MidTerm
University of Dhaka
Department of Computer Science and Engineering
CSE 3101: Computer Networking
Total time: 1 hour 15 minutes   Total Marks: 30

Answer all the following questions:

1. Because of the connection-oriented nature of TCP, a connection setup phase is required at the beginning of each session, as well as a connection tear-down phase at the end of the session. Enumerate the events below in the order they occur as host A opens a TCP connection to host B, transmits data and then closes the connection. Write a 1 next to the event that occurs first and continue like that until all occurring events are enumerated (the first event has been enumerated for you). You may assume that no segments are lost. Also indicate at which host the event happens. Please note that there might be events listed below that are not a part of the above data transfer and hence should not be enumerated.

   5

Order	Host	Event
		Send an ACK segment
		Do the rest of the data exchange
		Close the connection
		Send an ACK segment
		Send a FIN segment
1	A	Send a SYN segment
		Send a FIN segment
		Send a RST segment
		Send a SYN-ACK segment
		Enter the TIME-WAIT state
		Send an ACK+DATA segment
		Close the connection

2. If the RTT from Dhaka to Shanghai is 100ms and all links in the network have a 145 Mbits/second data-rate, how much data can fit in the "pipe"? Express your answer in bytes.   2

3. Distinguish between a time-out event and the three duplicate ACKs event. Which one is strong evidence of congestion in the network and why?   2

4. In TCP, what is the range of a header? If in the header the headlen value is 0111, how many bytes of options are included in the segment?   2

5. In a connection, the value of *cwnd* is 3000 and the value of *rwnd* is 5000. The host sent 2000 bytes, which have not been acknowledged. How many more bytes can be sent?   2

6. Consider a reliable data transfer protocol that uses only negative acknowledgments. Suppose the sender sends data only infrequently. Would a NAK-only protocol be preferable to a protocol that uses ACKs? Why?   2

7. Suppose a router receives an IP packet containing 600 data bytes and has to forward the packet to a network with maximum transmission unit of 200 bytes. Assume that IP header is 20 bytes long. What are fragment offset values for divided packets?   2

8. Compare virtual circuit and datagram.   2

9. What happens if two TCP endpoints simultaneously do an active open such that the source and destination IP addresses and port numbers match? Will a connection be established or not? Use the TCP

finite state machine to explain why or why not. NOTE: You do not have to draw the finite state machine. Simply use the names of the states such as SYN_SENT, etc in your explanation. 2

12. Which of the following are true statements about TCP? You do not have to provide any justification. In your answer booklets, simply write down the letters of the statements that you think are true. 2

a. TCP allows a single source to simultaneously transmit to multiple receivers.

b. The slow start algorithm increases a source's rate of transmission faster than additive increase.

c. There is no performance benefit to having a window size of W packets at the TCP sender, if the time to transmit W packets is greater than the RTT between the sender and the receiver.

d. A TCP receiver reduces the advertisement window size in response to congestion at routers along the path.

e. The AIMD (Additive Increase Multiplicative Decrease) mechanism ensures that if n TCP connections share a bottleneck link of bandwidth B, then the average transmission rate of each connection is approximately B/n.

10. Answer all the questions in one/two words: 3

I. What is a socket address?

II. What is the range of well-known ports?

III. In a TCP segment, what does a sequence number identify?

IV. To achieve reliable transport in TCP, what is used to check the safe and sound arrival of data.
a)Packetb)Bufferc)Segmentd) Acknowledgment

V. If the value available in "fragment offset" field of IP header is 100, then the number of bytes ahead of this fragment is

(a) 100 (b) 200 (c) 1600 (d) 800

VI. The checksum computation in IP header includes

(a) IP header and data (b) IP header (c) IP header and Pseudo header (d) None

11. Fill in the following table showing the congestion window size for TCP Reno assuming that the initial threshold is 8 and that a loss event will occur when the window size is 14. Recall that TCP Reno employs the fast recovery mechanism that skips slow start after a loss event. 4
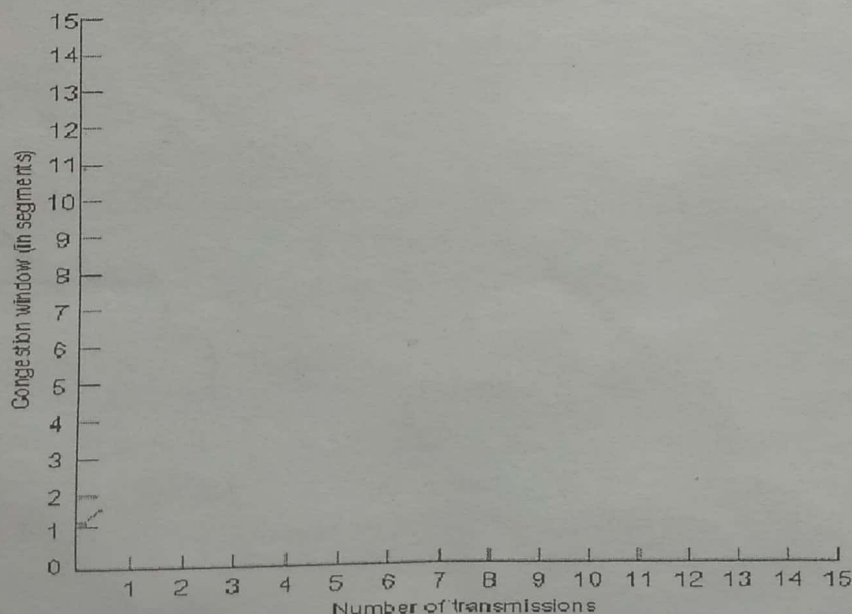
Answer all the questions

1. State the advantages and disadvantages of the evolutionary model of software development. Is it more, or less, suitable than the waterfall model for safety-critical projects? Justify your answer.   5

2. What are the three most important characteristics of a requirements specification? Explain why each of them is so important.   3

3. Consider the following requirement specification statement "*The system must be fast enough to handle peak production throughput*". Do you see any problem in this specification? Explain.   2

4. Identify functional and non-functional requirements of the following system. "A supermarket needs to develop software to encourage regular customers. For this, the customer needs to supply his name, address and telephone number. A customer is assigned a unique customer number (CN) by the computer. When a customer makes a purchase, the value of the purchase is credited against his CN. At the end of each year, surprise gifts to 10 customers who have made the highest purchase are given. In addition, gold coin is given to every customer who has made a purchase over Taka 80,000/- a month on an average."   5

5. Draw a use case diagram for ticket distributor for a train system. The system includes two actors: a traveler, who purchases different types of tickets, and a central computer system, which maintains a reference database for the tariff. Use cases should include: *BuyOneWayTicket, BuyWeeklyCard, BuyMonthlyCard, UpdateTariff*. Also include the following exceptional cases: *Time-Out, TransactionAborted, DistributorOutOfChange, and DistributorOutOfPaper.*   5

6. Suppose you are specifying a system reading signals from a sensor. Along with units of signals give two other properties about a sensor signal that are worth mentioning in a requirements specification.   2

7. Describe at least three different scales/aspects/attributes on which prioritization of requirements can be done? (we are not asking for different prioritization methods) For each scale/aspect/attribute: why are they important and what could happen if they were not taken into account?   3

8. Choose any piece of software which you use regularly. Briefly describe the requirements that the software meets (for you as the user). Suggest three ways in which the software could be improved (for you), and estimate the amount of resources that would be required to make the improvements.   5

Time: 75 minutes   Full Marks: 30

1   Highlight the differences between a microprocessor and a microcontroller.   4

2   Translate the following C code snippet into assembly language: 6
```
sum = 0;
for (i = 0; i <= 10; i++)
    sum += i
```

3   An assembly code snippet is given below: 10
```
.data
first   db    00h, 04Fh, 012h, 0A4h
second  dw    165
third   db    "adf"

.code
mov   eax, first          ; (A)
inc   eax                 ; (B)
mov   ebx, [eax]          ; (C)
mov   [second], ebx       ; (D)
mov   byte [third], 11o   ; (E)
```

What are the contents of "data" memory (byte after byte in hex) just after each line (A, B, C, D, and E) of code executed on an x86 machine?

4   What is the layout and content (byte after byte in hex) of the data memory segment on an   3
x86 machine?

```
buffer   times   4   db   0FDh
x      dd    00010111001101100001010111010011b
blog   db    "ad", "b", "h", 0
fft    times   10   db   14o
min    dw   -19
```

5   Why does an x86 machine need two different multiplication instructions (MUL and IMUL)   3
to perform multiplication?

6   Consider the following C program: 4

```
int main(void)
{
    unsigned short   ushort;
    signed char      schar;
    int    integer;

    schar = 0xAF;
    integer = (int) schar;
    integer++;
    ushort = integer;
    printf("ushort = %d\n", ushort);
}
```

What does this program print on the console? Explain your answer.

Total Marks: 30   Time: 1 Hour 30 Minutes

(Answer All of the following Questions)

1. a) Why is RAID important in organizing disks?   2
    b) Describe RAID level 1 (Mirrored disks with block stripping) and level 5 (block-   4
        interleaved distributed parity). How do you make a choice between these levels? Explain
        in terms of the usage in applications.

2. a) Briefly explain the possible ways of organizing records in files.   4
    b) What is system catalog? What information is kept in data dictionary?   2

3. a) Consider the following relation with 'ID' as candidate key. The relation is sorted on   3
        attribute 'Age'. Draw two secondary indices on candidate key 'ID' and non-candidate key
        'City'.

ID	Name	City	Age
09	A	Dhaka	30
07	B	Rajshahi	32
10	F	Rajshahi	32
04	G	Khulna	35
08	Z	Dhaka	37
06	I	Sylhet	48
01	M	Dhaka	48
05	B	Khulna	48
02	C	Rajshahi	53
03	R	Dhaka	60

    b) Compare B+-tree with indexed-sequential file in terms advantages and disadvantages.   3

4. a) Classify indexing and hashing.   2
    b) How leaf nodes of a B^+-tree differ from other nodes?   2
    c) Considering relation in Question 3(a), let you have 3 buckets and each bucket can hold 4   2
        records. A hash function has been designed on 'Age' attribute that returns the sum of the
        digits of age modulo no. of buckets. Now organize the relation in Question 3(a) using
        hash file organization.

5. a) Draw the steps involved in query processing.   1
    b) Although linear search is slower than other selection algorithms for query processing,   1+2
        where is its importance lies? Find the cost for the following query processing algorithms:
        i) Primary B^+-tree index, equality on key
        ii) Primary B^+-tree index, equality on non-key
        iii) Secondary B^+-tree index, equality on key
        iv) Secondary B^+-tree index, equality on non-key
        Consider the usual notation for no. of records, blocks, height of the tree, seek time, block
        transfer time etc.
    c) What is the problem with 'materialization' approach of evaluation of expression? If   2
        'pipelining' approach is an alternative, what is the limitation of this approach?

1. We know that, in 2D, we must fix two points to properly describe a particular line. How many points do we need   10
to fix, to describe a particular line in 3D? Explain.

2. How can you write the equation of a line in 3D? Explain with example.   10

3. Find a vector that has the same direction as <2, 4, -3> but has length 15.   10

4. Three forces act on an object. Two of the forces are at an angle of 100 degrees to each other and have magnitudes   10
25 N and 12 N. The third is perpendicular to the plane of these two forces and has magnitude 4 N. Calculate the
magnitude of the force that would exactly counterbalance these three forces.

5. Determine whether the given vectors are orthogonal, parallel, or neither.   10
i) $u = <-3, 9, 6>$, $v = <4, -12, -8>$ ii) $u = i - j + 2k$, $v = 2i - j + k$ iii) $u = <a, b, c>$, $v = <-b, a, 0>$

6. How can we find the minimum distance between any two planes? Briefly describe the method. You should   10
assume finding the distance between a point (x_1, y_1, z_1) and a plane $(ax + by + cz + d = 0)$ is $D = |ax_1 + by_1 + cz_1 + d| / \sqrt{(a^2 + b^2 + c^2)}$

7. Mark true or false. Justify each answer briefly.   10
  i. If $Ax = \lambda x$ for some vector x, then λ is an eigenvalue of A.
  ii. A matrix A is not invertible if and only if 0 is an eigenvalue of A.
  iii. A number c is an eigenvalue of A if and only if the equation $(A - cI) = 0$ has nontrivial solution.
  iv. To find the eigenvalues of A, reduce A to echelon form.

8. Let $A = \begin{bmatrix} -3 & 12 \\ -2 & 7 \end{bmatrix}$. Diagonalize A.   20