2.3.3.

We want to send a ~~256kbps~~ 256kbps flow on a 20kHz noiseless digital channel. How many signal levels are needed?

$C = 2B \log_2 L \Rightarrow$ ~~[illegible]~~ $L = \lceil 2^{\frac{C}{2B}} \rceil = \lceil 2^{\frac{256 \cdot 10^3}{20 \cdot 10^3}} \rceil = \lceil 2^{6.4} \rceil = \lceil 84.45 \rceil = 85$

(taking 1kbps = 1000 bps)

2.3.5.

We want to send video signal with 480×500 px, with 32-value pixels, at 30fps

a) Compute the needed transmission rate.

b) Is it possible to use a 4.5MHz channel with 35dB SNR? If not, what changes to the signal coding can be done to fix this?

a) 32 values $\Rightarrow \log_2 32$ bits/px $= 5$ b/px

$480 \cdot 500 \frac{\text{px}}{\text{frame}} \cdot \frac{\text{frame}}{\text{img}} = 240 \cdot 10^3 \frac{\text{px}}{\text{img}}$

$R = 5 \frac{\text{b}}{\text{px}} \cdot 240 \cdot 10^3 \frac{\text{px}}{\text{img}} \cdot 30 \frac{\text{img}}{\text{s}} = 36 \cdot 10^6 \text{ b/s} = 36 \text{ Mbps} = 34.33 \text{ Mibps}$

b) $R_{channel} \leq B \cdot \log_2(1 + \frac{S}{N}) = 4.5 \text{ MHz} \cdot \log_2(1 + 10^{3.5}) = 52.32 \text{ Mbps}$

Yes, it's possible.

2.3.6.

TV channels are 6 MHz wide. Asuming a noiseless channels, how many bits per second can we send with four-level digital signals?

$R = 2B \log_2 L = 2 \cdot 6 \text{MHz} \cdot \log_2 4 =$ ~~[illegible]~~ 24 Mbps

2.3.7.

We want to use a 4kHz channel to transmit 100kbps. What is the minimum SNR?

$R = B \log_2(1 + \frac{S}{N}) \leq B \log_2(1 + 10^{\frac{SNR_{dB}}{10}}) \Rightarrow 1 + 10^{\frac{SNR_{dB}}{10}} \geq 2^{\frac{R}{B}} \Rightarrow SNR_{dB} \geq 10 \log_{10}(2^{\frac{R}{B}} - 1) = 75.26 \text{ dB}$