

3.5-1 A compact disc (CD) records audio signals digitally using a binary code. Assume that the audio signal bandwidth is 15 kHz.

(a) What is the Nyquist rate?

If maximum frequency to be sampled is 15kHz, then Nyquist rate is twice that at 30kHz

(b) If the Nyquist samples are quantized into $L = 65536$ levels and then binary coded, what number of binary digits is required to encode a sample.

16 bits are required (2^{16})

(c) Determine the number of binary digits/s (bits/s) required to encode the audio signal.

16 bits to record in one sample, 30 thousand samples per second

$$16 \text{ bits} * 30,000 \frac{\text{samples}}{\text{second}} = 480,000 \frac{\text{bits}}{\text{s}}$$

(d) For practical reasons discussed in the text, signals are sampled at a rate well above the Nyquist rate. Practical CDs use 44100 samples/s. If $L = 65536$, determine the number of pulses/s required to encode the signal.

$$16 \text{ bits} * 44,100 \frac{\text{samples}}{\text{second}} = 705,600 \frac{\text{pulses}}{\text{s}}$$