signals and systems

Gate2021-ec-Q52

EE23BTECH11014- Devarakonda Guna vaishnavi

Question:

A message signal having peak-to-peak value of 2 V, root mean square value of 0.1 V, and bandwidth of 5 kHz is sampled and fed to a pulse code modulation (PCM) system that uses a uniform quantizer. The PCM output is transmitted over a channel that can support a maximum transmission rate of 50 kbps. Assuming that the quantization error is uniformly distributed, calculate the maximum signal-to-quantization noise ratio (rounded off to two decimal places).
solution:

Term	Description	Formula	Value
Peak-to-Peak	Peak-to-peak value of the message signal (in volts).	$\sqrt{2} \times \text{RMS}$	1.414 V
RMS	Root mean square value of the message signal (in volts).	$\frac{2}{2\sqrt{2}}$	0.707 V
Bandwidth	Bandwidth of the message signal (in kilohertz).	-	-
N	Number of bits per sample used in quantization.	-	5
Quantization range	Range of values in which the quantized signal falls (in volts).	$2 \times \text{Peak-to-Peak}$	2.828 V
Step size	The size of each quantization interval (in volts).	$\frac{\text{Quantization range}}{2^N}$	-
Sampling rate	Rate at which the message signal is sampled (in kilohertz).	-	10 kHz
Maximum transmission rate	Maximum transmission rate supported by the channel (in kilobits per second).	-	50 kbps

TABLE I
INPUT PARAMETERS

Calculate SQNR(Signal-to-quantization noise ratio):

$$\text{SQNR} = 6.02 \times N + 1.76 \tag{1}$$

$$\implies \text{SQNR} = 31.86 \tag{2}$$