

## Homework Help - Problem Set 7 Solutions

**[MAC Design]** MAC Design is covered in Lectures 14-16 extensively, with indications on some lecture pages of HWH. Problem Set 7 starts with a  $2 \times 2$  two-user channel in Problem 5.16. Initially the design is a MAC for this channel. This first channel requires the ability to convert the channel correctly to frequency domain from time-domain, run it through normal water-filling for a single-user highest possible data rate, and then compare with best MAC and see the consequent loss.

Specifically, Lecture 15 has a page marked HWH7 - on these pages are commands that students may want to review and understand, but which also help address the MAC Design. The idea here is to see that when both transmitter and receiver can be optimized, this is highest data rate. Nonetheless, with only receiver coordination, that is the MAC, the data rate comes close on this channel with the GDFE (implemented by the `mu_mac` program. The student should exit this problem starting to feel good that they could design a good MAC if given the channel in time or frequency domain.

The input for Problem 5.16 is fixed initially, but the last portions of the problem encourage the student to investigate maximum rate sum.

**[MAC Input Design]** More mature MAC Design addresses the MAC's input optimization for a given data rate and/or energy vector. Problem 5.17 cascades upon Problem 5.16's channel to investigate channel input design.

The `minPMAC` and `admMAC` programs are helpful. The student should be looking at Lecture 14's (roughly slides 14-20) `SWF` and `macmax` programs to gain example guidance on how to work Problem 5.17.

**[BC Design]** BC Design is covered in Lectures 16-17 extensively, with indications on some lecture pages of HWH. Problem 5.18 follows 5.16 with the same channel and a fixed equal-energy/dimension input, focusing on design using the `mu_bc` program.

Lecture 16 at the end (slides 28-31) provide an example of how to proceed that is very useful for Problem 5.18 and more generally as well.

**[BC Input Design]** More mature BC Design addresses the BC's input optimization for a given data rate and/or energy vector. Problem 5.19 cascades upon Problems 5.16-18's using MAC input optimization with duality and the `mac2bc` program to find an optimum BC design for the same channel.

Lecture 17 slides 13-15 are marked HWH7 and have useful command series that the student should understand and then potentially use for Problem 5.19. Upon completion of this problem, the student should feel reasonably comfortable in an ability to design either a MAC or BC well for any given data rate and energy constraints.

[IC] See the last half of Lecture 17.