Problem 1 Solution:

a. When circuit switching is used, at most 15 circuit-switched users can be supported. This is because each circuit-switched user must be allocated its 10 Mbps bandwidth, and there is 150 Mbps of link capacity that can be allocated.

b. No. Under circuit switching, the 29 users would each need to be allocated 10 Mbps, for an aggregate of 290 Mbps more than the 150 Mbps of link capacity available.

c. The probability that a given (specific) user is busy transmitting, which we'll denote $p$, is just the fraction of time it is transmitting, i.e., 0.100. The probability that one specific other user is not busy is $(1-p)$, and so the probability that all of the other $N_{ps}-1$ users are not transmitting is $(1-p)^{N_{ps}-1}$. Thus the probability that one specific user is transmitting and the remaining users are not transmitting is $p(1-p)^{N_{ps}-1}$, which has the numerical value of 0.0052334763302736. This user will be transmitting at a rate of 10 Mbps over the 150 Mbps link, using a fraction 0.0667 of the link's capacity when busy.

d. The probability that exactly one (any one) of the $N_{ps}$ users is busy is $N_{ps}p(1-p)^{N_{ps}-1}$, which has the numerical value of 0.15177081357793.

e. The probability that 15 specific users of the total 29 users are transmitting and the other 14 users are idle is $p^{15}(1-p)^{14}$. The numerical value of this probability is $1.774295655841E-08$.

f. The probability that more than 15 users of the total 29 users are transmitting is $\sum_{i=16}^{29} \binom{29}{i} p^i(1-p)^{29-i}$. The numerical value of this probability is $1.88317594851384E-09$. It's important to note that 15 is the maximum number of users that can be supported using circuit switching (the answer to part (a)). With packet switching, nearly twice as many (29) users are supported with a small probability that more than 15 of these packet-switching users are busy at the same time.

Problem 2 Solution:

Link 1 transmission delay = $L/R = 8000$ bits / 100 Mbps = 0.08000 msec.
Link 1 propagation delay = $d/s = 3$ Km / 3*10**8 m/sec = 0.01000 msec.
Link 2 transmission delay = $L/R = 8000$ bits / 10 Mbps = 0.800000 msec.
Link 2 propagation delay = $d/s = 5000$ Km / 3*10**8 m/sec = 16.666667 msec.
Link 3 transmission delay = $L/R = 8000$ bits / 1000 Mbps = 0.008000 msec.
Link 3 propagation delay = $d/s = 2$ Km / 3*10**8 m/sec = 0.006667 msec.

Thus, the total end-to-end delay is the sum of these six delays: 17.499333 msecs.

Problem 3 (Wireshark Intro) Solution:

Answers will vary due to the details of your connection and local area network. See instructor for examples or with questions.

Discussion of Q1. Some of the common protocols that you should see are UDP, TCP, ARP, ICMP, MDNS, and STUN.

Discussion of Q2. By default, the value of the Time column in the packet listing window is the amount of time, in seconds, since Wireshark tracing began. To display the Time field in time-of-day format, select the Wireshark View pull down menu, then select Time Display Format, then select Time-of-day. In one example, the GET was sent at 11.300694 and the reply was received at 11.301658. The delay was thus 0.000964 seconds. If yours varied significantly, try to assess why you think this is so.

Discussion of Q3. The IP address of gaia.cs.umass.edu is 128.119.245.145. The address of your computer will vary.