   This assignment is a bonus assignment which can be substituted for two
quizzes. Only the first 25 submissions before 10pm on April 2nd, 2010 will
be evaluated. The time of submission will be taken from the timestamp in
Moodle where the solution needs to be uploaded. The student will be given an
appointment to meet the instructor and explain his/her solution. **Any evidence
of plagiarism or cheating will result in negative marks being awarded to the
student.**

1. **Go-back-N ARQ simulation:** Suppose we want to calculate the throughput of
   GBN ARQ by simulation. Then we need to calculate the expected value of the time
   taken to communicate a frame X, i.e. we need to calculate $E[X]$. If a frame has n bits,
   the throughput is given by $\frac{n}{E[X]}$. Alternatively, we can calculate the expected value
   of Y which is the time taken to communicate N frames and calculate throughput
   as $\frac{nN}{E[Y]}$. In class (Lecture 17), assuming the probability of ACK error $P_{AE} = 0$ the
   theoretical value of $E[Y]$ was calculated as

   $$E[Y] = NT_f \left[1 + \frac{NP_{FE}}{1 - P_{FE}} \right]$$

   where P_{FE} is the probability of frame error and T_f is the frame transmission duration.
   We had also assumed that the round-trip time was less than NT_f. The implication
   was that by the time the source finishes sending N frames at least the first frame's
   acknowledgement would have come back if the first frame was not corrupted.

   (a) Write a Scilab program to estimate $E[Y]$ using simulation assuming that the
       ACKs are always error free. The window size should be taken to be $N = 2^m - 1$
       where m is the number of bits used to store the sequence number. Compare
       your estimate with the theoretical expression above.

   (b) Modify your program to allow the case when ACKs can be in error. Try to guess
       the theoretical expression for this case.