FACULTY OF ENGINEERING AND TECHNOLOGY

FINAL EXAMINATION FOR THE BSC (HONS), INFORMATION TECHNOLOGY (BIT) & BSC (HONS) COMPUTER NETWORKING AND SECURITY (BCNS) & BSC (HONS) COMPUTER SCIENCE (BCS) & BSC (HONS) SOFTWARE ENGINEERING (BSE); YEAR 2

ACADEMIC SESSION : APRIL 2025 SEMESTER

SUBJECT   : NET2201 – COMPUTER NETWORKS

EXAMINATION   : AUGUST 2025

TIME ALLOWED   : 2 HOURS + 10 MINUTES READING TIME

INSTRUCTIONS TO CANDIDATES

- This question booklet contains **two sections**.
- **Section A**: Answer **all 25 compulsory** Multiple Choice Questions.
  - o **All MCQ** answers must be transferred to the **Multi Choice Answer Sheet** <u>using a pencil only</u>.
- **Section B**: Answer <u>any two</u> **out of the three available questions.**
  - o Write your answers **in the answer booklet provided**, using **blue or black ink pen only**.

IMPORTANT NOTES TO CANDIDATES

Materials Allowed

Standard Items: Pen, Pencil, Eraser, Correction Fluid, Ruler
Special Items   : Non Programmable Calculators

It is your responsibility to ensure that you do NOT have in your possession any unauthorised notes or any other means that would improperly help you in your work. If you have any unauthorised materials with you, hand it to the invigilator BEFORE reading any further.

DO NOT REMOVE THIS QUESTION PAPER FROM THE EXAMINATION HALL

[This paper contains **28** questions printed on **11** pages, including cover page]

> **Section A** – *Compulsory section* – **50 Marks**
>
> ***All MCQ answers must be transferred to the Multi Choice Answer Sheet <u>using a pencil only.</u>***

1 Which of the following best describes an application-layer message?   (2 marks)

    a) A packet that includes source and destination IP addresses used for routing.
    b) A protocol data unit encapsulated by the transport layer for reliable transmission.
    c) The data generated by an application, such as an HTTP request or email content.
    d) A bit stream transmitted over a physical medium such as copper or fiber.

2 What is a network-layer datagram primarily responsible for?   (2 marks)

    a) Providing error detection on frames.
    b) Identifying the user application on a device.
    c) Breaking application messages into bits for physical transmission.
    d) Encapsulating transport segments with source and destination IP addresses for routing.

3 Which of the following are the four main components of end-to-end delay in a packet-switched network?   (2 marks)

    a) Transmission delay, queuing delay, propagation delay, processing delay
    b) Processing delay, storage delay, routing delay, queuing delay
    c) Channel delay, encryption delay, decoding delay, queuing delay
    d) Propagation delay, switching delay, bandwidth delay, circuit delay

4 Which two of the following delay components are usually considered constant for a given path and packet size?   (2 marks)

    a) Queuing delay and processing delay
    b) Transmission delay and propagation delay
    c) Processing delay and queuing delay
    d) Transmission delay and queuing delay

5   Why might an application developer choose to run an application over UDP rather than TCP?   (2 marks)

   a) UDP provides faster transmission by avoiding connection setup and reliability overhead.
   b) UDP guarantees reliable, in-order delivery of packets, which is ideal for all applications.
   c) UDP supports advanced congestion control, making it suitable for file transfer applications.
   d) UDP automatically retransmits lost packets without any delay.

6   How does Web caching reduce the delay in receiving a requested object?   (2 marks)

   a) By compressing the requested object during transmission.
   b) By increasing the bandwidth of the end user's connection.
   c) By directly routing all HTTP requests to the destination web server.
   d) By storing frequently accessed objects closer to users, reducing access time.

7   Will Web caching reduce the delay for all objects requested by a user? Why or why not?   (2 marks)

   a) Yes, because all web content is automatically cached in the user's local device.
   b) No, because caching only helps for objects that have previously been stored in the cache.
   c) Yes, because Web proxies always prefetch all website objects in advance.
   d) No, because cached objects take longer to validate than downloading new ones.

8   What is the primary role of the forwarding table within a router?   (2 marks)

   a) To store login credentials for router administration
   b) To determine the best route to establish a TCP connection
   c) To map destination IP addresses to the appropriate outgoing interface
   d) To encrypt packet headers before forwarding

9   Suppose a process in Host C has a UDP socket bound to port 6789. Both Host A and Host B send UDP segments to Host C with destination port 6789. What happens to these segments?   (2 marks)

   a) Only the segment from Host A is accepted; the one from Host B is discarded.
   b) Both segments are directed to different sockets based on the source IP addresses.

    c) Both segments are directed to the same socket at Host C since the destination port is the same.

    d) Host C automatically opens separate sockets for each source host.

10 Refer to Question 9, how can the receiving process at Host C distinguish between the segments sent by Host A and Host B?   (2 marks)

    a) By analyzing the source port and IP address information from each received segment.

    b) By checking the transport-layer checksum in the UDP header.

    c) By looking at the size of the payload, which is always unique per host.

    d) By using the MAC address of the source hosts encoded in the UDP header.

11 When a packet from end system A arrives at a router, what information does the router primarily use to decide the outgoing link for forwarding the packet?   (2 marks)

    a) The source MAC address

    b) The destination IP address

    c) The destination port number

    d) The source IP address

12 Is it possible for an application to achieve reliable data transfer when using UDP instead of TCP?   (2 marks)

    a) No, UDP does not support any form of reliable communication.

    b) No, because routers block UDP packets in most networks.

    c) Yes, because UDP automatically retransmits lost packets.

    d) Yes, if the application implements its own reliability mechanisms on top of UDP.

13 Host A sends two TCP segments back-to-back to Host B. The first segment has sequence number 90, and the second has sequence number 110. How much data is in the first segment?   (2 marks)

    a) 10 bytes

    b) 20 bytes

    c) 110 bytes

    d) It cannot be determined without the ACK number

Refer to **Figure 1** to answer **Questions 14-19**. Let's replace the router between subnets 1 and 2 with a switch S1, and label the router between subnets 2 and 3 as R1.
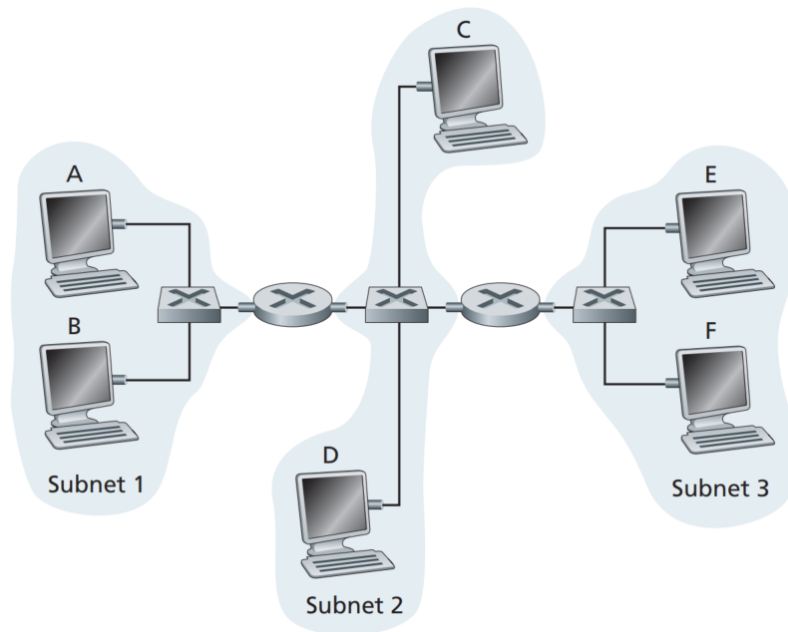

Figure 1

14   Host E wants to send an IP datagram to Host F. Will Host E involve Router R1 to forward the datagram? Why?   (2 marks)

      a)   Yes, because all datagrams must pass through a router before reaching their destination.
      b)   No, because both E and F are in the same subnet, so E can send the datagram directly.
      c)   Yes, because Host E cannot discover Host F's MAC address.
      d)   No, because switches, not routers, are responsible for forwarding IP datagrams.

15   In the Ethernet frame sent from Host E to Host F, what are the source and destination IP and MAC addresses?   (2 marks)

      a)   IP: Src = E, Dest = F; MAC: Src = E, Dest = F
      b)   B. IP: Src = R1, Dest = F; MAC: Src = E, Dest = R1
      c)   C. IP: Src = E, Dest = R1; MAC: Src = E, Dest = F
      d)   D. IP: Src = E, Dest = F; MAC: Src = R1, Dest = F

16   Suppose Host E wants to send a datagram to Host B, and E's ARP   (2 marks)
cache does not contain B's MAC address. Will E perform an ARP
query for B's MAC? Why?

  a) Yes, because the IP address of B is known and ARP is
      needed to discover the MAC address.
  b) Yes, because ARP is always required regardless of
      destination subnet.
  c) No, because Host B is in a different subnet; E will send the
      datagram to router R1 instead.
  d) No, because ARP is only used in Subnet 3.

17   In the Ethernet frame that Host E sends to Router R1 for delivery   (2 marks)
to Host B, what are the source and destination IP and MAC
addresses?

  a) IP: Src = E, Dest = B; MAC: Src = E, Dest = B
  b) IP: Src = E, Dest = B; MAC: Src = E, Dest = R1
  c) IP: Src = E, Dest = R1; MAC: Src = E, Dest = B
  d) IP: Src = R1, Dest = B; MAC: Src = R1, Dest = B

18   Host A sends an ARP request to find B's MAC address. What will   (2 marks)
switch S1 do upon receiving this broadcast ARP request?

  a) Switch S1 will forward the ARP request to all interfaces
      except the one it came from.
  b) Switch S1 will ignore the broadcast and drop the frame.
  c) Switch S1 will send the ARP request only to Host B.
  d) Switch S1 will forward the request to Subnet 3 via Router
      R1.

19   Will router R1 receive the ARP request from Host A for Host B's   (2 marks)
MAC address? Will R1 forward the request to Subnet 3?

  a) Yes; and R1 will forward it to Subnet 3.
  b) No; R1 ignores all ARP messages.
  c) Yes; but R1 will not forward it because ARP requests are
      not forwarded across routers.
  d) No; ARP requests are only handled by switches.

20   What is one key advantage of a circuit-switched network over a   (2 marks)
packet-switched network?

  a) It uses IP addressing, allowing global connectivity across
      subnets.
  b) It supports higher throughput by avoiding connection
      establishment.
  c) It provides a guaranteed and predictable data rate once the
      circuit is established.
  d) It allows multiple users to share the same path
      simultaneously without delay.

21 Which of the following best describes the primary use of SMTP? (2 marks)

    a) Retrieving emails from a server to a client using remote access
    b) Sending and forwarding email messages between mail servers
    c) Encrypting emails during transit between two clients
    d) Archiving emails on a cloud-based storage server

22 What is a key advantage of IMAP over POP for email access? (2 marks)

    a) IMAP allows access to email messages from multiple devices while keeping them on the server.
    b) IMAP downloads all emails to the local device and deletes them from the server.
    c) IMAP uses the HTTP protocol to access webmail interfaces.
    d) IMAP compresses email content before downloading it to reduce bandwidth.

23 Which of the following best describes a centralized routing algorithm? (2 marks)

    a) A. Each router independently computes its own routing table using only local information.
    b) Routing decisions are based on fixed paths determined during initial configuration.
    c) A central controller has complete knowledge of the network and computes all routing paths.
    d) Routers randomly choose paths to avoid congestion.

24 What is a key characteristic of a distributed routing algorithm? (2 marks)

    a) It suffers of single point of failure.
    b) It does not adapt to network changes.
    c) It uses a pre-defined static routing table.
    d) Each router shares link cost information only with its directly connected neighbors.

25 Suppose your department uses a local DNS server for all its computers. As an ordinary user (not a system administrator), can you determine whether an external website was likely accessed by someone in your department a few seconds ago? (2 marks)

    a) A. No, because only system administrators can access DNS information.
    b) Yes, by checking the local ARP table of your computer.
    c) Yes, if you have access to the local DNS cache and see a recent resolved entry for that domain.
    d) No, because DNS queries are encrypted and cannot be monitored.

Section B – 50 Marks
*Answer **any TWO questions** from this section.*
Write your answers **in the answer booklet**, using **blue or black ink pen only**.

Question 1 (25 marks)

a) Consider the following string of ASCII characters that were captured by Wireshark when the browser sent an HTTP GET message (i.e., this is the actual content of an HTTP GET message). The characters *<cr><lf>* are carriage return and line-feed characters (that is, the italized character string *<cr>* in the text below represents the single carriage-return character that was contained at that point in the HTTP header). Answer the following questions, indicating where in the HTTP GET message below you find the answer.

```
<cr><lf>Accept-Language: en-us,en;q=0.5<cr><lf>Accept-
Encoding: zip,deflate<cr><lf>Accept-Charset: ISO
-8859-1,utf-8;q=0.7,*;q=0.7<cr><lf>Keep-Alive: 300<cr>
<lf>Connection:keep-alive<cr><lf><cr><lf>

GET /cs453/index.html HTTP/1.1<cr><lf>Host: gai
a.cs.umass.edu<cr><lf>User-Agent: Mozilla/5.0 (
Windows;U; Windows NT 5.1; en-US; rv:1.7.2) Gec
ko/20040804 Netscape/7.2 (ax) <cr><lf>Accept:ex
t/xml, application/xml, application/xhtml+xml, text
/html;q=0.9, text/plain;q=0.8,image/png,*/*;q=0.5
```

    i.   What is the URL of the document requested by the browser?   (3 marks)

    ii.   What version of HTTP is the browser running?   (3 marks)

    iii.   Does the browser request a non-persistent or a persistent connection?   (3 marks)

    iv.   What is the IP address of the host on which the browser is running?   (3 marks)

    v.   What type of browser initiates this message? Why is the browser type needed in an HTTP request message?   (3 marks)

b)   The text below shows the reply sent from the server in response to the HTTP GET message in the question above. Answer the following questions, indicating where in the message below you find the answer.

```
HTTP/1.1 200 OK<cr><lf>Date: Tue, 07 Mar 2008
12:39:45GMT<cr><lf>Server: Apache/2.0.52 (Fedora)
<cr><lf>Last-Modified: Sat, 10 Dec2005 18:27:46
GMT<cr><lf>ETag: "526c3-f22-a88a4c80"<cr><lf>Accept-
Ranges: bytes<cr><lf>Content-Length: 3874<cr><lf>
Keep-Alive: timeout=max=100<cr><lf>Connection:
Keep-Alive<cr><lf>Content-Type: text/html; charset=
ISO-8859-1<cr><lf><cr><lf><!doctype html public "-
//w3c//dtd html 4.0transitional//en"><lf><html><lf>
<head><lf> <meta http-equiv="Content-Type"
content="text/html; charset=iso-8859-1"><lf> <meta
name="GENERATOR" content="Mozilla/4.79 [en] (Windows NT
5.0; U) Netscape]"><lf> <title>CMPSCI 453 / 591 /
NTU-ST550ASpring 2005 homepage</title><lf></head><lf>
<much more document text following here (not shown)>
```

i.   Was the server able to successfully find the document or not?   (3 marks)

ii.   What time was the document reply provided?   (2 marks)

iii. When was the document last modified?   (3 marks)

iv.   How many bytes are there in the document being returned?   (2 marks)

Question 2 (25 marks)

a)   How long does it take a packet of length 1,000 bytes to propagate over a link of distance 2,500 km, propagation speed 2.5×10^8 m/s, and transmission rate 2 Mbps? Does this delay depend on packet length? Does this delay depend on transmission rate?   (5 marks)

b)   Suppose you would like to urgently deliver 50 terabytes data from Ipoh to Georg Town, Penang. You have available a 100 Mbps dedicated link for data transfer. Would you prefer to transmit the data via this link or instead use FedEx overnight delivery? Explain.   (5 marks)

c)   Suppose there is exactly one packet switch between a sending host and a receiving host. The transmission rates between the sending host and the switch and between the switch and the receiving host are R1 and R2, respectively. Assuming that the switch uses store-and-forward packet switching, what is the total end-to-end delay to send a packet of length L? (Ignore queuing, propagation delay, and processing delay.)   (5 marks)

d)   Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rates R1 = 500 kbps, R2 = 2 Mbps, and R3 = 1 Mbps.

     i.   Assuming no other traffic in the network, what is the throughput for the file transfer?   (5 marks)

     ii.   Suppose the file is 4 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B?   (5 marks)

Question 3 (25 marks)

a)   Do you agree with the following statements? Justify your answer.

     i.   If the traffic intensity is larger than 0.9, congestion becomes severe.   (5 marks)

     ii.   A control plane based on software-defined networking in the network layer enables each router to compute its own forwarding table.   (5 marks)

b)   Consider the following network in Figure 2:
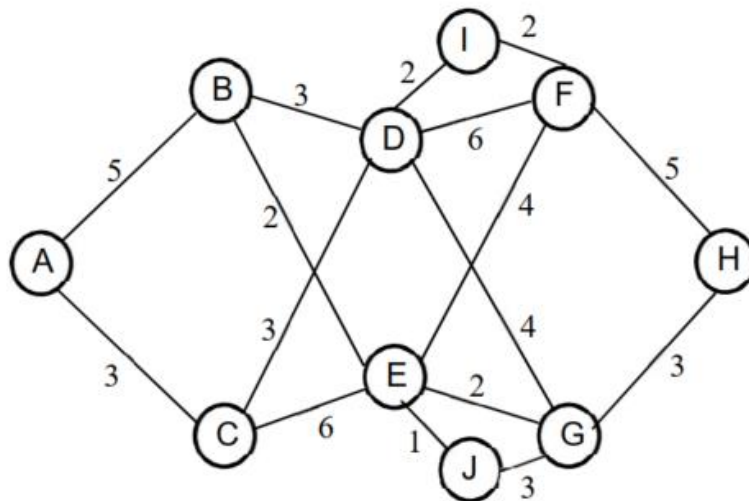

Figure 2

     i.   Use Dijkstra's shortest path algorithm to compute the shortest path from node A to the rest of the nodes in the network. The link cost is indicated on each link. Fill in Table 1 to demonstrate your answer.   (9 marks)

Table 1. Routing Algorithm Output

Step	N'	D(B) p(B)	D(C) p(C)	D(D) p(D)	D(E) p(E)	D(F) p(F)	D(G) p(G)	D(H) p(H)	D(I) p(I)	D(J) p(J)
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

    ii.   Show the least-cost path tree for the network.   (3 marks)

    iii.   Show a forwarding table for node A.   (3 marks)

~ END OF QUESTION PAPER ~