Signal Compression (ECE 242) **April 7, 2011**
Gibson

Homework No. 2

Due on April 14th

1. Use Eqs. (9.27) and (9.28) to verify the step points and output levels for the 4 level Gaussian quantizer in Table 9.6 of Sayood.

2. Do Problem 1 on page 270 of Sayood.

3. An exact closed form expression for the rate distortion function of a memoryless Gaussian source with zero mean and unit variance subject to the absolute value of the error fidelity criterion cannot be found. However, a lower bound can be developed. Plot the lower bound given by

$$R_L(D) = \frac{1}{2}\log\frac{\pi\sigma^2}{2eD^2}, \text{ for } 0 \le D \le \sqrt{\frac{\pi\sigma^2}{2e}}$$

4. Message $m_1(t)$ is sampled 8000 times/sec to yield the values 8, 291, 504, 172, -12, -210, -525, and -268. Message $m_2(t)$ is similarly sampled to produce 28, 127, 300, 492, 299, 131, 54, and 6. Encode these samples using the table on the next page and time-division multiplex the two sequences.

5. The 10 sample values taken from a zero mean, variance 4 Gaussian distribution given by -2, -1.45, -0.2, +0.15, +0.24, +0.68, +2.2, +2.9, +3.6, +3.9, +4.95 are to be quantized using a 16-level MMSE Gaussian quantizer and encoded using a folded binary code. What are the resulting binary sequence and output amplitudes?

6. The uniform and nonuniform quantization tables in Chapter 9 of Sayood are for unit variance inputs. Show that if $\sigma^2 > 1$ then we simply scale the quantizer step points and output levels by σ.

TABLE 9.6.1 Quantizer Characteristic and Code Assignment for D2, D3, and D4 Channel Bank Codecs[a]

Input Amplitude Range:	Step Size:	Polarity Bit:	Quantization Segment Code:	Quantizer Step Code:	Output Value:
0–1	1	1	111	1111	0
1–3				1110	2
3–5	2	1	111	1101	4
⋮				⋮	⋮
29–31				0000	30
31–35				1111	33
⋮	4	1	110	⋮	⋮
91–95				0000	93
95–103				1111	99
⋮	8	1	101	⋮	⋮
215–223				0000	219
223–239				1111	231
⋮	16	1	100	⋮	⋮
463–479				0000	471
479–511				1111	495
⋮	32	1	011	⋮	⋮
959–991				0000	975
991–1055				1111	1023
⋮	64	1	010	⋮	⋮
1951–2015				0000	1983
2015–2143				1111	2079
⋮	128	1	001	⋮	⋮
3935–4063				0000	3999
4063–4319				1111	4191
⋮	256	1	000	⋮	⋮
7903–8159				0000	8031

[a] Positive inputs only; assumed symmetric about zero.

From J. D. Gibson, *Principles of Digital and Analog Communications*, 1993.