1. Suppose a stationary, autoregressive Gaussian source with mean zero and autocorrelation coefficient $\rho = .9$ must be fixed-rate encoded with rate $R=4$ with an encoder that can use at most 1000 ops/sample. Estimate the largest SNR that can be obtained with

(a) Optimal unstructured VQ
(b) Two-stage VQ, where each stage uses unstructured quantization with the same dimension.
(c) Tree-structured VQ.

In each of the above parts, you will need to make as good an estimate as you can, based on the theory and results presented in class and the notes. You will need to choose the dimensions of the quantizers. You may use high-resolution approximations.

(d) Suppose we use two-stage VQ, where each stage uses tree-structured VQ with the same dimension. What is the largest possible dimension we could use? How does it compare to the dimensions you found in (a), (b), (c)? (You need not find the SNR in this case.)