Thapar Institute of Engineering & Technology, Patiala

Department of Electronics and Communication Engineering

UEC639 – Digital Communication

B. E. (Third Year): Semester-V (ENC)

Solution Tutorial-2

$ \begin{array}{c} \textbf{Q1} & If a continuous signal with highest frequency component 15 kHz is sampled and transmitted using PCM system at a transmission rate of 144 Kbps (Data Rate = R_b = 144 kbps) then determine the values of sampling rate fs, the quantizing level L, and the binary digits. $		Solution Tutorial-2
$f_S \geq 2 \ f_m = 2*15 \ kHz = 30 \ kHz$ $n \ f_S \leq R_b = 144*10^3$ $n \leq \frac{R_b}{f_S} \leq \frac{144*10^3}{30*10^3} \leq 4.8$ Hence, number of bits = n = 4	Q1	using PCM system at a transmission rate of 144 Kbps (Data Rate = R_b = 144 kbps) then
$n f_S \leq R_b = 144*10^3$ $n \leq \frac{R_b}{f_S} \leq \frac{144*10^3}{30*10^3} \leq 4.8$ Hence, number of bits = n = 4 Finally, the sampling rate for this combination will be $f_S = \frac{R_b}{n} = 144*\frac{10^3}{4} = 36 kbps$ In a binary PCM system, the output signal to quantization noise ration is required to be held to a minimum value of 40 dB. Determine the value of quantization level and mean square value of quantization error. Sol. In a binary PCM system, $L = 2^n$, where n is the number of binary digits. $ \frac{\left(\frac{S}{N_q}\right)_{odb}}{\left(\frac{S}{N_q}\right)_{odb}} = 1.76 + 20 \log 2^n = 1.76 + 6.02n \mathrm{dB} $ Now $ \frac{\left(\frac{S}{N_q}\right)_{odb}}{\left(\frac{S}{N_q}\right)_{odb}} = 40 \mathrm{dB} - \left(\frac{S}{N_q}\right)_o = 10000 $ $ (\mathrm{SNR})_o = \left(\frac{S}{N_q}\right)_o = \frac{3}{2}L^2 $ $ L = \sqrt{\frac{2}{3}\left(\frac{S}{N_q}\right)_o} = \sqrt{\frac{2}{3}(10000)} = [81.6] = 82 $ and the number of binary digits n is $ n = \lceil \log_2 82 \rceil = [6.36] = 7 $ Then the number of levels required is $L = 2^7 = 128$, and the corresponding output signal-to-quantizing-noise ratio is	Sol	
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