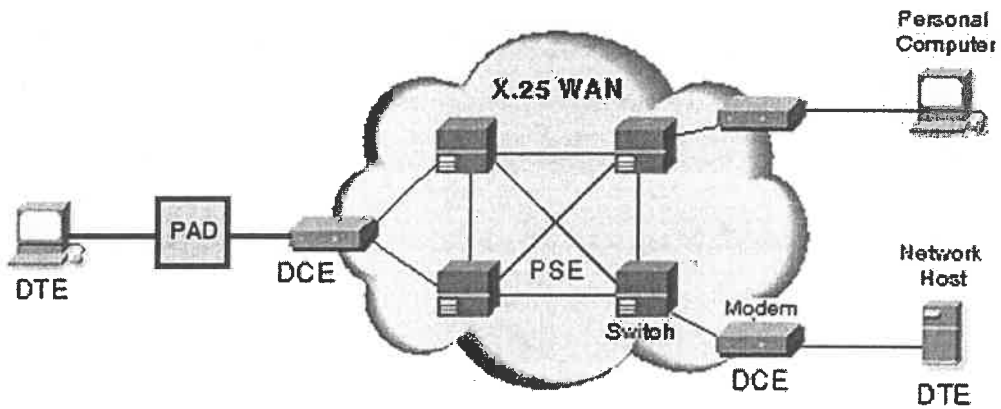

Figure 9

[3 marks]

(c) In the ADSL architecture, how are internet requests handled?

[3 marks]

(d) Explain how a single-mode fiber optic may be yielded/achieved by adjusting with the diameter of the fiber.

[2 marks]

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(e) Figure 10 shows two very small and neighbouring towns – Town A and Town B. The two towns borders each other. Radio waves are used for communication - both indoors and outdoors. Anticipate any potential problem, given this setting and state what is done to resolve it.

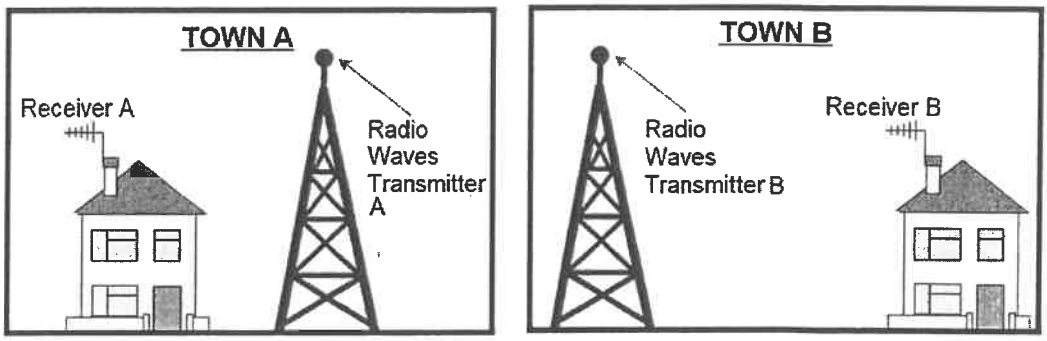

Figure 10

[3 marks]

(f) (i) In Frequency Division Multiplexing, what is used to separate the frequencies in the composite signal?

(ii) In Time Division Multiplexing, what is used to separate the data streams frequencies in the single signal?

[2x1 marks]

(g) Write down two disadvantages of employing Frequency Modulation (FM).

[2x1 marks]

(h) A Local Area Network (LAN) uses a shared transmission medium configured in a bus topology as shown in Figure 11. Stations use the Slotted Aloha protocol to gain access to the shared transmission medium.

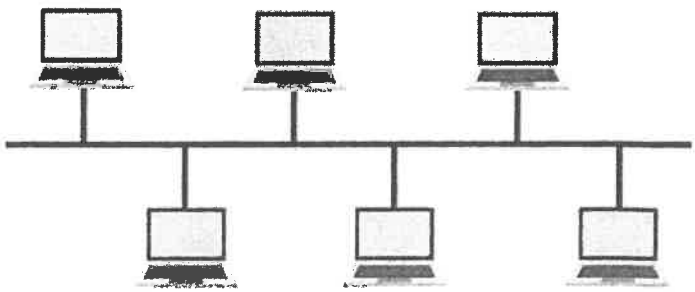

Figure 11

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(i) Why should transmitted frames be of equal length (size) when using this protocol?

(ii) With Slotted Aloha, stations are only allowed to transmit at slot boundaries. What is the length of a slot equivalent to?

[2+2 marks]

(i) Provide a discussion of a major limitation of the character count framing method which accounts for its rare deployment.

[3 marks]

[Total 25 marks]

END OF QUESTION PAPER