Note! The problem set consists of two parts:

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

Part I: The problem specifications

NTNU
The Norwegian University of
Science and Technology
Department of Telematics

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English

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The exam rooms will be visited in the time period between 10am and 12am.

Exam in course:
"TTM4100 COMMUNICATION – SERVICES AND NETWORK"

18. May 2004
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Grading results: 23. June 2004
(This is the date for sending the results from the Department of telematics to the Student and Academic Division of NTNU)

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

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Rules:

The problem set consists of two parts:

- Part I (numbered pages 1 to 20) defines the rules to follow and the questions to be answered.
- Part II (numbered pages 1 to 4) defines the answer alternatives. The rules must be followed when answering the questions.

The answer part (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 shall be written twice on all answer pages (Part II) ***with digits.*** The sheets will be read optically, except for "written text" answers (see Type 1 below). 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 need to correct, ask for a new sheet. You are not allowed to use rubber or other correcting means, for example scratching. Do not write outside the box fields or the student number fields.

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

- **Type 1: 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*.
- **Type 2: Check 1 of 5 boxes**: *You obtain 0 points if an incorrect box is checked or if none, two or more boxes are checked. For correct answer you get X points, if you only have checked one box.*
- **Type 3: Check 1 of N boxes**: *You obtain 0 points if an incorrect box is checked or if none, two or more boxes are checked. For correct answer you get X points, if you only have checked one box.*
- **Type 4: 'true – false':** *Check one box per statement, or do not check. If 'correct' and 'incorrect' 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*
3	*3*
i	*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 Type 4 problem does not give incorrect marks if you do not check any of the two boxes for a given statement.

1 OVERVIEW (25 points)

1.1 Switching principles (15 points)

A Message with length M = 32768 bytes shall be transferred between the transport layer entities in two Hosts A and B through a network SAVAN. SAVAN has two Nodes connected by a geostationary satellite, and the external boundary for SAVAN is between the network and transport layers in the Hosts. The network layers in the Hosts offer a connectionless service to the transport layers. Concerning the switching principle within the network layer in SAVAN, this is open, and we are interested in the total transfer time for packet switching based on datagram (DG), packet switching based on virtual circuit (VC) and circuit switching (CS).

The speed of light delay between the Hosts and the Nodes is zero, and the speed of light delay between the Nodes is 300 msec. The transmission capacity on all transmission channels is 64,000 bytes/sec. There are no processing delays in Hosts or Nodes, no errors on the transmission links and no delay because of waiting.

For packet switching based on datagram, the Header length is 80 bytes. For packet switching based on VC the Header length is 4 bytes. For both DG and VC, the packet length excluding the Header is 4096 bytes.

If connection-oriented switching is used, a protocol for establishment of connections and also disconnection of the connections is needed. Signaling packets are used for this. The switching principle applied for the transfer of the signaling packets through SAVAN is based on DG (Datagram) and the length of the signaling packet is 80 bytes. There is no procedure for acknowledgement of information units.

We shall compare the total transfer times *(T)* for a Message. The transfer time (T) is the time from a message is delivered to the Network layer entity in Host A by the Transport layer entity in Host A and till it is delivered to the Transport layer entity in Host B by the Network layer entity in Host B.

If connection oriented switching is used within the Network Layer, the time needed to perform the signaling procedure for connection establishment must be included in the total transfer time T.

Setuptime: Connection establishment time (For CS and VC)	Tvc: T when packet switching based on virtual circuit is used
Tdg: T when packet switching based on datagram is used	Tcs: T when circuit switching is used

(Check in the answer page the 'correct' OR the 'incorrect' box, or do not check, for each statement)

1.1.1	Setuptime < 0,70 sec
1.1.2	Tdg < 1,00 sec
1.1.3	Tdg < Setuptime
1.1.4	Tvc > 1,5 sec
1.1.5	Tvc = Tdg + 2*0,30 sec

1.1.6	Tvc > Tdg
1.1.7	Tvc > Tcs

1.2 Switching and QoS (2,5 points)

(Check in the answer page the 'correct' OR the 'incorrect' box, or do not check, for each statement)

1.2.1	Circuit switching can give a predictable throughput
1.2.2	Packet switching based on datagram does not loose packets
1.2.3	Circuit switching gives high jitter in the end-to-end transfer time
1.2.4	Packet switching based on datagram guarantees that data are delivered in correct sequence
1.2.5	Circuit switching will never waste transmission channel capacity
1.2.6	Consider the QoS-related information transfer modes. Circuit switching can support synchronous transfer mode.
1.2.7	Consider the QoS-related information transfer modes. Packet switching based on datagram can support isochronous transfer mode

1.3 Protocols and layering (2,5points)

(Check in the answer page the 'correct' OR the 'incorrect' box, or do not check, for each statement)

1.3.1	The OSI presentation Layer presents Web pages to the human Web user.
1.3.2	A protocol is the set of rules (syntax and semantics) that determine the behavior between entities on adjacent layer ((N+1)-layer and (N)-layer)
1.3.3	A (N)-PDU carries the (N)-SDU in the (N)-Header
1.3.4	A (N)-PDU can never carry the whole (N)-SDU
1.3.5	A (N)-PDU can always carry the whole (N)-SDU
1.3.6	An entity offering a connection less service must use a connection less protocol
1.3.7	An entity offering a connection oriented service must use a connection oriented protocol

1.4 Protocol (5 points)

Figure 1-1 shows a message sequence chart (MSC) for a connection oriented transport service based on a connection oriented network service. We shall describe the network entity behavior in the Host where the transport connection is initiated.
An uncompleted state transition diagram for this network layer entity is illustrated in Figure 1-2.

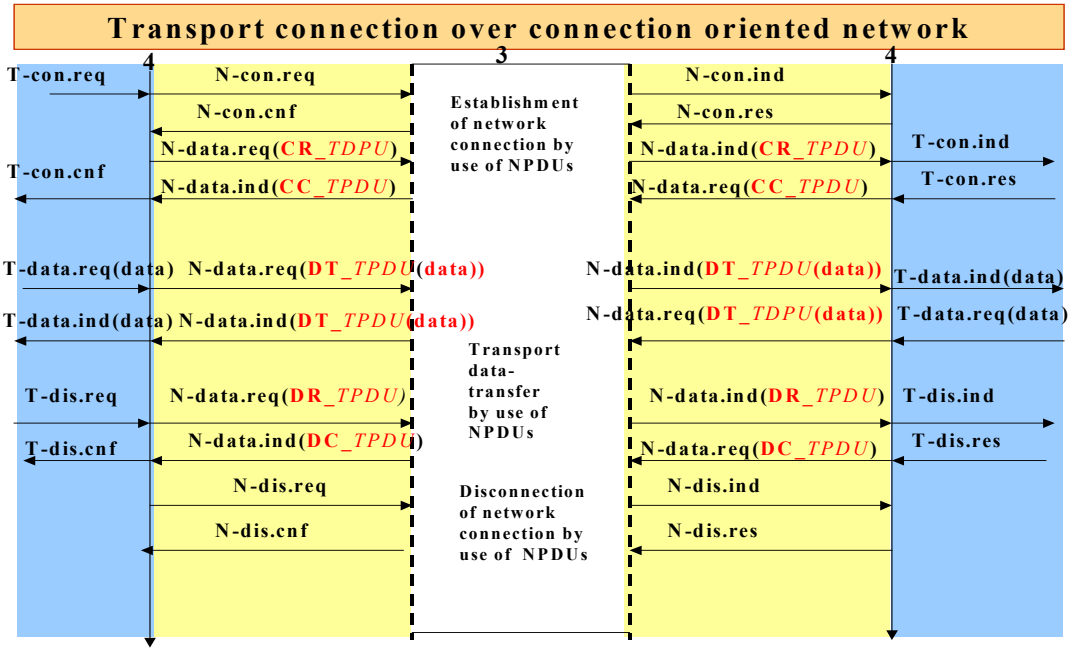


Figure 1-1 MSC for Connection Oriented Transport Service based on a Connection Oriented network Service

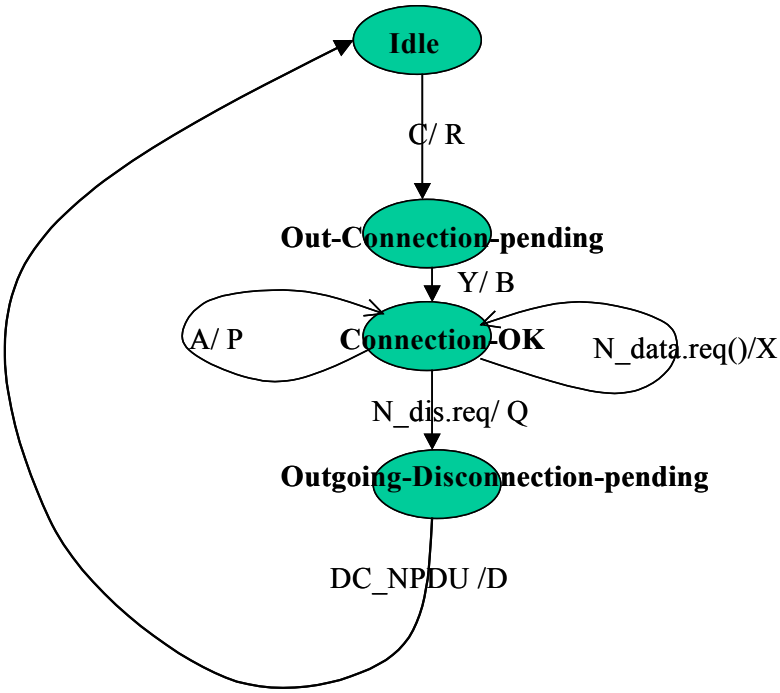


Figure 1-2 Uncompleted State transition diagram for network layer entity

(Check in the table in the answer page. Only one mark pr. row for the questions)

1.4	Fill in one mark per row in the table in the answer pages to make the diagram complete, i.e. exactly which service primitive or N-PDU corresponds to A,B,C,D,P,Q,R,X and Y as they appear in the uncompleted state transition diagram in Figure 1-2.

2 THE PHYSICAL LAYER (7,5 points)

2.1 1 of 5 (2,5 points)

A noiseless 4 KHz channel is sampled every 125 microsec.

(Check one box in the answer page)

A	The Nyquist theorem determines the maximum bit rate
B	The maximum bit rate is 64 kbits/sec
C	The maximum bit rate is 8 kbits/sec
D	The maximum bit rate is 16 kbits/sec
E	The maximum bit rate depends on the modulation type applied

2.2 1 of 5 (2,5 points)

A modem has a constellation diagram as in Figure 2-1 with data points at the coordinates: (1,1), (1,-1), (-1,1) and (-1,-1).

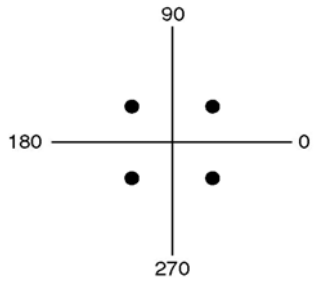


Figure 2-1 Modem constellation diagram

(Check one box in the answer page)

A	The modulation applied is amplitude and phase shift keying.
B	Assume a symbol rate at 1200 baud and no parity bits. Then the maximum bit rate is 4800 bits/sec.
C	The modem operates at 4 frequencies
D	Assume a symbol rate at 1200 baud and that one bit is used as parity bit. Then the maximum bit rate is 1200 bits/sec.
E	Assume a symbol rate at 1 Mbaud and no parity bits. Then the maximum bit rate is 1 Mbits/sec

2.3 1 of 5 (2,5 points).

An ADSL system, which is using 248 channels for data, is using 50% of the available data channels to the down stream link. Assume that QAM-64 modulation is used on each channel and that the symbol rate is at 4000 baud. (QAM-64 has 64 data points in the constellation diagram).

(Check one box in the answer page)

A	Each ADSL modem operates at 64 frequencies
B	QAM-64 has 64 bits/baud
C	Each channel has bit rate 64000 bits/sec
D	The subscriber loop is based on time division multiplexing
E	The total downstream bit rate is 2,976 Mbits/sec

3 THE LINK LAYER / THE MAC LAYER (10 points)

3.1 General : 'true'/'false' (2,5 points)

(Check in the answer page the 'correct' OR the 'incorrect' box, or do not check, for each statement)

3.1.1	Asynchronous framing can be used with synchronous transmission
3.1.2	Physical layer coding violation is a synchronous framing method.
3.1.3	Framing based on Flags need stuffing (bit or character stuffing)
3.1.4	HDLC is a character-oriented version of the Point-to-point protocol (PPP)
3.1.5	Dividing binary value 11010110110000 by 10011 gives a remainder of 1110.
3.1.6	If two words have a Hamming distance d, d bit errors are needed to transform one word into another valid word.

3.2 Hamming code: 1 of 5 (2,5 points)

The byte 10101111 *is to be encoded using an even parity Hamming code. What is the binary value after encoding?*

(Check one box in the answer page)

A	1010 1010 1111
B	1010 0101 1111
C	1011 0100 1111
D	1010 0100 1111
E	1110 0100 1111

3.3 Cyclic Redundancy Check: 1 of 5 (2,5 points)

The byte 10011111 is transmitted using the standard CRC method using the generator polynomial $\boldsymbol{x^3 + 1}$*. Which bit pattern below would be the transmitted bit stream:*

(Check one box in the answer page)

A	10011111
B	10011110
C	10011111000
D	10011111010
E	10011111110

3.4 General : ‘true’ / ‘false’ (2,5 points)

(Check in the answer page the ‘correct’ OR the ‘incorrect’ box, or do not check, for each statement)

3.4.1	Wireless LANs needs the functionality of the two Link sub-layers
3.4.2	The baud rate of the standard 10 Mbits/sec Ethernet is 10 Mbaud.
3.4.3	Assume an Ethernet (without repeaters) with bit rate 1 Gigabits/sec and cable length 1.2 km with signal propagation speed at 200,000 km/sec. This network has a Contention period less than 10 microsec
3.4.4	The CD in CSMA/CD stands for “Carrier Detection.”
3.4.5	The protocol used to determine who goes next on a multi-access channel belong to a sub-layer in the data link layer called Logical Link Control (LLC).
3.4.6	MACA used in Wireless LANs applies error correction
3.4.7	A “cut-through switch” starts to forward an incoming frame before it has arrived completely.

4 THE NETWORK LAYER (10 points)

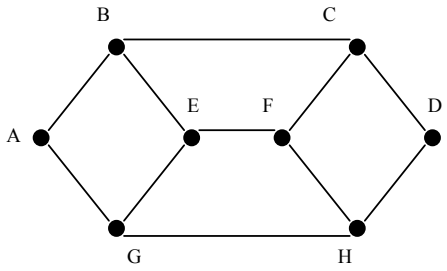
4.1 General : 'true'/'false' (2,5 points)

(Check in the answer page the 'correct' OR the 'incorrect' box, or do not check, for each statement)

4.1.1	Fragmentation of packets is never needed in a virtual circuit subnet.
4.1.2	Routing algorithms cannot be adaptive.
4.1.3	Assuming that the transport protocol is TCP, an IP packet will contain the TCP header bytes in its data field.
4.1.4	There is no functionality in IP packets for error correction.
4.1.5	There are different IP addresses for the same computer if it is connected to several different networks.
4.1.6	"Tunneling" is possible in datagram subnets.
4.1.7	The Address Resolution Protocol (ARP) maps Transport Service Access Point addresses into IP addresses.

4.2 Routing : 1 of 5 (2,5 points)

In the Network shown in the figure, a flooding routing algorithm is applied. If a packet to be sent from A to D has a maximum hop count of 3, then the list of all routes which will be used is one of the following alternatives:



(Check one box in the answer page)

A	ABCD, ABCF, AGHD, AGHF
B	ABEF, ABEG, AGEF, AGEB
C	ABCD, ABCF, ABEF, AGHD, AGHF, AGEF
D	ABCD, ABCF, ABEF, ABEG, AGHD, AGHF, AGEF, AGEB
E	ABCD, ABCF, CFHD, ABEG, AGHD, AGHF, HFCD, AGEB

4.3 Subnets: 1 of 5 (2,5 points)

A network on the Internet has a subnet mask of 255.255.240.0 . The maximum number of hosts it can handle is:

(Check one box in the answer page)

A	1024 hosts
B	2048 hosts
C	4096 hosts
D	8192 hosts
E	16384 hosts

4.4 IP addresses: 1 of 5 (2,5 points)

An IP address has hexadecimal representation C22F1582. If converted to dotted decimal notation the address will be:

(Check one box in the answer page)

A	184.27.21.30
B	194.37.121.30
C	194.47.21.130
D	214.47.21.140
E	214.57.121.140

5 Mobile telephony (5 points)

5.1 General : 'true' / 'false' (2,5 points)

(Check in the answer page the 'correct' OR the 'incorrect' box, or do not check, for each statement)

5.1.1	In the GSM system, the Visitor Location Register (VLR) is a database used for storage and management of GSM subscriptions.
5.1.2	Voice mail services are supported by GSM.
5.1.3	The GSM uses 124 frequency channels with eight users sharing a single channel.
5.1.4	Frequency Division and Time Division Multiplexing are both used in the GSM system.
5.1.5	UMTS is the only 3rd Generation Mobile System
5.1.6	Only one base transceiver station provides the whole radio coverage for a Location area
5.1.7	GPRS is used to achieve higher bit rates than the 3rd Generation Mobile Systems.

5.2 GSM : 1 of 5 (2,5 points)

Assume a GSM mobile phone system operating at 900 MHz with hexagonal cells. This means that each cell has six adjacent cells, and that it is not allowed to use the same frequency in two adjacent cells. Assume that 840 frequencies are available. How many frequencies can be used in a given cell?

(Check one box in the answer page)

A	120
B	140
C	280
D	420
E	840

6 THE TRANSPORT LAYER (15 points)

Figure 6-1 is a state transition diagram that illustrates the behavior of a simplified version of TCP. Figure 6-2 shows a message sequence chart with states for a possible TCP behavior. This diagram has the states A-O, service primitives a-f and protocol data units (PDUs). Find the proper names for the states A-O and the service primitives a-f in Figure 6-2 based on the names used in Figure 6-1. Note that Figure 6-1 does not show the use of predicates and internal state transitions. (An internal transition is a transition from one state to the same state).

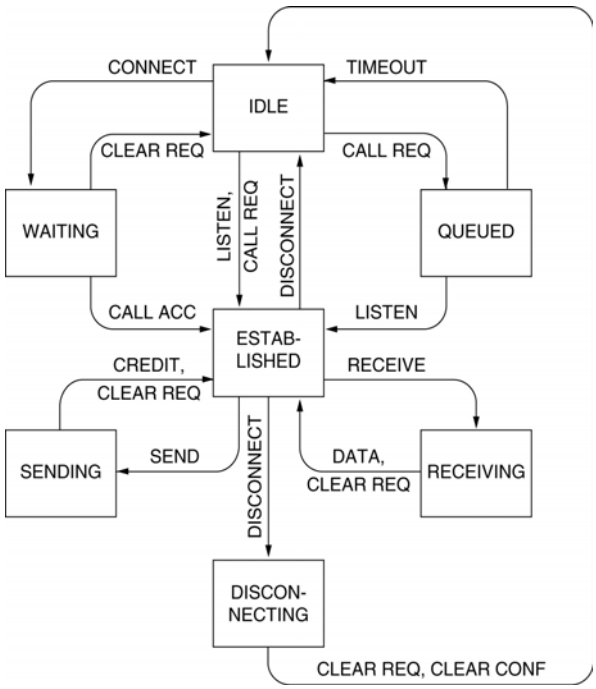


Figure 6-1 Simplified TCP behavior description

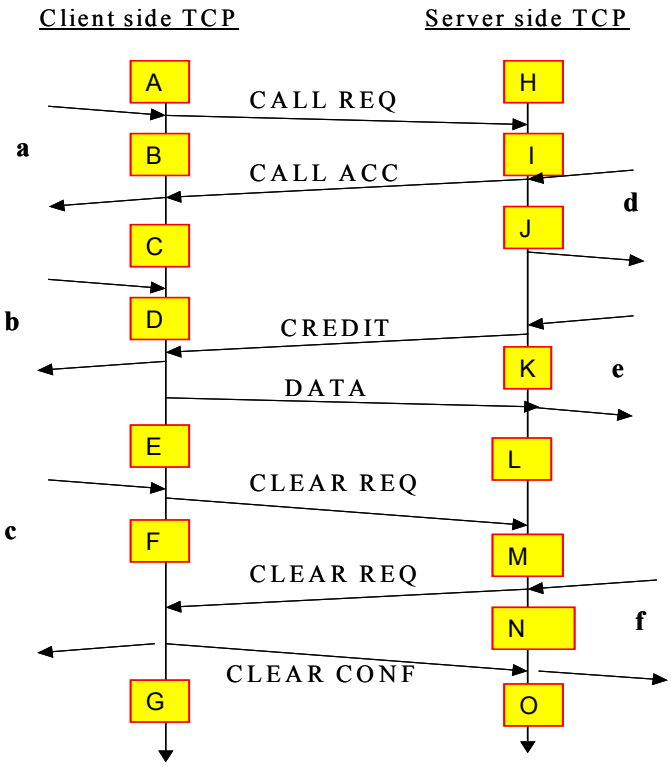


Figure 6-2 A Message Sequence Chart with states

6.1 (10 points)

(Check in the table in the answer page one mark only pr. row for the questions)

6.1	Fill in the table in the answer pages for the states.

6.2 (5 points)

(Check in the table in the answer page one mark only pr. row for the questions)

6.2	Fill in the table in the answer pages for the service primitives.

7 THE APPLICATION LAYER (25 points)

7.1 HTTP request vs. HTTP response (2,5 points)

For items *I, II* and *III, you shall s*how what may be a valid or invalid **first line** in either an HTTP request or an HTTP response.

I. POST / HTTP/1.0
II. HTTP/1.1 200 Ok
III. get / http/1.1

(Check in the answer page the 'correct' OR the 'incorrect' box, or do not check, for each statement)

7.1.1	*I* is not valid for an HTTP request because of the truncated URL
7.1.2	*II* is valid for an HTTP request
7.1.3	In *II,* the leading keyword HTTP identifies this is the beginning of a HTTP request
7.1.4	*I* and *II* are correct for HTTP requests and HTTP responses, respectively
7.1.5	*I* and *III* are correct for HTTP requests
7.1.6	*II* is the response of *I*

7.2 HTTP header (2,5 points)

In the table below there are examples of some HTTP requests. Decide for each of them if they are correct according to the specification.
(Check in the answer page the 'correct' OR the 'incorrect' box, or do not check, for each statement)

7.2.1	*GET /path/file.html HTTP/1.0* *From: someuser@item.ntnu.no* *User-Agent: HTTPmodule/2.0* *[blank line here]*
7.2.2	*GET /path/file.html HTTP/1.1* *Host: www.host1.com:80* *[blank line here]*
7.2.3	*GET /path/file.html HTTP/1.1* *From: someuser@item.ntnu.no* *User-Agent: HTTPmodule/2.0* *[blank line here]*
7.2.4	*GET /path/file.html HTTP/1.0* *[blank line here]*

7.3 HTTP request: 'true'/'false' (2,5 points)

"GET" and "POST" are two methods used in HTTP. Evaluate the following statements.
(Check in the answer page the 'correct' OR the 'incorrect' box, or do not check, for each statement)

7.3.1	POST is *only* used to upload data to the server
7.3.2	GET is the only method allowed in HTTP/1.0
7.3.3	POST can not be used in the HTTP response
7.3.4	When POST is used, payload data can be contained in the HTTP message
7.3.5	When GET is used, payload data can be contained in the HTTP message
7.3.6	POST can only be used to request a web page that is created dynamically (on the fly)

7.4 General: 'true'/'false' (2,5 points)

URL = Uniform Resource Locator
URI = Uniform Resource Identificator
SMTP = Simple Mail Transfer Protocol
SSL = Secure Sockets Layer

(Check in the answer page the 'correct' OR the 'incorrect' box, or do not check, for each statement)

7.4.1	HTTP/1.0 can be used with Secure Socket Layer (SSL)
7.4.2	JavaScript is a client side scripting language
7.4.3	"sftp://john:password@samson.item.ntnu.no/?param1=yes" is a valid URL
7.4.4	Cookies are stored on the web server
7.4.5	DNS is needed because of two few IP addresses in IPv4
7.4.6	DNS is a centralized database
7.4.7	SMTP is an ASCII based Presentation layer protocol
7.4.8	POP3 (Post Office Protocol 3) is a stateless protocol

7.5 Multimedia: 'true'/'false' (2,5 points)

(Check in the answer page the 'correct' OR the 'incorrect' box, or do not check, for each statement)

7.5.1	When using *streaming,* the content is consumed at the receiver side in the same speed as it is sent from a streaming server.
7.5.2	When using streaming, a buffer at the receiver side is used to compensate for variable network delay.
7.5.3	*Progressive download* is the same as *streaming media*.
7.5.4	*Error resilience* is a mechanism in the receiver player that sends retransmit requests to the streaming server in case of missing IP packets.

7.5.5	CBR(Constant bit rate) video is preferred for streaming media, because the bit rate can be customized to the bit rate of the access network.
7.5.6	Assume that the RTSP (Real Time Streaming Protocol) is used to control a video-on-demand service session and that the user clicks the pause button in the media player. Is it so that the streaming server continues to stream media packets while in pause mode to ensure a lot of locally stored media content when the user decides to continue?
7.5.7	Media content providers can select to use HTTP streaming to ensure that users behind firewalls can receive the content.
7.5.8	In Voice over IP (VoIP) both the user that calls and the one that is called must have an IP telephone.

7.6 HTTP Functionality: (5 points)

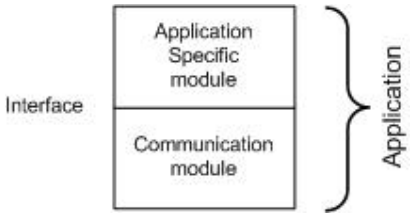
HTTP requests using the *If-Modified-Since* header can be made for pages containing various MIME-types.

Specification of the *If-Modified-Header* (quoted from the HTTP specification):
The If-Modified-Since request-header field is used with a method to make it conditional: if the requested variant has not been modified since the time specified in this field, an entity will not be returned from the server; instead, a 304 (not modified) response will be returned without any message-body.

(Write the answers as written text in the box in the answer page for the questions)

7.6	Do you think the effectiveness of this technique is better or worse for binary data (e.g a JPEG image) as compared to plain text (e.g. as HTML)? Think carefully about what "effectiveness" means and explain your answer.

7.7 HTTP, Client – Server architecture (7,5 points)



In the following we will describe a distributed system, referred to as the *System*. The *System* is made up of *Application* entities. The figure above illustrates the composition of such an *Application* entity. From this figure you can see that an *Application* entity consists of two sub-entities (modules): *Communication module* and *Application Specific module*.

Two peer entities of the *Communication module* use HTTP to communicate. Two peer entities of the *Application Specific module* use some other unknown protocol to communicate.

The *Communication module* is offering a set of services to the *Application Specific module* by at set of primitives through a defined interface.

Requirements to the *System* are given below:

(1) A Client may have several states. Two necessary states are LoggedOn and LoggedOff.
(2) The Server must be able to send a message to a given logged on Client at any time.
(3) The Server must be able to send messages to all logged on Clients at any time
(4) A logged on Client must be able to receive messages from the Server at any time regardless of previous events.
(5) The *System* design must not limit the number of separate Clients that can run on a single host.

(Write the answers as written text in the boxes in the answer page for the questions)

7.7	Select two of the requirements listed above that cannot be solved by HTTP alone. Explain which functionality you must add to your system to meet these two requirements.