Question 1.

DNS is organized logically as a hierarchy of distributed name servers (or zones). [1 pt]

There are three types of name servers: local name servers, root name servers, and authoritative name servers. [1 pt; 0.5 pts if only one or two types of servers mentioned]

An iterated query occurs typically between the local name server and the root name server. The reply to an iterated query does not contain the requested mapping from hostname to IP address, but the address of the next (intermediate) name server the chain. The local name server then directly queries this next server. [1 pt]

A recursive query is propagated through the hierarchy of servers, so that another name server obtains the mapping on behalf of another name server. [1 pt]

Question 2.

a) UDP (User Datagram Protocol) adds multiplexing [1 pt] (by the introduction of a socket address in addition to the IP address), so that a process can be addressed on the machine with the IP address in question. It also adds a checksum to the message [1 pt].

b) The goal is to transmit data as long as possible, without interruptions, although the rate may be lowered. TCP counts the number of duplicate ACKs and assumes that three duplicates means a lost packet, and thus does a retransmit before the (retransmission) timer goes off [1 pt]. A timeout in the TCP congestion control mechanism means time wasted in recuperating and waiting (backing off to do slowstart again) [1 pt].

Question 3.

a) The Link State algorithm consists of the following steps - each node (router) periodically [0.5 pts per step]

i) collects information about its neighbours’ IDs

ii) collects information about the cost of the link to reach each of its neighbours

iii) broadcasts the information above and also collects respective information from all the other nodes in the network (using flooding and ACKs)

iv) computes the all-to-all shortest paths using Dijkstra’s algorithm, and constructs the routing table.

b) One problem that can occur with LS routing is oscillation, which is solved by not allowing all nodes to run the LS algorithm at the same time. Another problem is distinguishing duplicates and/or which data is the newest one (related to the problem of when to build LSP packets), which is solved partly by using sequence numbers and the age field, in addition to waiting for a while before adding LS packet to the Dijsktra’s calculation step. [1 pt for problem, 1 pt for solution]

c) OSPF uses LS, which is an interior gateway protocol. BGP makes use of DV, which is an exterior gateway protocol. (Another example of DV is RIP, which is an interior gateway protocol.) [1 pt for two names, 1 pt for respective protocol’s usage areas]
Question 4.

a) Retransmissions are handled by the DLL and are invisible to the NL [1 pt]. Only when all successive retransmissions for the same frame fail will the NL entity be notified that there is a delivery failure [1 pt] (cf. the labs!).

b) For collision detection to work, the transmission time must be at least twice the one-way propagation delay (this is the collision domain of CSMA/CD) [1 pt].

With $T_{\text{prop}} = \frac{\text{distance-between-stations}}{\text{speed-of-light}}$, and $T_{\text{transm}} = \frac{\text{length-of-data}}{\text{transmission-rate}}$, we get that

$$2 \times \frac{\text{max-distance-between-stations}}{\text{speed-of-light}} = \frac{\text{length-of-data}}{\text{transmission-rate}}$$

$$= \frac{500 \times 2 \times 10^8}{2 \times 10 \times 10^6} = 5000 \text{ meters}$$

[1 pt for in principle correct calculation, 1 pt for correct answer]

c) CSMA/CD is contention-based (or handles collisions; or senses the medium before transmitting) while TR is token-based (you need a token in order to transmit; or no collisions can occur). [0.5 pts for each correct description, which also gives the difference]

Question 5.

a) You can use either Forward Error Correction (FEC) (adding redundancy), Interleaving (originally adjacent packets are reshuffled before they are sent), or Receiver-based repair of damaged audio streams (a replacement is produced by receiver by interpolation or copying of previous packet). See Kurose & Ross, pp. 546–550. [2 pts for correct description by an example, including a name on the method]

b) The leaky bucket is a traffic-shaping or policing method. See example in Kurose & Ross, pp. 576–577 or the lecture slides. [2 pts for correct description and example]

Question 6.

a) Use the IPsec framework. This framework offers a key management method, in addition to two different types of protocol headers that are added before the IP header in order to create different security services. The AH header provides host authentication and data integrity but not confidentiality. The ESP header provides host authentication, data integrity, and confidentiality. The service is implemented by using the Security Association (SA) concept, which transforms the connectionless IP layer in the Internet into a layer with logical connections. [1 pt for the name of a method, 2 pts for a correct and complete description of the method; for IPsec both the key mgmt and the headers need to be included in the answer]

Question 7.

a) The NOS does not assume that the underlying hardware is homogeneous, and that it should be managed as if it were a single system. [1 pt for each of these differences]

b) The three-tiered architecture is used, for example, in RPC. The server can act as a client in a client-server architecture, that is, the processing programs may be partly distributed across the client and server machines. [1 pt for example, 1 pt for explanation]
Question 8.

a) Transparency make the distributed system look like a single system to the user. Examples: location transparency, where a user cannot tell if a resource is physically located (cf. the URL on the Web); and access transparency, where differences in data representation and the way resources can be accessed are hidden from the user (cf. sending an integer from an Intel-based workstation to a Sun SPARC machine). See Tanenbaum & van Steen, pp. 5–7 for more examples of different transparencies.

b) Transparency is not good when, for example, there is a large distance between two processes: the speed of light, among other things, puts a limit on the signal transmission.

Question 9.

IDL in Corba provides a precise syntax for expressing methods and their parameters, resembling a programming language and thus is at a high level of abstraction. It is also the only way to describe the interface.

Question 10.

See Kurose & Ross, pp. 169–170 or the lecture slides. [1 pt per correct explanation of each term]