

Notes:

- (i) Candidates are permitted to use approved calculators
- (ii) Candidates are not permitted to use the Engineering Mathematics Handbook
- (iii) An information sheet of protocol headers is provided

Candidates should attempt THREE questions. All questions carry 20 marks.

1. (a) Sketch a diagram showing each of the seven layers in the *Open Systems Interconnection (OSI) Reference Model*. Include the position of each protocol layer in the diagram. [4 marks]

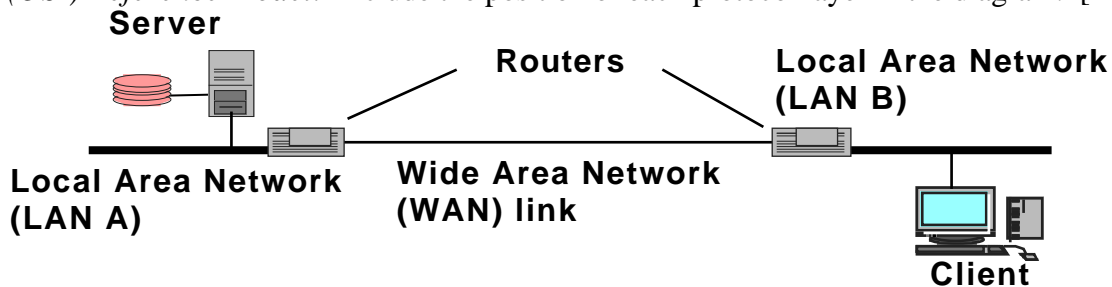


Figure 1: Two computers (server and client) connected via a network .

- (b) The *ping* program may be used to validate an end-to-end *Internet Path* through the above network (figure 1). Explain (using appropriate diagrams) how the client and server exchange *Internet Control Message Protocol (ICMP)* during a test. [8 marks]

- (c) In figure 1, the *Maximum Transfer Unit (MTU)* on the *Wide Area Network* link is 576 B. Explain how *Path MTU (PMTU)* discovery may be used by end systems on LAN A to discover a maximum packet size to send to end systems connected to LAN B. [8 marks]

2. (a) Describe the Ethernet transmit process, and explain the algorithm used to ensure retransmission following a collision in the transmission medium. [10 marks]

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0100 5e02 dc3e 00d0 bbf7 c6c0 0800 4500 00cc e206 0000 7111 a1a9 84b9 8476 e002
dc3e
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Figure 2: Header of a Transmitted Ethernet Frame

- (b) Figure 2 shows the hexadecimal dump of the first few bytes of a packet sent on an Ethernet interface by a computer. What is the computer's hardware source address? [2 marks]

- (c) By using the supplied reference sheet, identify the *Internet Protocol (IP)* header, and then the location of the IP header checksum of the packet shown in figure 2. What is the value of the IP header checksum ? [2 marks]

- (d) Explain why checksums and *Cyclic Redundancy Checks (CRCs)* are applied at a number of protocol levels in a typical packet? [4 marks]

- (e) Outline two ways in which a packet may be lost by a network router? [2 marks]

continued over

3. (a) Some protocols are said to provide a “reliable” service. What four things need to be guaranteed to say that a protocol is reliable? [4 marks]
- (b) The *Trivial File Transfer Protocol (TFTP)* may be used to provide a reliable service over an IP network using a stop-and-wait retransmission protocol. Explain in detail (e.g. using a packet transition diagram) how TFTP may receiver from missing IP packets. [8 marks]
- (c) Define what is meant by the “Throughput” of a protocol layer [2 marks]
- (d) An end system sends 50 packets per second using the *User Datagram Protocol (UDP)* over a 10B2 Ethernet LAN. Each packet consists 1500B of MAC payload data. What is the throughput, when measured at the UDP layer? [6 marks]
4. (a) Before an end system may communicate over a Local Area Network (LAN) it must first perform name resolution, and hardware address resolution. Explain the frames / packets exchanged when performing:
- (i) Name resolution using the *Domain Name Service (DNS)* [6 marks]
- (ii) Hardware address resolution using the *address resolution protocol (arp)*[6 marks]
- (b) An end system uses the *Transmission Control Protocol (TCP)* transport protocol to communicate with another system a 10 Mbps LAN. The sender transmits 10 packets per second with 120 B of TCP data, and receives 5 packets per second of TCP protocol control information with no transport layer data. Calculate the size of each packet, total volume of data sent on the network each second, and hence the utilisation of the network. [8 marks]
5. (a) Which of the following cable technologies may be used to support a 100 Mbps Ethernet Local Area Network?
- (i) Coaxial cable
- (ii) Fibre optic cable
- (iii) Unshielded twisted pair cable [3 marks]

(b) Consider the following network shown in figure 3:

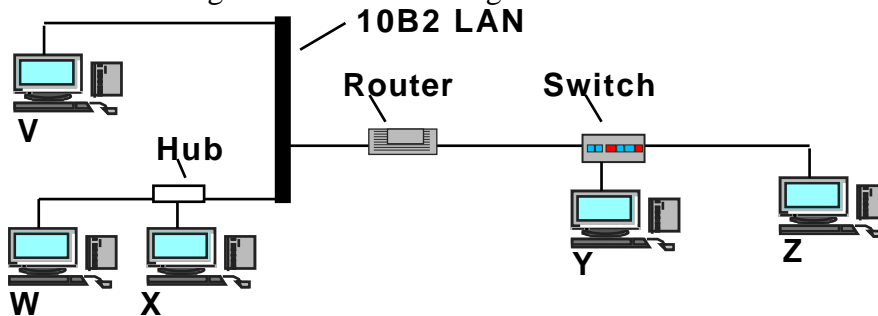


Figure 3: A network connecting 5 End Systems (V,W,X,Y,Z).

- (i) If W sends an Ethernet frame to X, which systems also receive this frame at their physical interface? [3 marks]
- (ii) If X sends an (unicast) Ethernet frame to Y, which system’s *Medium Access Control (MAC)* address will be inserted in the source address of the frame received by Y? [2 marks]
- (iii) If V sends a broadcast frame, which *End Systems* will receive it? [2 marks]
- (iv) Explain how the Ethernet switch builds a table of addresses to allow it to determine whether to forward an Ethernet frame received from Z (the source address) and destined for V (the destination address). [5 marks]
- (c) Explain how the router uses the destination IP address of a packet to decide whether to forward an IP packet received from Z and destined for V. [5 marks]