PROPERTIES OF CONVOLUTIONAL CODES

↳ Distance property of convolution codes

↳ Systematic & Non-systematic

↳ Performance bounds of convolution codes

↳ Coding gain

↳ Catastrophic error propagation

* Distance properties of convolution codes

↳ It is a free distance or minimum Hamming distance btw any two codes sequence

↳ It is used to determine its ability to correct errors

↳ It is expressed as $d_{min} = \min_{c_i, c_j \in C, c_i \neq c_j}$

ex: Consider two code words

$c_1 = 11101$, $c_2 = 11010$

The Hamming distance these codewords is

d_{min} = Hamming dist (c_1, c_2)

$d_{min} = 3$

Systematic & Non-Systematic Codes

↳ In systematic, code structure has systematic form

↳ In systematic, message bits & parity bits are arranged such that they can be identified

↳ In systematic, generation & Detection is simple & this is suitable for random errors

↳ Syndrome decoding is used in systematic code eg: Hamming code, Cyclic codes

Non-Systematic

↳ In non-systematic, code structure has non-systematic

↳ In non-systematic it is difficult to arrange message bits & parity bit

↳ Generation & Detection is difficult & it is suitable for burst errors

↳ Viterbi decoding is used in non-systematic code. eg: Cyclic code & Convolution co

Performance Bounds of Convolutional Codes

the Probability of bit error P_B, for a binary convolution codes as follows

$$P_B \leq \left. \frac{d\,T(D,N)}{dN} \right|_{N=1,\, D = 2\sqrt{p(1-p)}}$$

where p is the prob of channel symbol error

we know that $T(D,N)$ is obtained from $T(D,L,N)$ when $L=1$

$$T(D,N) = T(D,L,N)$$

$$\text{So, } P_B \leq \frac{\{2[p(1-p)]^{1/2}\}^5}{\{1-4[p(1-p)]^{1/2}\}^2}$$

Coding gain

It is a measure of improvement in performance achieved by using error correcting codes

↳ It is defined as the difference in SNR btw uncoded system and coded system required to achieve a certain error rate

i.e.,

$$G = \left(10 \log_{10} \frac{1}{BER_{coded}}\right)$$

Catastrophic Error Propagation

↳ It is defined as an event whereby finite no. of code symbol error causes an infinite no. of decoded data bit error

↳ Catastrophic error can occur if and only if, any closed loop path in the diagram has zero weight.