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Homework 5

Problem 1: Let Q = probability of one message failing. Let P(n) be the probability of the nth message succeeding. Then

$P(n) = (1 - Q) Q^{(n - 1)}$

Let N be the number of messages that must be transmitted in order to get one good message. The expected value of N is:

$E(N) = \Sigma\, n\, P(n) = \Sigma\, n\, (1 - Q) Q^{(n - 1)} = (1 - Q) \Sigma\, n\, Q^{(n - 1)}$

$E(N) = (1 - Q) / (1 - Q)^2 = 1 / (1 - Q)$

Since $Q = (1 - 0.8^{10}) = 0.8926258$, then $E(N) = 9.31$ …

Therefore, **10 transmissions** must be sent in order to expect that, on the average, one good transmission will occur.

Another way to obtain the same result *in this case* (since Q constant for every message):

$n P' \geq 1$ where P' represents the probability of one message succeeding.

Since the transmissions are all independent,

$n \geq 1 / P' = 1 / 0.8^{10} = 9.31$ → **10 transmissions** must be sent.

Problem 5:

The original string:

011110111110111110

The new string with stuffed bits & locations shown clearly:

01111011111 0 011111 0 10

The new string actually transmitted:

01111011111001111010

Continued on next page …

Problem 15:

M(x) is represented by 10011101

G(x) is represented by 1001

Append 4 zeros to M(x) → x^4 M(x) = 100111010000

Divide G(x) into x^4 M(x) → 100111010000 / 1001 = 100011001 with R(x) = 0001

Now subtract x^4 M(x) – R(x) = **100111010001 = T(x) .. the Transmit string.**

During transmission, the 3rd bit from left is inverted → 101111010001

On receipt, this string is divided by G(x):

101111010001 / 1001 = 101010001 with R(x) = 1000

Since the remainder is nonzero, we have detected a transmission error.

Problem 32:

#bits = 1.544 (10^6) bit s^{-1} (1 / ((2/3) (2.998) (10^{10}) cm s^{-1})) (100 km) (10^2 cm/10^{-3} km)

#bits = 772.515 → **772 bits**