L15

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Other properties / def'n of linear codes.

* Recall that $\vec{x} = G \cdot \vec{m}$

  We say a linear code is "systematic" if G has the form $G = \begin{bmatrix} I_k \\ P_{(n-k)\times k} \end{bmatrix}$.

* The first k bits of a systematic code is called the <u>systematic bits</u>

* The remaining $(n-k)$ bits are called the <u>parity bits</u>

* One can easily "read" the message bit values by examining the values of the systematic bits

* A <u>non-systematic</u> code does not have this feature

* A <u>non-systematic</u> code can be converted to a systematic code by column operations (Gaussian elimination)

* Such conversion does not change the codebook (the set of all codewords)

* The FER remains the same after this conversion

* The ber may change though.

Generating one code from another.

* A code is usually denoted by an (n, k) code where the generator matrix is G: n by k

* Puncturing (a code): $(n, k) \longrightarrow (n-1, k)$

* Extending: $(n, k) \longrightarrow (n+1, k)$

* Expurgating: $(n, k) \longrightarrow (n, k-1)$

* Augmenting: $(n, k) \longrightarrow (n, k+1)$

* Shortening: $(n, k) \longrightarrow (n-1, k-1)$

  (puncturing + expurgating)

* lengthening: $(n, k) \longrightarrow (n+1, k+1)$

(Extending + Augmenting)

Puncturing: $\vec{C}_m = G\vec{m}$. and then simply discard one position. (puncture)

We usually discard a parity bit/position but not always.

Extending $\vec{C}_m^{NEW} = \begin{bmatrix} \vec{C}_m^{old} \\ \\ b^{new} \end{bmatrix}$

where $b^{new} = G^{extension} \cdot \vec{m}$

Expurgate: Usually done by hardwiring one message bit to zero. (thus $k \to k-1$)

Augment: Expand G from $n \times k$ to $n \times (k+1)$ by adding a new column.

Shortening: Usually done by hardwiring

Shortening: Usually done by hardwiring one message bit and discard the
(expurgate) (puncture)
corresponding systematic bit.