ECE 242
Gibson

Nov. 1, 2005

Mid-Term Exam

Instructions: Open book, notes, homework. Do all problems. Problems are weighted as shown. Do your own work. Due at 10am on Nov. 3rd.

(30) 1.) For an input source X, we wish to design a scalar quantizer to minimize the mean absolute error (MAE) criterion, $E[|X-Y|]$, where Y is the reconstructed value.

(a) Find the necessary conditions for optimality for an N-level quantizer and compare to the MSE conditions from class.

(b) Let X have the Laplacian pdf as on p. 20 of the text. Find the optimum quantizers for $N=2$ and $N=4$

(c) If X is uniformly distributed over $\left[\frac{-V}{2}, \frac{V}{2}\right]$ for the optimum quantizer for $N \geq 2$.

---

(15) 2.) In class, we presented the MMSE scalar quantizers for unit variance inputs. Show that if $\sigma^2 > 1$, we simply scale the quantizer step points and output levels by σ.

---

(30) 3.) In class, we set up the optimum entropy-constrained scalar quantization problem for a MSE distortion measure and presented the necessary conditions. Derive the necessary conditions for an N-level quantizer.

---

(25) 4.) Given the A-law companding characteristic in Eq. (5.5.4) on p. 159 with $A = 87.6$,

(a) Find the SNR for small signals,

(b) Find the SNR for large signals,

(c) Compare to the SNR for a uniform quantizer.

(d) What is the companding gain?
