

ECEN5533 Exam #1 30 September 2010

1) A noise free signal $x(t)$ is input into an N level uniform mid-rise quantizer. The signal $x(t)$ is known to have a voltage PDF $f_X(x) = 1 - |x|$; $-1 \leq x \leq +1$ volt.

[25] Determine the minimum number of steps N required to insure the quantizer output SNR is ≥ 99 dB, subject to the constraint N must be an even number. [Answer: 126,040]

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2) A satellite receiver system consists of a 3.0 meter diameter parabolic antenna with an efficiency $\eta = 0.55$ that feeds a 90 dB, 95 degrees Kelvin LNA. The antenna temperature is 59 degrees Kelvin. The LNA output feeds a coaxial cable with a loss of 9.5 dB. The cable feeds a receiver amplifier with a noise bandwidth of 72 MHz, a noise temperature of 3500 degrees Kelvin, and power gain of 19 dB.

This system receives a signal from a satellite that has an EIRP = 37.3 dBW, a carrier center frequency of 900 MHz, other losses of 2.6 dB, and is 27,700 miles away.

[5] **Compute** the gain of the 3.0 meter parabolic antenna. [26.43 dB]

[10] **Compute** the received power P_r out of the antenna. [-123.4 dBW]

[10] **Compute** the SNR at the receiver output. [2.980]

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3) A 2nd order low pass Butterworth filter has the transfer function $H(f) = 1/(1 + j0.707f + 0.25f^2)$. A signal with power spectral density $G_X(f) = 10/(4 + f^2)$ is present at the input.

[25] **Compute** the D.C. power available at the output. [0 watts]

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4) A 1.6 watt signal $r(t) = m(t)\cos(2\pi 32000t)$ is input to a receiver where it is multiplied by a sinusoid $s(t) = \cos(2\pi 32000t)$, yielding a signal $y(t) = r(t)s(t)$. $y(t)$ is then input to an ideal low pass filter with an Absolute Bandwidth of 40 KHz and a D.C. voltage gain of 1, yielding $yf(t)$. The absolute bandwidth of $m(t)$ is known to be ≤ 8 KHz.

[10] **Compute** the power of $y(t)$. [1.2 watts]

[15] **Compute** the power of $yf(t)$. [0.8 watts]