1. A cricket website displays live scores of ongoing matches. A user notices that sometimes a score which is a few balls old is shown after the latest score is shown. What can you say about the transport layer protocol being used by the website?

2. Suppose a client wishes to establish a TCP connection with a server which is directly connected to it over a noisy link. Ignore the data link layer's ability to provide reliable communication for the moment. Can the TCP connection be established if

   (a) the link drops every odd-numbered packet which appears on it.
   (b) the link drops every even-numbered packet which appears on it.
   (c) the link drops every third packet which appears on it.

3. TCP maintains three pointers into the receiver buffer to enable flow control through window advertisement: LastByteReceived, NextByteExpected and LastByteRead.

   (a) Which of the following are valid scenarios if MaxReceiveBuffer is 2000 bytes? Calculate the value of AdvertisedWindow in each valid scenario.
      i. LastByteReceived = 1000, NextByteExpected = 2001, LastByteRead = 3000
      ii. LastByteReceived = 3000, NextByteExpected = 2001, LastByteRead = 1000
      iii. LastByteReceived = 1000, NextByteExpected = 1000, LastByteRead = 1000
      iv. LastByteReceived = 1000, NextByteExpected = 1001, LastByteRead = 1000
      v. LastByteReceived = 2500, NextByteExpected = 2001, LastByteRead = 1000

   (b) Which of the above are valid scenarios if MaxReceiveBuffer is 1500 bytes? Calculate the value of AdvertisedWindow in each valid scenario.

   (c) In the scenarios above which are valid, have the bytes arrived in order or out-of-order?

4. TCP maintains three pointers into the send buffer to enable flow control by calculating the maximum number of unacknowledged bytes which can be in transit: LastByteWritten, LastByteSent and LastByteAcked.

   (a) Which of the following are valid scenarios if AdvertisedWindow is 1000 bytes and MaxSendBuffer is 2000 bytes? Calculate the value of EffectiveWindow in each valid scenario.

    i. LastByteWritten = 2000, LastByteSent = 3000, LastByteAcked = 4000

    ii. LastByteWritten = 4000, LastByteSent = 3000, LastByteAcked = 2000

    iii. LastByteWritten = 2000, LastByteSent = 2000, LastByteAcked = 2000

    iv. LastByteWritten = 2000, LastByteSent = 2001, LastByteAcked = 2000

    v. LastByteWritten = 4500, LastByteSent = 3000, LastByteAcked = 2000

(b) Which of the above are valid scenarios if AdvertisedWindow is 1000 bytes and MaxSendBuffer is 1500 bytes? Calculate the value of EffectiveWindow in each valid scenario.

(c) In any of the scenarios above which are valid, does the send side TCP block the sending application?

5. Suppose the consecutive SampleRTTs on a connection are observed to be the following sequences of numbers (in seconds). Plot the value of EstimatedRTT using the equation $\text{EstRTT} = \alpha \times \text{EstRTT} + (1 - \alpha) \times \text{SampRTT}$ for $\alpha = 0.9$.

(a) 2, 2, 2, 2, 2, 2

(b) 10, 2, 2, 2, 2, 2

(c) 1, 2, 3, 3, 2, 1