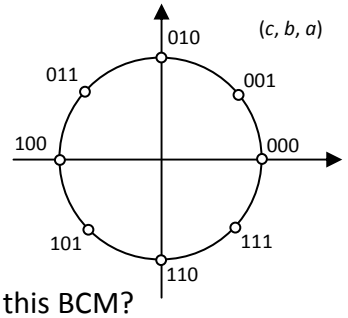
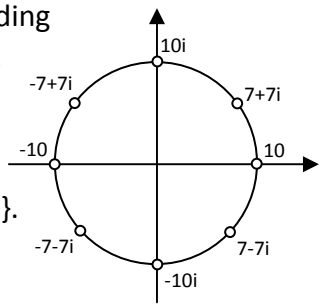
2007 Advanced Coding Theorem HW#4 Due date :2007.06.20

1. Consider a block-coded modulation using 8PSK signals as shown in the figure, where each signal is labeled by (c, b, a). The block length is 16. Suppose that each (a_1, a_2,…,a_{16}) is in the (16, 1, 16) binary code and each (b_1, b_2,…,b_{16}) is in the (16, 11, 4) binary code, and each (c_1, c_2,…,c_{16}) is in the (16, 15, 2) binary code.



   (a) What is the minimum squared Euclidean distance of this BCM?
   (b) What is the coding rate (the number of information bits carried by each 8PSK signal)?

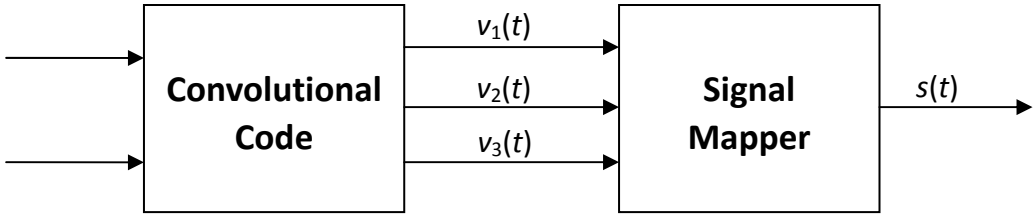
2. Consider BCM using 8PSK for the interleaved flat Rayleigh fading channel. The transmitted signal constellation is shown in the figure. The component codes C_a, C_b, C_c are (4, 1, 4), (4, 3, 2), (4, 4, 1) codes respectively. Assume the CSIs are {0.5, 1, 2, 1} and the received signals are {2+4i, -8i, -18-2i, 12}. Do the multistage decoding.



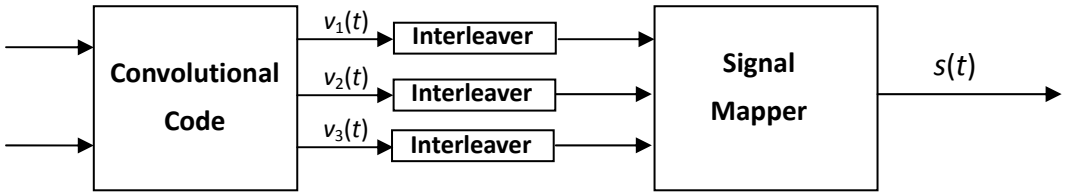
3. Consider BCM-1: $C_a = C_b = C_c$ = (8, 7, 2) code and
   BCM-2: C_a = (8, 4, 4), $C_b = C_c$ = (8, 7, 2) code, all use 8PSK.
   (a) For Ungerboeck's set partition labeling, what are the values of MSD and MPD for both BCM?
   (b) Change the signal labeling for both BCM individually to improve the error performance. Explain why the improvement can be obtained?

4. Consider (A) the TCM (B) the BICM which are indicated below. Let $\underline{v}$={…,v(0), v(1),…} and $\underline{v}'$={…,v'(0), v'(1),…} be two distinct code sequence of C and $v(i)$, $v'(i)$ are represented by (a, b, c) where a denotes the bit of the 1st level, b denotes the bit of the 2nd level, c denotes the bit of the 3rd level. Assume that Ungerboeck's set partitioning is used. Let $\underline{s}$ and $\underline{s}'$ be the signal sequences corresponding to $\underline{v}$ and $\underline{v}'$ respectively. Let $v(t+i)$ = (000) for all i, $v'(t+i)$ = (000) for $i < 0$ and $i > 2$, $v'(t)$ = (101), $v'(t+1)$ = (111), $v'(t+2)$ = (011). All use 8PSK.
   (a) What's the SED between $s(t)$ and $s'(t)$ for (A) and (B)?
   (b) What's the symbol distance and product distance between $s(t)$ and $s'(t)$ for (A) and (B) over Rayleigh fading channels? (infinite symbol interleaving is assumed)

(A)


Convolutional Code
$v_1(t)$
$v_2(t)$
$v_3(t)$
Signal Mapper
$s(t)$

(B)


Convolutional Code
$v_1(t)$
$v_2(t)$
$v_3(t)$
Interleaver
Interleaver
Interleaver
Signal Mapper
$s(t)$