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# TECHNOLOGICAL UNIVERSITY DUBLIN

**City Campus, Grangegorman**

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**TU856 – BSc. (Honours) in Computer Science**

**TU858 – BSc. (Honours) in Computer Science (International)**

**Year 2**

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**SEMESTER 2 EXAMINATIONS 2024/25**

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## **Data Communications**

Internal Examiners

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**Duration: 2 hours.**

### ***Instructions to candidates:***

***Answer 4 out of 5 questions - all questions carry 25 marks.***

1. A transmission system comprising a coaxial cable operates with a maximum bandwidth of 50MHz. The following questions relate to the transmission of *analogue* or *digital* signals over this system.
- (a) An analogue signal comprising frequency components at: 5MHz, 15MHz, 25MHz, 35MHz, and 45MHz. Calculate the bandwidth of this signal showing your calculations and, explain if all components will pass through the system without distortion. (5 marks)
- (b) Explain the characteristics of a *digital signal* in terms of *harmonics* and state its *Absolute Bandwidth*. In your answer, explain the impact on the signal's harmonics, and the effect this has on the shape of the pulses as the signal is passed through the coaxial cable. (10 marks)
- (c) The following table, Table 1, shows different data rates associated with a digital signal passing through the coaxial cable and the corresponding number of surviving *harmonics*. Analyze the table and explain the effects on the received signal at various data rates. In your answer, explain if it is realistic to attempt to transmit data at a rate of 10 Mbps.

Data Rate (Mbps)	Number of Surviving Harmonics
10	3
5	9
2.5	19
1	49

Table 1 - *Data Rate versus Surviving Harmonics*.

(10 marks)

2. Consider two computers (Hosts A and B) communicating using the HDLC protocol and employing *modulo 8* numbering. The network is experiencing occasional frame loss.
- (a) Describe the key differences between the *Go-Back-N ARQ* and *Selective Reject ARQ* techniques with respect to the *retransmission of lost frames* and, how *out-of-sequence frames* are handled. In your answer explain which technique is more efficient in terms of *network traffic* and explain which technique requires less *processing load* at the receiver station. (12 marks)
- (b) Host B receives frames: I(6, 1), I(7, 1), I(1, 1), I(2, 1). Assume *Go-Back-N* is in use. Describe how Hosts A and B would respond to this scenario. In your answer, identify all data frames and control messages exchanged and include frame numbers. (6 marks)
- (c) Assuming the scenario outlined in question (b) above is fully resolved, identify an appropriate *positive ACK* message that would allow for the continuation of frame transmission from Host A. In your answer explain how Hosts A and B would respond if this ACK did not arrive at Host A resulting in a timer expiring - identify all control messages exchanged and include frame numbers. (7 marks)
3. In relation to Ethernet Bus and Star LANs:
- (a) Explain the term CSMA/CD and separately explain the purpose of CSMA and CD. In your answer, list the basic steps undertaken by stations employing CSMA/CD before transmission of a frame, during transmission and after a collision occurs on an Ethernet Bus LAN. (7 marks)
- (b) Explain how the use of *store-and-forward* within a *Switching Hub* eliminates the need for the use of CSMA/CD. (8 marks)
- (c) Explain how a *Switching Hub* can facilitate simultaneous communications between two separate pairs of communicating hosts: A & B and C & D and, explain how this impacts on *throughput* from the perspective of each host when compared to hosts connected to a *Shared-medium* Hub device. In your answer, explain the relationship between *contention* and *throughput*. (10 marks)

4. Refer to the *Internetwork* shown in Figure 1 and the partially completed *Address Allocation Table* shown in Table 2. The address block: 192.168.1.0/24 has been allocated to the internetwork.

The table identifies: the address mask for each subnet in *CIDR* notation and, a single valid host address from within each subnet's address block.

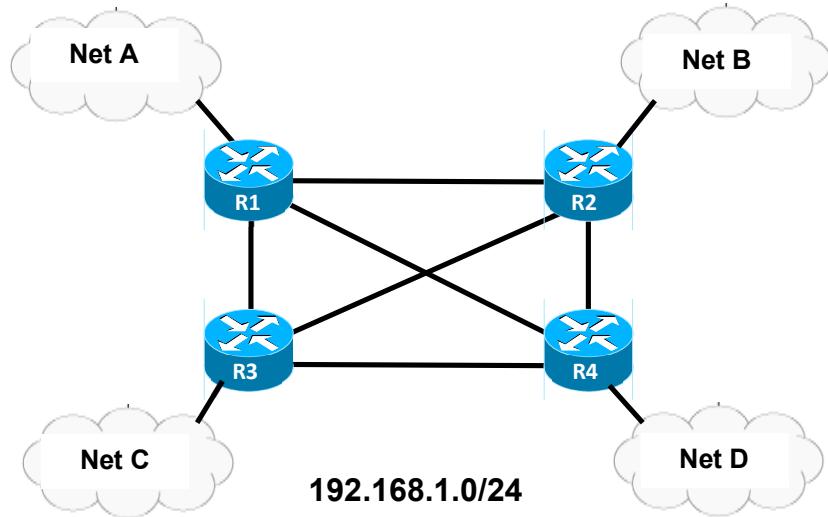


Figure 1 - An Internetwork.

Network Identifier	Single Host Address	Mask	Network Address	1 <sup>st</sup> Host Address	Last Host Address	Broadcast Address
A:	192.168.1.50	/26				
B:	192.168.1.80	/27				
C:	192.168.1.99	/28				
D:	192.168.1.114	/28				
R1-R2	192.168.1.130	/30				
R1-R3	192.168.1.133	/30				
R1-R4	192.168.1.138	/30				
R2-R3	192.168.1.141	/30				
R2-R4	192.168.1.146	/30				
R3-R4	192.168.1.149	/30				

Table 2 – An Address Allocation Table.

Question 4 continues on next page.

- (a) Copy the table into your answer book and using the address mask and host address shown, derive the missing elements for each subnet and complete the table. Show your calculations.

In your answer, identify the following for each subnet: Network address, First and Last Host addresses and Broadcast address – all addresses should be in *Dotted Decimal Notation*.

Table: (10 marks)

Calculations: (10 marks)

- (b) Identify the total number of addresses allocated to each subnet and state how many addresses from the original block remain unallocated, if any. Show your calculations.

(5 marks)

5. Refer to Figure 2 which shows an internetwork with three interconnected sub-networks and a routing table available at each router. Consider the transmission of a frame with an encapsulated packet leaving Host X connected to Net A and destined for Host Y connected to Net B.

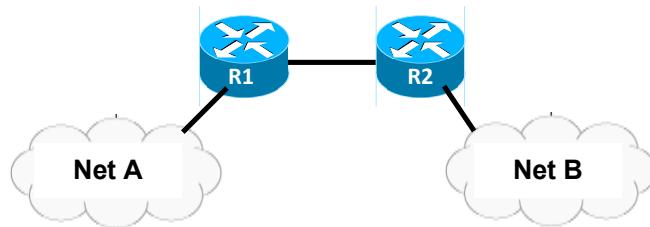


Figure 2 – A small internet.

- (a) What would be the impact on communication if a host had an IP address but did not have a MAC address? In your answer, identify the type of *network* each address relates to and, identify which the layer of the ISO OSI 7-layer model each address relates to.
- (6 marks)
- (b) Identify where any source/destination IP or MAC addresses contained in the packet/frame are changed, if at all.
- (5 marks)
- (c) Explain *Next Hop Routing* and identify what addresses are used in the routing process and what addresses are returned in any queries.
- (6 marks)
- (d) Explain the role of ARP in *Next Hop Routing*. In your answer identify what is contained in an ARP table and explain the high-level process by which entries are added.
- (8 marks)