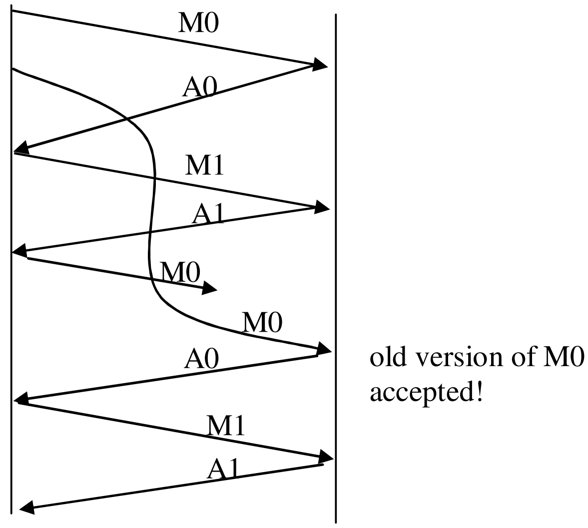
EE3009 Tutorial 10 (Solution)

Problem 1



Problem 2

(Note: It is much more important to understand the concept than to memorize the following explanations.)

- We want to avoid having the leading edge of the receiver's window (i.e., the one with the "highest" sequence number) wrap around in the sequence number space and overlap with the trailing edge (the one with the "lowest" sequence number in the sender's window).
- That is, the sequence number space must be large enough to fit the entire receiver window and the entire sender window without this overlap condition.
- Suppose that the lowest-sequence number that the receiver is waiting for is packet m. In this case, its window is $[m, m+w-1]$ and it has received (and ACKed) packet m-1 and the w-1 packets before that, where w is the size of the window.
- If none of those w ACKs have been yet received by the sender, then ACK messages with values of $[m-w, m-1]$ may still be propagating back. If no ACKs with these ACK numbers have been received by the sender, then the sender's window would be $[m-w, m-1]$.
- Thus, the lower edge of the sender's window is m-w, and the leading edge of the receiver window is $m+w-1$. In order for the leading edge of the receiver's window to not overlap with the trailing edge of the sender's window, the sequence number space must thus be big enough to accommodate $2w$ sequence numbers.
- That is, the sequence number space must be at least twice as large as the window size, $k \geq 2w$.

Problem 3

The rightmost column and bottom row are for parity bits.

1 0 1 0 0
1 0 1 0 0
1 0 1 0 0
1 0 1 1 1
0 0 0 1 1

Problem 4

Probability that the receiver makes a decoding error
= Probability that any two bits are in error + Probability that all three bits are in error

$$= 3(1-10^{-3})(10^{-3})^2 + (10^{-3})^3 = 2.997\times10^{-6} + 10^{-9} = 2.998\times10^{-6}$$

Problem 5

Received codeword: `1001010`
$s_1 = 1 + 0 + 0 + 0 = 1$
$s_2 = 0 + 0 + 1 + 0 = 1$
$s_3 = 1 + 0 + 1 + 0 = 0$
$S = 011_2 = 3$
Flip the bit in the 3-rd position, we obtain `1011010`.
The data bits are 1010.