B1. Networks (25 points)

Company X announces a new next generation file transfer application called FTP-NG which runs over UDP, not TCP. Company X claims that not only does FTP-NG provide exactly the same services as the popular FTP application that runs over TCP, but also that FTP-NG on average, transfers files 3 times faster.

a) (5 points) Explain the differences between a protocol and a service.

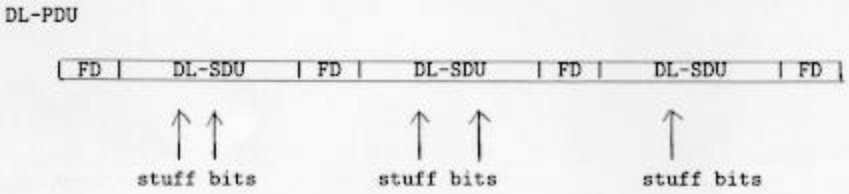
b) (5 points) Describe the most important services a file transfer protocol should provide.

c) (10 points) Describe the *additional* services that FTP-NG must implement that the existing FTP application does not need to consider. (That is, what services does TCP provide for FTP that UDP does not provide for FTP-NG.)

d) (5 points) Analyze and comment on what you'd guess is the most likely reason(s) FTP-NG transfers files faster.

B2. Networks (25 points)

Three related functions that often appear in a Data Link (DL) Layer Protocol are Framing, Concatenation, and Bit Stuffing. To send multiple DL-SDUs (Service Data Units) concatenated together inside a single DL-PDU (Protocol Data Unit), the DL layer (1) specifies a frame delimeter (FD) to put before, between, and after each DL-SDU, and (2) bitstuffs the SDUs so that the FD sequence does not appear within them. (See figure below.)



a) (15 points) Assume the FD is 011110. Specify a transmitter's concatenating/bitstuffing procedure, and the receiver's inverse splitting/unstuffing procedure. (Note: Your specifications must be precise, preferably as finite state machines or clear pseudo code.) In specifying the receiver, take care that any channel noise which damages one DL-SDU should not prevent the receiver from accurately decoding the other DL-SDUs.

b) (5 points) Using your procedure, concatenate and bitstuff the following DL-SDUs into one DL-PDU.

```
SDU 1   101111
SDU 2   011011111111100101
SDU 3   111
```

c) (5 points) Unstuff/split the following received DL-PDU into multiple DL-SDUs.

```
011110111101111001111001110111100111100111110011110
```

B3. Networks (25 points)

The Astronomy Department of the University of Delaware recently set up a 100 Mbps point-to-point link between the earth and the moon. The distance between the earth and the moon is approximately 240,000 miles. Data travels over the link at 186,000 miles per second.

a) (4 points) How long does it take to transmit X Kbytes of data over a Y Mbits/sec link? Give your answer in terms of X and Y. (Note: byte vs. bits in question.)

b) (4 points) What is the minimum round-trip propagation time in seconds? (rounded to the nearest 100 msec.)

c) (6 points) A digital camera on the moon is taking pictures of the earth periodically. Each picture is of 25 Mbyte(Mega-Byte) in size. Suppose we would like to download the most recent picture from the moon. What is the minimum amount of time needed from when the request for the picture goes out from earth to when the picture is received completely? (Assume that both the size of the request and processing time on the moon are negligible.)

d) (7 points) Now we want to retrieve all the pictures. Suppose that pictures are transmitted back to earth as a sequence of frames of size 1 Mb(Mega-bit) each using the Go-Back-N and the Selective-Repeat sliding window protocols. How many bits, at a minimum, should the sequence numbers be for Go-Back-N and Selective-Repeat, respectively to operate properly?

e) (4 points) Assuming no errors in the link, what is the maximum utilization for Go-Back-N and Selective-Repeat protocols, respectively?

B4. Networks (25 points)

Company udel.com currently operates isolated bridged-LANs in six departments, with 100-200 hosts each. You are hired as a system administrator to interconnect the existing departmental networks and connect the resulting corporate network to the Internet via a single IP router. Describe two approaches to IP address assignments and discuss their impact on routing and addressing.