ICE 3261 Assignment-2
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1. What is Nyquist capacity for a signal with a frequency bandwidth of 1KHz, using Binary Phase Shift Keying (BPSK) modulation.

Ans: First BPSK is the binary form of PSK, where each signaling symbol can take on one of two values (i.e a phase shift of either 0 radians mapped to a logical "0", or π radians mapped to a logical '1'), therefore

$M=2$, So, $C = (2 * 1KHz) \log_2(2)$

$= 2000$

$= 2$ Kbps

(2) What is the Shannon-Hartly theoretical capacity for a signal with a frequency bandwidth of 1KHz and a SNR = 200 ?

Ans: We know, $C = B\log_2(1+SNR)$ | $B = 1KHz$, $SNR = 200$

$= 1\times10^3 \log_2(1+200)$

$= 1\times10^3 \times 7.651$

$= 7651$ bps

$= 7.6$ Kbps Ans

(3) Find the Capasity of the ordinary voice grade telephone line whose bandwidth is 31000Hz. And SNR = 30dB.

Given, $SNR_{db} = 10\log_{10} SNR$

$30 = 10\log_{10} SNR$

$3 = \log_{10} SNR$

$antilog(3) = SNR$

$\therefore SNR = 1000$

$\therefore C = B\log_2(1+SNR)$

$= 31\times10^3 \log_2(1+1000)$

$\cancel{= 308984 \text{ bps}}$

$\cancel{= 308 \text{ kbps}}$

$= 31\times10^3 \times 9.97$

$= 309$ kbps

(4) If the bandwidth of a noisy channel is 4 KHz, and the signal to noise ratio is 100, then the maximum bit rate will be what?

Given, $B = 4\ KHz = 4 \times 10^3\ Hz$

$SNR = 100$

We know, $C = B \log_2 (1 + SNR)$

$= 4 \times 10^3 \log_2 (1 + 100)$

$= 4 \times 10^3 \times 6.66$

$= 26\ kbps$ Ans.

(5) Television channels are 12 MHz wide. How many bits/sec can be sent if 8-level digital signals are used? Assume a noiseless channel.

Ans: Given, $B = 12\ MHz$

$L = 8$

We know, for noiseless channel

$C = 2B \log_2 L$

$= 2 \times 12 \times 10^6 \log_2 8$

$= 2 \times 12 \times 10^6 \times 3$

$= 72\ Mbps$ Ans

⑥ What is signal-to-noise ratio in order to put a T1 carrier on a 150-KHz line? The data rate of T1 is 1·544 Mbps.

Ans: Given, Date rate, $C = 1{\cdot}544\,Mbps$.

Bandwidth, $B = 150\,KHz$.

$$C = B \log_2 (1+SNR)$$

$$\frac{C}{B} = \log_2 (1+SNR)$$

$$1+SNR = 2^{\frac{C}{B}}$$

$$SNR = 2^{\frac{C}{B}} - 1$$

$$= 2^{\frac{1{\cdot}544\times10^6}{150\times10^3}} - 1$$

$$= 2^{10{\cdot}2933} - 1$$

$\therefore SNR = 1253{\cdot}87$ Ans

⑦ Calculate the maximum bit rate for a channel having bandwidth 5400 Hz & SNR 20 dB

Ans Given, $SNR_{dB} = 10 \log_{10} (SNR)$

$$20 = 10 \log_{10} SNR$$

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

$$SNR = 10^2 = 100$$

We know, $C = B \log_2 (1+SNR)$

$$= 5400 \log_2 (1+100)$$

$$= 35954.34$$

$$= 36 \text{ kbps}$$ Ans

⑧ Given, a bandwidth of a telephone transmission facility 3 kHz, and a normal SNR of 56 dB. Calculate maximum channel capacity of the telephone line

Given, $SNR_{dB} = 10 \log_{10} SNR$

$$56 = 10 \log_{10} SNR$$

$$\frac{56}{10} = \log_{10} SNR$$

$$\therefore SNR = 10^{\frac{56}{10}}$$

$$= 398107.1706$$

$\therefore C = B \log (1+SNR)$

$$= 3\times10^3 \log_2 (1+398107.1706)$$

$$= 55 \text{ kbps}$$

(9) Given, an intended capacity 20 Mbps, the bandwidth of channel is 3 MHz, what is the signal to noise ratio required to achieve this capacity?

Ans. $C = 20$ Mbps, $B = 3$ MHz.

We know, $C = B \log_2 (1+SNR)$.

$$\frac{C}{B} = \log_2 (1+SNR).$$

$$\therefore 1+SNR = 2^{\frac{C}{B}}$$

$$SNR = 2^{\frac{C}{B}} - 1$$

$$= 100.6 \quad \text{Ans.}$$

(10) Assume we wish to transmit a 56 kbps data stream using a spread spectrum. Find the channel ~~band~~ bandwidth required when $SNR = 0.1, 0.01, 0.001$

We know, $C = B \log_2 (1+SNR)$

$C = 56$ Kbps

$SNR = 0.1$

$$B = \frac{C}{\log_2 (1+SNR)}$$

$$= 407 \text{ KHz} \quad \text{Ans}$$

$C = 56$ kbps

$SNR = 0.01$

$$B = \frac{C}{\log_2 (1+SNR)}$$

$$= \frac{56 \times 10^3}{\log_2 (1+0.01)}$$

$$= 3.9 \text{ MHz}$$

$$\approx 4 \text{ MHz} \quad \text{Ans}$$

$C = 56$ kbps

$SNR = 0.001$

$$B = \frac{C}{\log_2 (1+SNR)}$$

$$= \frac{56 \times 10^3}{\log_2 (1+0.001)}$$

$$= 38.8 \text{ MHz}$$

Ans.