Note! The problem set consists of two parts:

- ***Part I: The problem specifications pages***
- ***Part II: The answer pages***

Part I: The problem specifications

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English (original)

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Exam in course:

"TTM4100 COMMUNICATION – SERVICES AND NETWORKS"

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Grading results 12 June 2009
(This is the date for sending the results from the Department of Telematics to the Student and Academic Division of NTNU)

Remedies:
D: No printed or handwritten remedies allowed.
Determined, simple calculator allowed.

Rules:

The problem set consists of two parts:

- Part I, the problem specifications pages (numbered pages 1 to 8), define the rules to follow and the questions to be answered.
- Part II, the answer pages (numbered pages 1 to 14), include "Written text" fields and the answer alternatives for choice-type questions. The rules must be followed when answering the questions. Part II also includes 3 pages where you may give comments related to *formal issues* about Part I or Part II, or the exam in general. These pages may also be used for "Written text" answers. The sensors will read and decide how to use the comments.

The answer pages (Part II) shall be delivered as your answer. Two copies of Part II are handed out. Only one copy shall be delivered as your answer.

The student number should be written on all answer pages (Part II) ***with digits.***
Follow the rules below to avoid wrong interpretations.

Use blue or black ballpoint-pen, ***not a pencil.***

Check the boxes as clear as you can, like this: ☒

If you check the wrong box, fill it completely, like this: ■

Then check the correct box.

Other correction methods e.g. use of eraser, correcting fluid, etc., are not permitted

Do not write outside the box fields or the student number fields.

Score

The maximum score for the exam is 100 points. A sub-problem has a defined maximum score of *X* points. A sub-problem may be defined by using various types of box fields. In this exam we mainly have two different types of box fields:

- **Written text**. *A sub -problem shall be answered by written text. In that case the answer shall be written in the supplied marked box in the answer page. The answer can give from 0 to max X points .*
- **True or False***: Check one box per statement, or do not check.*
  If 'True' and 'False' both are checked for a statement, it counts as an incorrect mark. If the sub-problem has M statements and the maximum score for this sub-problem is X points, then the resulting score is calculated as follows:

  $$Points = dif * \frac{X}{M},$$ *where "dif" is the difference between the number of correct marks and the number of "discounts points" and where "discount points" are found from the Table below.*

number of incorrect marks	***discount points***
1	*0*
2	*1,5*
i >= 3	*i*

Formally we have: dif =Max{(number of correct marks – discount points), 0},

This mapping between incorrect marks and discount points allows you to guess wrong once without being punished.

Note that the True or False problem does not give incorrect marks if you do not check any of the two boxes for a given statement.

1. “True” or “False” questions. (50 points)

1.1 Application Layer (10 points)

(Check in the answer page the ‘True’ or the ‘False’ box, or do not check, for each statement.)

1.1.1	A Layer offering a connection-oriented service must use a connection-oriented protocol.
1.1.2	When a data packet moves from the upper layer to the lower layers, headers are added.
1.1.3	With non-persistent connections between browser and origin server, it is possible for a single TCP segment to carry two distinct HTTP request messages.
1.1.4	For a P2P file-sharing application, there is no notion of client and server sides of a communication session.
1.1.5	A machine with a single DNS name can have multiple IP addresses.
1.1.6	E-mail does not use DNS.
1.1.7	POP3 servers do not carry state information across POP3 sessions.
1.1.8	Only SMTP can be used between a user mail agent and an Internet mail server.
1.1.9	A user requests a Web page that consists of some text and two images. For this page, the client will send one request message and receive three response messages.
1.1.10	Two distinct Web pages (for example, www.item.ntnu.no/index.html and www.idi.ntnu.no/index.html) can be sent over the same persistent connection.

1.2 Transport Layer (10 points)

(Check in the answer page the ‘True’ or the ‘False’ box, or do not check, for each statement.)

1.2.1	Transport layer protocol data units are processed by both routers and end hosts.
1.2.2	All transport layer protocols must perform flow control.
1.2.3	In a Go-Back-N protocol, the sender is generally allowed to transmit multiple packets without waiting for an acknowledgment.
1.2.4	TCP provides message stream transport service.
1.2.5	When TCP is used, the TCP port number at the receiver side must be the same as the sender side.
1.2.6	UDP is not a reliable protocol.
1.2.7	Suppose Host A is sending a large file to Host B over a TCP connection. If the sequence number for a segment of this connection is n, then the sequence number for the subsequent segment will necessarily be $n+1$.
1.2.8	Suppose Host A sends two TCP segments back to back to Host B over a TCP connection. The first segment has sequence number 90; the second has sequence number 110. Then, there are 20 bytes is in the first segment.
1.2.9	Suppose Host A sends one segment with sequence number 38 and 4 bytes of data over a TCP connection to Host B. In this same segment the acknowledgment number is necessarily 42.
1.2.10	Suppose a process in Host C has a UDP socket with port number 6789. Suppose both Host A and Host B each send a UDP segment to Host C with destination port number 6789. Then, both of these segments will be directed to the same socket at Host C.

1.3 Network Layer (10 points)
(Check in the answer page the 'True' or the 'False' box, or do not check, for each statement.)

1.3.1	The Network Layer is responsible for providing reliable end-to-end transmission.
1.3.2	The service provided by the Internet Network Layer is connectionless.
1.3.3	The 32-bit binary equivalent of the IP address 223.1.3.27 is 11011111 00000001 00000011 00011011
1.3.4	IP guarantees that the packets will arrive in the right sequence.
1.3.5	The forwarding process of a router is responsible for transferring a packet from an incoming link to an outgoing link.
1.3.6	In a packet-switched network, routers must remember what connection each packet belongs to.
1.3.7	Each interface of a router in the Internet should have one IP address.
1.3.8	In the Internet, a node may receive multiple copies of the same packet.
1.3.9	With DHCP, a host may be assigned an IP address that is different each time the host is connected to the network.
1.3.10	NAT (Network Address Translation) is used to translate hostnames into IP addresses.

1.4 Link Layer and LANs (10 points)
(Check in the answer page the 'True' or the 'False' box, or do not check, for each statement.)

1.4.1	Link layer also needs to provide flow control.
1.4.2	Error control based on even parity means that a parity bit is added so that the number of '1's is even.
1.4.3	CRC (Cyclic Redundancy Check) detects all errors.
1.4.4	In CRC (Cyclic Redundancy Check), the generator polynomials used by the sender and the receiver need not be the same.
1.4.5	Dividing the binary value 10011100 by 1001 using modulo-2 without carries gives a remainder of 101.
1.4.6	Bridges use IP addresses to route frames to their destinations.
1.4.7	Hubs use the frame destination address to route frames to their destination.
1.4.8	The slotted ALOHA protocol is more efficient than the pure ALOHA.
1.4.9	Ethernet provides connectionless service to the network layer.
1.4.10	If all the links in the Internet were to provide reliable delivery service, then the TCP reliable delivery service would be redundant.

1.5 Wireless Networks, Multimedia Networking and Miscellaneous (10 points)
(Check in the answer page the 'True' or the 'False' box, or do not check, for each statement.)

1.5.1	Ethernet and 802.11 use the same frame structure.
1.5.2	Hosts associated with a base station are often referred to as operating in infrastructure mode, where traditional network services, such as address assignment and routing, are provided by the network to which a host is connected via the base station.
1.5.3	Before an 802.11 station transmits a data frame, it must first send an RTS (Request to Send) frame and receive a corresponding CTS (Clear to Send) frame.
1.5.4	It is possible for a CDN (Content Distribution Network) to provide worse performance to a host requesting a multimedia object than if the host has requested the object directly from the distant origin server.
1.5.5	Circuit switching gives higher variation in the end-to-end transfer time than packet switching.
1.5.6	In a packet switching network, assume that all packets have the same length and the queuing delay is ignored. Then, for the connection-oriented service, the connection setup time is always longer than the propagation time of a packet from the sender to the receiver.
1.5.7	In order to maintain registration, SIP (Session Initiation Protocol) clients must periodically send REGISTER messages.
1.5.8	If stored video is streamed directly from a Web server to a media player, the application is using TCP as the underlying transport protocol.
1.5.9	FTP runs on top of UDP.
1.5.10	RTSP (Real-Time Streaming Protocol) does not restrict how streamed media is transported.

2. Explain connection-oriented service and connectionless service: (10 points)

2.1. Explain connection-oriented service.
2.2. Explain connectionless service.
2.3. What is the principal difference between connection-oriented service and connectionless service?

3. In a packet-switched network, when a packet travels through the network, the packet suffers from several types of delays. (10 points)

3.1. Consider a packet of length L which begins at end system A, travels over one link to a packet switch, and travels from the packet switch over a second link to a destination end system. Let di , si and Ri denote the length, propagation speed, and the transmission rate of link i, for $i = 1,2$. The packet switch delays each packet by $dproc$. Suppose now the packet length is 1000 bytes, the propagation speed on both links is $s1 = s2 = 2.5 \cdot 10^8$ m/s, the transmission rates of both links is $R1 = R2 = 1$ Mbps, the packet switch processing delay is $dproc = 2$ msec, the length of the first link is 6000 km, and the length of the last link is 3000 km. Assuming no queuing delays, what is the total end-to-end delay for the packet?

3.2. Suppose $N=100$ packets arrive simultaneously to a link at which no packets are currently being transmitted or queued. Each packet is of length $L=1000$ *bytes* and the link has transmission rate $R=1$ *Mbps*. What is the average queuing delay for these packets?

4. Flow control is needed in communication networks. (10 points)

4.1 What is flow control?
4.2 Which Layer (or Layers) may implement flow control? Explain why.
4.3 Explain stop-and-wait flow control.
4.4 Discuss two disadvantages or problems of stop-and-wait flow control.
4.5 Assume the propagation delay between the sender and receiver is 100ms, and the maximum packet size is 1500 bytes. What is the maximum data rate that can be achieved by stop-and-wait flow control?

5. Consider a datagram network using 32-bit addresses. (10 points)

5.1. Suppose a router in the network has the following (classless inter-domain routing) entries in its routing table:

Address/mask	**Next hop**
135.46.0.0/22	Interface 0
135.46.128.0/22	Interface 1
192.53.40.0/23	Router 1
Default	Router 2

For each of the following IP addresses, what does the router do if a packet with the following address arrives?

5.1.1 135.46.129.10
5.1.2 135.46.0.14
5.1.3 135.46.48.2
5.1.4 192.53.40.7
5.1.5 192.53.56.7

5.2. Suppose in the network there is a router that interconnects three subnets: Subnet 1, Subnet 2, and Subnet 3. Suppose all of the interfaces in each of these three subnets are required to have the prefix 192.53.40/24. Also suppose that Subnet 1 is required to support up to 125 interfaces, and Subnet 2 and Subnet 3 are each required to support up to 60 interfaces. Provide three network addresses (of the form a.b.c.d/x) that satisfy these constraints

6. DNS (Domain Name System) is used in the Internet. (10 points)

6.1. Explain why DNS is needed for the Internet, and give two Internet applications that use DNS.
6.2. Internet DNS uses UDP instead of TCP. If a DNS packet is lost, there is no automatic recovery. Does this cause a problem? Why?
6.3. The Internet DNS name space is divided into zones. Normally how many DNS servers are used for a zone? Why?