2. The network is saturated if there are 10 or more people sending. The cumulative probability is obtained by computing the probability that EXACTLY i nodes are transmitting, and then summing them up over all i >= 10.

So \[ \Pr[ \text{exactly i of the n nodes transmit} ] = \binom{n}{i} p^i (1-p)^{n-i} \]

where p = probability that a node transmits

3. Book Questions

1.5
(a) \[ \text{total time} = \text{(handshake)} + \text{(propagation delay)} + \text{(transfer time)} \]
   \[ = (2*100) \text{ms} + (100/2) \text{ms} + (1000*(10^3)*8) \text{bits} / (1000*(10^3) bps) \]
   \[ = 5.583 \text{ sec} \]
(b) The total time will be the same as above, except that we wait for an extra 999 RTTs, while sending the 1000 packets.
   So, \[ \text{total time} = 5.583 + 999*(0.1) = 105.483 \text{ sec} \]
(c) We send 20 pkt s in 1 RTT => 1000 pkt s can be sent in 50 RTTs
   \[ \text{total time} = \text{(handshake)} + 50^*\text{RTT} \]
   \[ = 52^\text{RTT} = 5.2 \text{ sec} \]
(d) \[ \text{num pkt s sent at k th RTT} = \binom{2^n}{k-1} \]
   So, \[ \text{num RTTs required for 1000 pkt s} = \text{ceil}(\log_2(1000+1)) = 10 \text{ RTTs} \]
   \[ \text{total time} = \text{(handshake)} + 10^*\text{RTT} \]
   \[ = 12^\text{RTT} = 1.2 \text{ sec} \]

Note: The answer for (c) and (d) may be different depending on the way in which the propagation delay is considered.

1.6
(a) \[ \text{total time} = \text{(handshake)} + \text{(propagation delay)} + \text{(transfer time)} \]
   \[ = (2*80) \text{ms} + (80/2) \text{ms} + (1500*(10^3)*8) \text{bits} / (10 * (10^6) bps) \]
   \[ = 1.4 sec \]
(b) The total time will be the same as above, except that we wait for an extra 1499 RTTs, while sending the 1500 packets.
   So, \[ \text{total time} = 1.4 + 1499*(0.08) = 121.32 \text{ sec} \]
(c) We send 20 pkt s in 1 RTT => 1500 pkt s can be sent in 75 RTTs
   \[ \text{total time} = \text{(handshake)} + 75^*\text{RTT} \]
   \[ = 77^\text{RTT} = 6.16 \text{ sec} \]
(d) \[ \text{num pkt s sent at k th RTT} = \binom{2^n}{k-1} \]
   So, \[ \text{num RTTs required for 1500 pkt s} = \text{ceil}(\log_2(1500+1)) = 11 \text{ RTTs} \]
   \[ \text{total time} = \text{(handshake)} + 11^*\text{RTT} \]
   \[ = 13^\text{RTT} = 1.04 \text{ sec} \]

1.7
\[ \text{Propagation delay} = \frac{2 \times (10^3) \text{km}}{2 \times (10^8) \text{km/sec}} = 10 \text{ microseconds} \]
\[ \text{100 byte packets} \quad 10^6 = \frac{(100^8 \text{ bits} / (8 \text{ bps})}{8 \text{ bps}} \quad \Rightarrow 8 \times (10^9) \text{bps} = 80 \text{ Mbps} \]
\[ \text{512 byte packets} \quad 10^6 = \frac{(512^8 \text{ bits} / (8 \text{ bps})}{8 \text{ bps}} \quad \Rightarrow 8 \times (10^9) \text{bps} = 409.6 \text{ Mbps} \]

1.13
\[ \text{Width of a bit} = \frac{1 \text{ bit}}{(19^*9 \text{ bps})} = 10^{-9} \text{ sec} \]
\[ \text{Length of a bit} = 2.3 \times (10^8) \text{ mysec} \times 2 \text{ ns} = 0.23 \text{ m} \]

1.16
To find the new checksum:
Complement the old checksum, subtract 1 or 256 (depending on lower or higher order byte decrement)
Complement the result!

Or equivalently, take the old checksum, and add 1 or 256. This gives the new checksum :)

Note: All calculations are performed using the given bps and RTTs. The results are approximations and may differ depending on the specific implementation of the network and the propagation delay considered.