Do the following problems:

1. Problem 10.1 in C&T. Justify the steps leading to (10.142), (10.143), and (10.144). Justify (10.143) in part by showing the more general result, that for any function $f(a,b)$,

$$\min_a \max_b f(a,b) \geq \max_b \min_a f(a,b).$$

2. Problem 10.3 in C&T.

3. Problem 10.4 in C&T.

4. **Enough Bandwidth:** Let $C_\infty$ denote the capacity of an infinite bandwidth power-limited additive white Gaussian noise channel. Find the bandwidth $W_{95}$ such that the bandwidth constraint reduces the capacity to $0.95 C_\infty$. The *spectral efficiency* of a bandlimited channel is the rate in bits per second per hertz. Numerically, find the spectral efficiency of a system using the above bandwidth?

Discuss whether high or low spectral efficiency is reasonable from the perspective of a communication system designer.

5. Consider a set of $N$ independent, discrete-time white Gaussian noise channels that can be used in parallel. The noise variance for the $n$th channel is given by $\sigma_n^2 = n^2$ for each $n$. The input signal is constrained by the condition $\sum_{i=1}^N P_i/n \leq 6$, where $P_i$ represents the power used on the $n$th channel.

   a. For $N=2$, what is the capacity of the set of parallel channels. (*Hint: if you set this up correctly, you should not have to do any complicated calculations.*)

   b. Redo part (a) for $N = \infty$. 