

3. What will the bit pattern look like after *bit-stuffing*, as discussed in class, has been done? (15 pts.)

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4. Briefly characterize asynchronous transmission. (10 pts.)

5. In the following figure, frames generated by *Node A* are sent to *Node C* through *Node B*. Determine the minimum transmission rate required between *Nodes B* and *C* so that the buffers of *Node B* are not flooded, based on the following: (20 pts.)
- a) The data rate between *A* and *B* is 2 Mbps.
 - b) The propagation delay is 4 $\mu\text{sec}/\text{km}$ for both lines.
 - c) There are full duplex lines between the nodes.
 - d) All data frames are 4000 bits long; ACK frames are separate frames of negligible length.
 - e) Between *A* and *B*, a sliding window protocol with window size of 7 is used.
 - f) Between *B* and *C*, stop-and-wait protocol is used.
 - g) There are no errors.

Hint: In order to not to flood the buffers of *B*, the average number of frames entering and leaving node *B* must be the same over a long interval.



6. Echo check is commonly used as a human-to-machine type error checking scheme. It is simple and straight forward, but sometimes it can be deceptive. Give an example. (10 pts.)

7. A message is received as 111000110101 and the common divisor is 110101. Is the message received correctly? Show work to support your answer. (15 pts.)