1. **The cooperative capacity of a multiple access channel.** (Figure 1)

![Multiple access channel with cooperating senders.](image)

(a) Suppose $X_1$ and $X_2$ have access to both indices $W_1 \in \{1, 2^{nR_1}\}, W_2 \in \{1, 2^{nR_2}\}$. Thus the codewords $X_1(W_1, W_2), X_2(W_1, W_2)$ depend on both indices. Find the capacity region.

(b) Evaluate this region for the binary erasure multiple access channel $Y = X_1 + X_2, X_i \in \{0, 1\}$. Compare to the non-cooperative region.

2. **Gaussian multiple access.**

A group of $m$ users, each with power $P$, is using a Gaussian multiple-access channel at capacity, so that

$$\sum_{i=1}^{m} R_i = C \left( \frac{mP}{N} \right),$$  \hspace{1cm} (1)

where $C(x) = \frac{1}{2} \log(1 + x)$ and $N$ is the receiver noise power. A new user of power $P_0$ wishes to join in.

(a) At what rate can he send without disturbing the other users?

(b) What should his power $P_0$ be so that the new users’ rate is equal to the combined communication rate $C(mP/N)$ of all the other users?