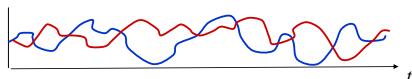


EE359 – Lecture 12 Outline

- **Announcements**
 - Midterm announcements
 - No HW next week (practice MTs)
- Maximal Ratio Combining
- MGF Approach to MRC Performance
- Equal Gain Combining
- Transmit Diversity
- Midterm Review

Review of Last Lecture

- Introduction to Diversity
 - Send same bits over independent fading paths
 - Time, space, frequency, or polarization diversity
 - Combine paths to mitigate fading effects



- Performance metrics: Array and Diversity gain
- Structure of a Diversity Combiner
- Combining Techniques
- Selection Combining and its Performance

EGC and Transmit Diversity

- EGQ simpler than MRC
 - Harder to analyze
 - Performance about 1 dB worse than MRC
- Transmit diversity
 - With channel knowledge, similar to receiver diversity, same array/diversity gain
 - Without channel knowledge, can obtain diversity gain through Alamouti scheme: works over 2 consecutive symbols

Midterm Announcements

- Midterm Thur Nov. 10, 6-8pm, Room 200-030
 - Open book/notes (bring textbook/calculators)
 - Covers Chapters 1-7
- Review session Mon Nov. 6, 7-9pm. Hewlett 103
- Extra OHs:
 - Me: 11/7 11-12pm, 11/9 12-1pm, 11/10 11-12pm and by appt.
 - Nima: 11/8 6-9pm, 11/9 2-3pm, 11/10 2-3pm
- No HW next week
- Midterms from past 3 MTs posted this week
 - 10 bonus points for “taking” a practice exam
 - Solns for all exams given when you turn in practice exam

MRC and its Performance

- With MRC, $\gamma_{\Sigma} = \Sigma \gamma_i$ for branch SNRs γ_i
 - Optimal technique to maximize output SNR
 - Yields 20-40 dB performance gains
 - Distribution of γ_{Σ} hard to obtain
 - Standard average BER calculation
- $$\bar{P}_b = \int P_b(\gamma_{\Sigma}) p(\gamma_{\Sigma}) d\gamma_{\Sigma} = \int \dots \int P_b(\gamma_1) p(\gamma_1) \dots p(\gamma_M) d\gamma_1 d\gamma_2 \dots d\gamma_M$$
- Hard to obtain in closed form
 - Integral often diverges

- MGF Approach
- $$\bar{P}_b = \frac{1}{\pi} \int_0^{\pi} \prod_{i=1}^M \mathcal{M}_i \left[\frac{-g}{\sin^2 \varphi}; \gamma_i \right] d\varphi$$

Main Points

- MRC optimally combines fading paths to maximize combiner SNR
 - MRC vs SC trade off complexity for performance.
 - MRC yields 20-40 dB gain, SC around 20 dB.
- Analysis of MRC simplified using MGF approach
- EGC easier to implement than MRC: hard to analyze: Performance about 1 dB worse than MRC
- Transmit diversity can obtain diversity gain even without channel information at transmitter.

Midterm Review

- Overview of Wireless Systems
- Signal Propagation and Channel Models
- Modulation and Performance Metrics
- Impact of Channel on Performance
- Fundamental Capacity Limits
- Diversity Techniques