

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

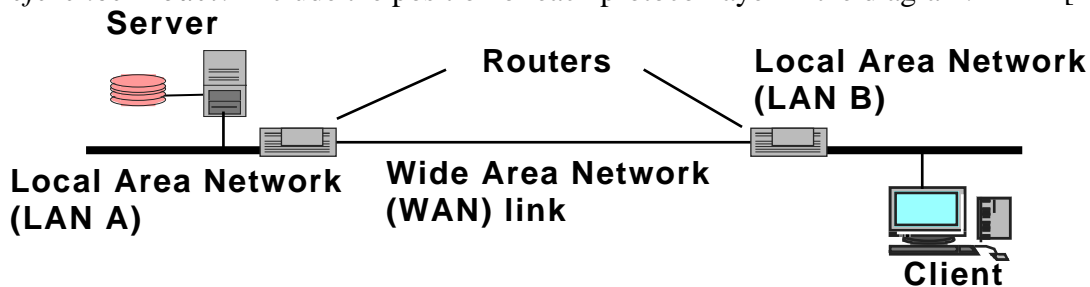


Figure 1: Two computers (server and client) connected via a network.

- (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) the packets which are exchanged during a test. [8 marks]
- (c) In figure 1, the *Maximum Transfer Unit (MTU)* on the WAN 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]

```

0100 5e02 dc3e 00d0 bbf7 c6c0 0800 4500 00cc e206 0000 7111 a1a9 84b9 8476 e002
dc3e 7982 7982 00b8 08a0 8005 dbc6 d721 69c0 0752 bb5f fe39 3600 8808 b120 8933
6219 9118 5128 ffc8 1321 bc10 933e aa23 3233 ba00 e892 a00c 1a3c 0a28 37ab 012d
aca5 4819 9088 0b39 64ba 43a0 b9a8 04b3 88b8 4bf8 3940 d024 0a98 8b0b 1703 0a3a
8820 a381 a21f 3bc0 9298 e893 90bd 042a 0a88 3287 59ab e980 1211 4002 2208 98b1
7039 0b26 e898 99ab b118 a1aa a702 9ac4 9128 ca21 7822 2971 090a 2194 98d0 27bb
0958 8092 993f b3b0 2922 337a 0f88 8810 8a29 0183 fb15 b888 0d4c
    
```

Figure 2: Transmitted Ethernet Frame

- (b) Figure 2 shows the hexadecimal dump of a packet sent using an Ethernet interface by a computer. What is the computer's own hardware address? [2 marks]
- (c) What is the value of the IP header checksum shown in figure 2? [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) What can cause the loss of a packet by a network router? [2 marks]

continued over

3. (a) Some protocols are said to provide a “reliable” service. What guarantees must a reliable protocol offer? [4 marks]
- (b) The *Trivial File Transfer Protocol (TFTP)* may be used to provide a reliable service over an IP network. Explain in detail (using appropriate diagrams) how TFTP may recover from missing IP packets. [8 marks]
- (c) Define the term “Throughput” [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 [6 marks]
 - (ii) Hardware address resolution [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 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:

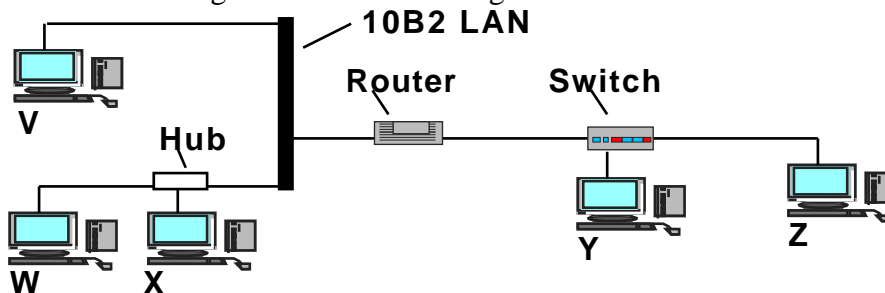


Figure 3: A network connecting 5 End Systems (V,W,X,Y,Z).

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