Problem 7

At the very beginning, all of the bits in the packet must be generated before trasmitsion started. This requires

$\frac{56\cdot 8}{64\times 10^3}$sec=7msec.

The time required to transmit the packet is

$\frac{56\cdot 8}{2\times 10^6}$Sec=$224\mu$sec.

Propagation Delay = 10 msec.

The delay until decoding is
7msec +224μsec + 10msec = 17.224msec

So, the time from a bit is created until the bit is decode is 17.224 msec.

Problem 8

a) When circuit switching is used, 20 users can be supported.
b) $p = 0.1$.
c) $\binom{120}{n} p^n (1-p)^{120-n}$.
d) $1 - \sum_{n=0}^{20} \binom{120}{n} p^n (1-p)^{120-n}$.

We use the central limit theorem to approximate this probability. Let X_j be independent random variables such that $P(X_j = 1) = p$.

$$P(\text{ “21 or more users” }) = 1 - P\left(\sum_{j=1}^{120} X_j \le 21\right)$$

$$P\left(\sum_{j=1}^{120} X_j \le 21\right) = P\left(\frac{\sum_{j=1}^{120} X_j - 12}{\sqrt{120\cdot 0.1\cdot 0.9}} \le \frac{9}{\sqrt{120\cdot 0.1\cdot 0.9}}\right)$$
$$\approx P\left(Z \le \frac{9}{3.286}\right) = P(Z \le 2.74)$$
$$= 0.997$$

when Z is a standard normal r.v. Thus $P(\text{ “21 or more users” }) \approx 0.003$.

Problem 15

Total delay $= \frac{L/R}{1-I} = \frac{L/R}{1-aL/R} = \frac{1/\mu}{1-a/\mu} = \frac{1}{\mu-a}$.