EE450: Computer Networks, Fall 2009
Homework #3, Solutions (100 points)

Problems #1, Answer: (7 points)

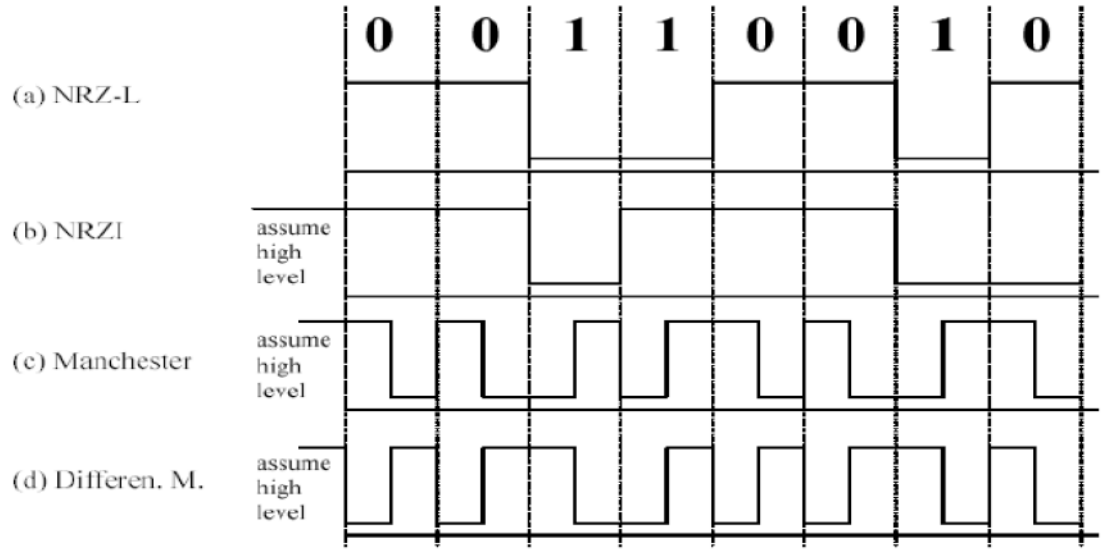
$C = W \log_2 (1 + S/N)$
C = capacity of channel
B = bandwidth in Hz
S/N = Signal to noise ratio
C/B = 3000/1000 = 3
$2^{C/B} = 2^3 = 8 = (1 + S/N)$
S/N = 7
[It's Ok if the students provide the SNR in dB as their final answer].

Problems #2, Answer: (7 points)

$C = W \log_2 (1 + S/N)$
S/N dB = 5 dB = 10 log (S/N) = > S/N = 3.162
$C = 500 \log_2 (1 + 3.162) = 1028.7$ bps

Problems #3, Answer: (20 points, 5 points each)

[It doesn't matter if the students start from low or high, both are correct].



Problems #4, Answer: (15 points, 5 points each)

Bit rate = signaling (or baud) rate * bits per baud. Solving for baud rate we get:
a) 36000/2 = 18000 Bd
b) 8000/5 = 1600 Bd
c) 3000/3 = 1000 Bd

Problems #5, Answer: (15 points, 5 points each)

Just like problem 4, with the only difference that it is the bit rate that we need to find. Hence:
a) 1000 * 5= 5000 bps
b) 2000 * 1 = 2000 bps
c) 5000 * 1 = 5000 bps

Problems #6, Answer: (8 points)

Bit rate, R_b = (8000)(8) = 64 kbps. $R_b = 2W\log_2 M$ or $64000 = 2(5000)\log_2 M$, hence, $\log_2 M = 6.4$. Since M must be a power of 2, the minimum value of M is 128 (i.e. Every symbol carries at least 7 bits.)

Problems #7, Answer: (8 points)

Synchronous TDM carrier supporting 30 voice channels of bandwidth 4000 Hz each with 8000 samples/sec to be quantized into 6 bits/sample:
30 x 8000 samples/sec x 6 bits/sample = 1.44 Mbps is the required min. bit rate.
It's Ok if the students include the synchronization overhead].

Problems #8, Answer: (20 points)

T1 line : 1.544 Mbps, and 1% is used for synchronization purposes, remaining is 1.544 Mbps x 0.99 = 1,528,560 bps (2 points). Thus:

(a) N = 1,528,560 bps/110 bps = 13,896 (2 points).
(b) N = 1,528,560 bps/300 bps = 5,095 (2 points).
(c) N = 1,528,560 bps/1200 bps = 1,273 (2 points).
(d) N = 1,528,560 bps/9600 bps = 159 (2 points).
(e) N = 1,528,560 bps/64 Kbps = 23 (2 points).

[In the following part it's ok if the students provide a numerical answer instead of just the qualitative argument.]
If the sources are operational 10% of the time, then, we can connect 10 times more of those devices to the T1 line (4 points). If we are further required to have only 80% utilization of the link, then we can increase the number of devices to 8 times more, rather than 10 times. (4 points)