1. (简答题) A word consists of letters A, B, C, and D. For each transmitted letter, use binary pulse encoding, with 00 replacing A, 01 replacing B, 10 replacing C, and 11 replacing D. Each pulse width is 5ms.
(1) When different letters appear equally, calculate the average information rate transmitted;
(2) If the probability of each letter appearing is P_A= 1/4, P_B=1/5, P_C=1/4, P_D=3/10, calculate the average information transfer rate.

(1) $\because P(A)=P(B)=P(C)=P(D)=\frac{1}{4}$

$\therefore H=-\frac{1}{4}lb\frac{1}{4}-\frac{1}{4}lb\frac{1}{4}-\frac{1}{4}lb\frac{1}{4}-\frac{1}{4}lb\frac{1}{4}$

$=-lb\frac{1}{4}=2$ bit /word.

(2) $\because P(A)=\frac{1}{4}, P(B)=\frac{1}{5}, P(C)=\frac{1}{4}, P(D)=\frac{3}{10}$

$\therefore H=-\frac{1}{4}lb\frac{1}{4}-\frac{1}{5}lb\frac{1}{5}-\frac{1}{4}lb\frac{1}{4}-\frac{3}{10}lb\frac{3}{10}$

$=-\frac{1}{2}lb\frac{1}{4}-\frac{1}{5}lb\frac{1}{5}-\frac{3}{10}lb\frac{3}{10}$

≈ 1.99 bit /word.

2. (简答题) The black and white TV image contains $3X10^5$ pixels per frame, with 16 equally probable brightness levels per pixel. Require 30 frames of image to be transmitted per second. If the channel output signal-noise ratio is 30 dB, calculate the minimum bandwidth required for transmitting the black and white TV image.

$\because C=V=3\times10^5\times16\times30=1.44\times10^8$.

$B=\frac{C}{\log_2(1+\frac{S}{N})}=\frac{1.44\times10^8}{30}=4.8\times10^6$ Hz.

6. (简答题) Assuming a channel bandwidth of 3kHz and a signal-noise ratio of 20dB. if a binary signal is transmitted, what is the maximum transer rate?

$\because SNR=\frac{S}{N}=10\lg\frac{P_S}{P_N}=20$.

$\therefore \frac{P_S}{P_N}=10^2=100$.

$\therefore C=V_{max}=2B\cdot lb(1+\frac{S}{N})=2\times3\times10^4\times lb(1+100)\approx4\times10^5$ Hz

Analogue signal is a continuous signal that smoothly over time. digital signal expresses variation in response to a set of discrete value.

Addition interference is a busy intersection where multiple roads converge, multiplicative interference is a highway with multiple lanes, each lane represent a different signal path

$$P_b = \frac{\bar{I}_e}{\bar{I}} = \frac{1}{25000} \approx 0.00004$$