TCOM 370

February 18, 1997 **Exam 1** **1 Hr. 10 Mins.**

One Summary Sheet Allowed

Equal Points for all Problems

Problem 1

(a) List the seven layers of the ISO-defined open systems interconnection protocol architecture.

(b) Identify the layers at which the following would be used:
(i) error-correcting codes; (ii) frame sequence numbers

Problem 2

The V.32*bis* modem standard is for transmission at 14.4 Kbps over a telephone channel with bandwidth of approximately 3 KHz. Why is this not in violation of Nyquist's signaling rate criterion? State any numerical parameters you know for this modem standard.

Problem 3

Shannon's formula for the ultimate capacity of a transmission link with bandwidth W is $C = W \log_2 \left(1+\frac{S}{N}\right)$ bps, where $\frac{S}{N}$ is the ratio of signal power to noise power at the receiver input.

(a) What is the minimum signal-to-noise ratio *in decibels* required at the receiver to allow in principle a bandwidth efficiency of 10, that is a data rate of 10 bps for each Hz of bandwidth?

(b) Do you know of any practical scheme that achieves approximately this efficiency?

Problem 4

In an ethernet LAN, frames of bits are sent at a bit-rate of 10 Mbps. The baseband line encoding scheme used is differential Manchester.

(a) What is the approximate bandwidth for this baseband scheme?

(b) Suppose the baseband differential Manchester encoded waveform is used to amplitude modulate (multiply) a sinusoidal carrier of frequency 50MHz. What is the approximate range of frequencies that are present in the resulting signal?

Problem 5

Seven bit ASCII characters are transmitted asynchronously using 1 start bit, 1 parity bit, and 1 stop bit. The transmitter always clocks bits out at a fixed rate (say 1 Kbps). The receiver is able to locate the start-bit center almost perfectly, but the receiver clock period may be off by as much as 2.5% relative to the transmit clock period. Assuming that a bit is received correctly if sampled in the middle half of its duration, determine if characters will be received correctly in this system.

Problem 6

Consider the following (5,2) linear block code. For each binary message $[d_1, d_0]$ the corresponding codeword is $[d_1, d_0, p_2, p_1, p_0]$. The appended bits are computed as:

$p_2 = d_1 + d_0$, $p_1 = d_1$, $p_0 = d_0$ ("+" is a modulo-2 sum)

(a) Write down all the codewords for this code, and determine the minimum Hamming distance d_{min} for this code.

(b) How many errors in a codeword is it guaranteed to correct?

(c) The bit error probability on the link used to transmit the codewords is $p_e = 10^{-3}$. Find the maximum probability of error in decoding a 2-bit message using this code.