Error Distributions. You are the system designer for a link layer protocol, and are trying to decide on the kind of error protection to provide. Frames are being carried across a telephone circuit, and the measured bit error rate is 10^{-4} (that is, one in 10000 bits is an error on average). The maximum frame size is 576 bytes. Assume that errors occur as random bit errors.

The binomial theorem will help to answer this question:

$$Prob(K) = N!/(K!(N-K)!) \times p^{K} \times (1-p)^{N-K}$$

a) What is the probability that the frame will have no errors? One or fewer errors? Two or fewer errors?

b) Describe how much error detection and error correction capability you require if the residual error rate (which is the rate of frames that have undetected errors) must be less than one frame in 1000 and retransmissions must be used for less than 10% of the frames.

Now assume that you build a system to the specifications you gave in part b), and it performs poorly. Further investigation shows that errors do not occur as random bits, but rather as random bursts (a sequence of bit errors). Bursts of length 1 through 15 are equally likely, and bursts of 16 or more bits are too rare to be observed. To simplify your analysis though, assume that all errors are bursts of exactly 8 bits and all bytes are either error-free or error bursts.

c) As before, what is the probability that the frame will have no errors? One or fewer errors? Two or fewer errors? (Hint: First convert all relevant parameters into what they would correspond to for bytes, not bits.)

d) As before, describe how much error detection and error correction capability you require if the residual error rate (which is the rate of frames that have undetected errors) must be less than one frame in 1000 and retransmissions must be used for less than 10% of the frames.