SCS2205 Computer Networks
Assignment - Introductory Part

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Question 1

a. To avoid aliasing, Sampling rate $S \geq 2f_{max}$. Here, f_{max} is the maximum frequency of the signal.

   Here. f_{max} is 5MHz ($5 * 10^6$ Hz) and quantized to 12 bits/sample, Let's find data rate for that value,

   Bit rate = samples per second X bits per sample

   Bit rate = 2f * 12

   Bit rate = $2 * 5 * 10^6 * 12$ bps

   Bit rate = 120 Mbps

   So, the minimum data rate is 120Mbps.The reason it's called minimum data is because in order to lower the data rate, we have to lower the sampling rate (samples per second) since bits [er sample is same. But we can't lower Sample rate because $2f_{max}$ is the minimum required sampling rate to avoid aliasing. Hence 120 Mbps is the minimum data rate.

b. It cannot be done

$20dB = 10 \times \log_{10}(S/N)$

$2 = \log_{10}(SNR)$

$SNR = 10^2$

$\text{Maximum bit rate} = W\log_2(1 + SNR)$

$= 5 * 10^6 \log_2(1 + 100)$

$= 5 * 10^6 * 6.658$

$= 33.26 * 10^6$ bits/second

bit rate = samples/second * bits/sample

$33.26 * 10^6 = 10 * 10^6 *$ bits/sample

so, maximum bits per sample is around 3.326, but this signal has 12 bits per sample. So, this signal cannot be sent over this channel.

Question 2

a)

$30\ dB = 10 \log_{10}(SNR)$

$3 = \log_{10}(SNR)_{\text{Linear}}$

$(SNR) = 10^3 = 1000$

$\text{Maximum bit rate} = W * \log_2(1 + SNR)$

$= 1 * 10^6 \log_2(1 + 1000)$

$= 1 * 10^6 \log_2(1001)$

$= 1 * 10^6 * 9.96$

$= 0.996 * 10^7$

≈ 10 Mbps

Since,

bits per sec = bits per sample * samples per sec

$1 * 10^6 =$ bits per sample $* 80 * 10^3$

bits per sample $= 1 * 10^6 / 80 * 10^3$

$= 125$

b) $S \geq 2f_{max}$

$S \geq 2 * 1 * 10^6$

$S \geq 2 * 10^6$ Hz

Since,

bits per sec = bits per sample * samples per sec

$1 * 10^7$ = bits per sample $*2 * 10^6$

bits per sample = $1 * 10^7 / 2 * 10^6$

= 5

Allowed number of quantization levels is 2^5. There are 2^{125} quantization levels in this signal. It will interfere with the channel noise. We can only quantify at 5 bits per sample to minimize interference from noise and correctly decode signal from the receiver

Question 3

i. Allocated slots for channels may be empty. That's why static channel access method does not ensure efficiency in this case.

ii. Deterministic access method
Probabilistic access method

c. Probabilistic access method

Because in this method, collisions are not avoided beforehand and only detected and acted accordingly as they occur.
Collisions happen very often under heavy traffic, and because in each collision transmitter has to resend or hold off; it's going to perform worse.

d. Probabilistic access method

Collisions are minimum because traffic is low. So transmitter would have to resend less frequently and don't have to wait for permission. If deterministic method is used, transmitter must wait for permission. This time is wasted. So probabilistic method performs better for low traffic.