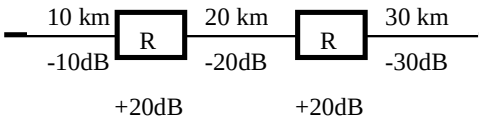
YOUR LASTNAME and NAME : _____

CmpE 475 Computer Networks, Fall 2002, Dr. M. Ufuk Çağlayan
Midterm 1, October 31, 2002, 200/1000 points (Individual points are shown in paranthesis)

1. **(50 total)** A 60km long fiber optic cable assembly consists of three segments, of lengths 10, 20 and 30km respectively, joined by two repeaters. Repeaters have 20dB gain and cable has 1dB/km attenuation.
   (i) What is the overall attenuation/gain of the cable assembly **(20)** ?
   (ii) What is the the S/N ratio of the outgoing signal at one end of cable assembly when a signal with 40 dB S/N is injected from the other end of cable assembly, (a) if cable assembly is perfect, i.e. doesnot add any additional noise **(15)**, (b) if repeaters add 3dB and cables add 0.1dB/km noise **(15)** ?



(i) **–10 +20+20+20-30 = -20dB (Attenuation)**

(ii) **(a) Since Cable is perfect, S/N won't change – i.e. 40dB in, 40dB out.**
(b) +3dB +3dB + 10*0.1 dB + 20*0.1dB + 30*0.1dB = 12dB
repeaters **cable**

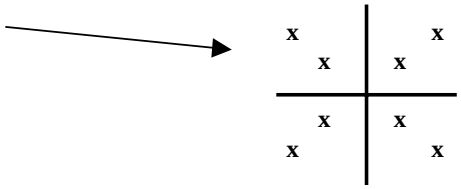
40dB – 12dB = 28dB S/N

2. **(30 total) i.** Compute the output rate of a codec that is converting a 20Khz bandwidth analog signal to an 16 bit digital signal (by using Nyquist theorem) **(15)**. **ii.** What is the required signal to noise ratio to put an E1 carrier (2048 Kbps) on a transmission line with 50 KHz bandwidth? (just write the necessary expression) **(15)**

(i) **40 K samples/sec * 16 bit /sample = 640 Kbps**
(ii) **S/N is found from 50,000 $\log_2(1 + S/N) = 2048*10^3$**

3. **(30 total) i.** Explain the difference in baud and bps (bits per second) rates of a modem by giving an example on how a QAM modem encodes digital data. **(15) ii.** What is the main idea behind Manchester encoding ? **(15) (Answers on the back of this page !)**

(i) **There are 8 signal level changes, therefore each baud corresponds to 3bps**



(ii) **Manchester encoding is self clocking. Long sequences of 1s and 0s do not harm digital synchronization when Manchester encoding is used.**

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4. (30 total) i. Bit error rate (BER) of a physical communication channel is the probability p of a single bit being corrupted while bits are being transmitted. Write an expression to compute the probability of a packet of n bits of information containing an error (one or more errors) **(15).**

$P(error) = 1 - (1 - p)^n$

Mathematically show that, if generator polynomial G(x) contains two or more terms, all single bit errors will be detected in CRC method **(15)**.

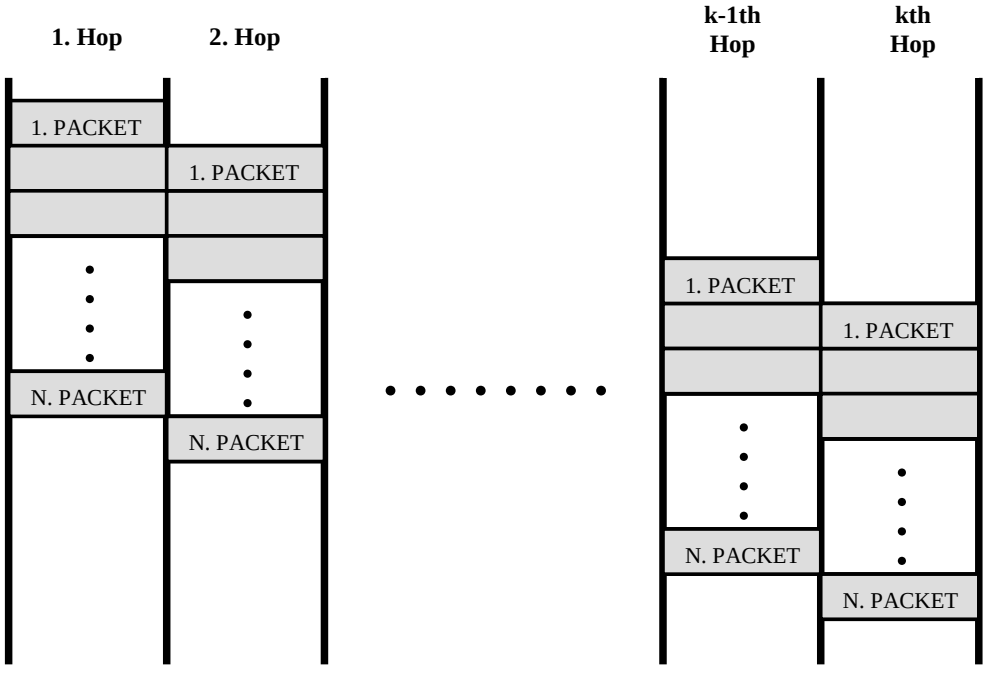
T(x) : transmitted bit string
T(x) + E(x): received bit string with error in it.
$E(x) = x^i$ (assuming it's a single bit error)

Receiver looks at (E(x) + T(x)) / G(x)
We know that G(x) divides T(x). If G(x) has two terms (i.e. x^i +1) then there is always going to be a reminder in the division E(x)/G(x) therefore the error will always be detected.

5. (30) If the current GSM/GPRS networks were to support **ad hoc networking only**, what type of changes will you foresee in the hand-held mobile devices and the GSM/GPRS network itself?

Ad hoc networks do not have a fixed layout. (no fixed base stations as in the case of GSM networks) Therefore client devices should somehow have relaying, routing capability. Also channel allocation problem must be solved.

6. (30 total) x bits of user data are to be transmitted over a k-hop path in a packet switched network as a series of packets, each with p data bits and h header bits. Assume x is much larger than p+h. The speed of lines is b bps and propogation delay is ignored. Write an expression to compute the total delay **(Answer on the back of the page)**



As you see in the figure above, total delay can be compute as follows:

$Delay_{total}$ = Delay due to packet#1 performing k hops + Delay due to (N-1) packets performing 1 hop

Or alternatively,

$Delay_{total}$ = Delay due to packet#1 performing k-1 hops + Delay due to N packets performing 1 hop

Where N is the total number of packets to be transmitted. (Both methods lead to the same answer)

I will use the second interpretation in this solution.

Number of packets = x / p
Time to transmit 1 packet = (p+h) / b

So,
$Delay_{total}$ = Delay due to packet#1 performing k-1 hops + Delay due to N packets performing 1 hop

$Delay_{total} = (p+h)/b * (k-1) + (p+h)/b * (x/p)$

7. (+5 for those who read the book carefully) What is the major contribution of Bob Metcalfe?

Bob Metclafe is the inventor of Ethernet.

8. (+5 for those who read the book carefully) What is the DIX standard?

DEC+Intel+Xerox standard which became IEEE 802.3 later