10/11/19 Q. If a periodic signal is decomposed into five

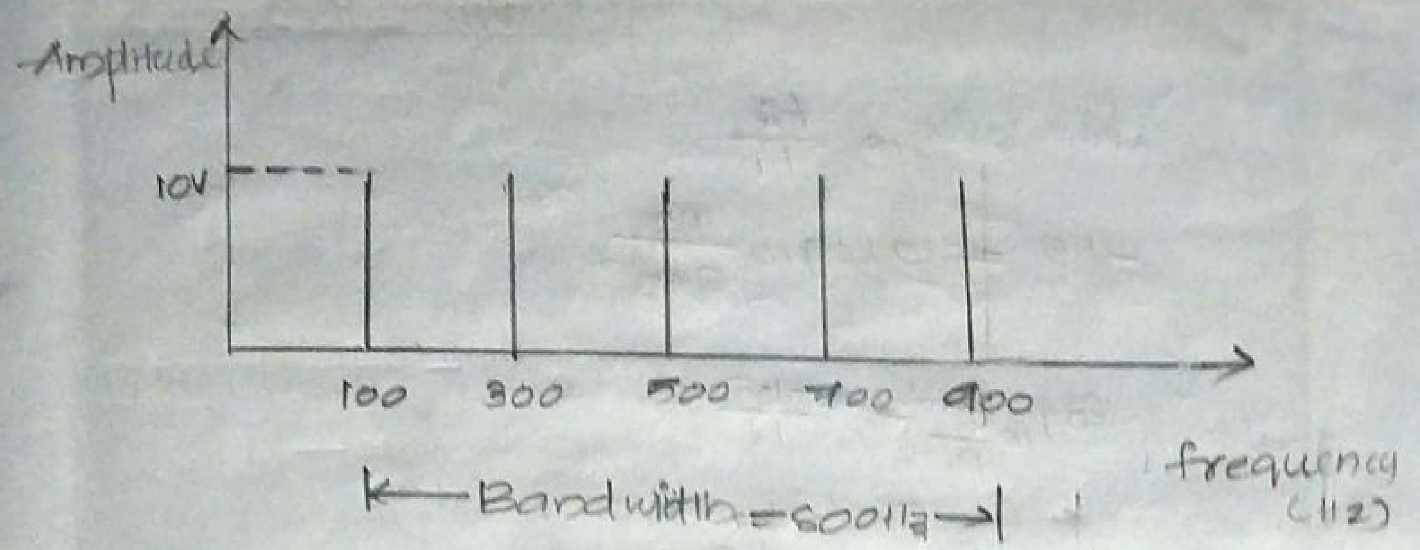
(1) sine waves with frequencies of 100, 300, 500, 700, and 900 Hz, what is its bandwidth? Draw the spectrum, assuming all components have a maximum ~~at~~ amplitude of 10V.

Bandwidth = highest frequency − lowest frequency

$= 900 - 100$

$= \underline{\underline{800 \text{ Hz}}}$

Amplitude = 10V



Q. A signal travels through an amplifier, and its power
(2) is increased 10 times.

$$dB = 10 \log_{10} \frac{P_2}{P_1}$$

$$P_2 = 10 \times P_1$$

$$10 \log_{10} = \frac{\log 10}{\log 10} = 1$$

$$dB = 10 \log_{10} \frac{10 \times P_1}{P_1}$$

$$= 10 \log_{10} 10$$

$$= 10 dB$$

Q. The loss in a cable is usually defined in decibels per
(3) km (dB/km). If the signal at the beginning of a cable with -0.3 dB/km has a power of 2 mW, what is the signal at 5km?

Beginning

loss in a cable $= -0.3$ dB/km

power $= 2$ mW

At 5km

loss in a cable $= 5 \times -0.3 = -1.5$ dB/km

$\boxed{\text{Antilog}_b(x) = b^x}$

$$dB = 10 \log_{10} \frac{P_2}{P_1}$$

$$-1.5 = 10 \log_{10} \frac{P_2}{2\times10^{-3}}$$

$$\log_{10} \frac{P_2}{P_1} = \frac{-1.5}{10}$$

$$\log_{10} \frac{P_2}{2\times10^{-3}} = \frac{-1.5}{10} = -.15$$

$$\frac{P_2}{2\times10^{-3}} = \text{antilog}_{10}(-.15)$$

$$\frac{P_2}{2\times10^{-3}} = 10^{-(.15)}$$

$$= .7079$$

$$P_2 = .7079 \times 2\times10^{-3}$$

$$= 1.415 \times 10^{-3}\,W$$

$$= \underline{\underline{1.415\,mW}}$$

(4) ? The power of a signal is 10 mW and the power of the noise is 1 μW; what are the values of SNR & SNR_{dB}?

$$1\,mW = 1000\,\mu W$$

$$SNR = \frac{\text{average signal power}}{\text{average noise power}}$$

$$= \frac{10\times1000}{1} = \underline{\underline{10{,}000}}$$

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

$= 10\log_{10} 10{,}000$

$= \frac{\log 10000}{\log 10} \times 10$

$= 4 \times 10$

$= \underline{40}$

? Consider a noiseless channel with a bandwidth of
(5) 3000 Hz transmitting a signal with 2 signal levels. The maximum bit rate can be calculated as.

$\text{Bit rate} = 2 \times \text{bandwidth} \times \log_2 L$

$= 2 \times 3000 \times \log_2 2$ $\qquad \frac{\log 2}{\log 2} = 1$

$= \underline{6000}$ ~~Hz~~ bits per second

? We can calculate the theoretical highest bit rate of a regular telephone line. A ~~8~~ telephone line normally
(6) has a bandwidth of 3000Hz (300-3300 Hz) assigned for data communications. The signal-to-noise ratio is usually 3162. For this channel the capacity is calculated as

$\text{Capacity} = \text{bandwidth} \times \log 2(1+SNR)$

$SNR = 3162$
$\text{bandwidth} = 3000$

$\text{Capacity} = 3000 \times \log 2\,(3163)$

$= \underline{34881.23}$ bps

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19/08/19

? If a TV picture is to be transmitted over a 45 MHz channel with a 35dB SNR. Find the capacity of the Channel?

~~Capacity = bandwidth * $\log_2(1+SNR)$~~

~~$= 45\times10^6 * \log_2(1+35)$~~

~~$= 232.64\times10^6$ bps~~

$B = 45\times10^6$ Hz

$SNR_{dB} = 35$

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

~~$SNR = \text{antilog}_{10}(35)$~~

~~$SNR = \frac{SNR_{dB}}{10\log_{10}}$~~

$SNR = \text{antilog}_{10}(35/10)$

$= 10^{3.5}$

$= 3162.28$

Capacity = bandwidth $\times \log_2(1+SNR)$

$= 45\times10^6 * \log_2(1+3162.28)$

$= 45\times10^6 * 11.627$

$= 52.322\times10^6$ bps

$= 52.322$ Mbps

Scanned by CamScanner

? A telephone line with a bandwidth 100kHz is
(8) known to have a attenuation of 20dB.
The i/p signal power is .5W & o/p noise level
is 2.5μW. Calculate the o/p SNR.

$$dB = 10\log_{10}\frac{P_2}{P_1}$$

$B = 100$ KHz

$P_1 = .5W$

~~dB = 2.5μW~~

$dB = -20dB$

$$-20 = 10\log_{10}\frac{P_2}{.5}$$

$$\frac{P_2}{.5} = \text{antilog}_{10}(-2)$$

$$= 10^{-2}$$

$$P_2 = .01 \times .5$$

$$= \underline{5\times10^{-3}} \; W$$

$$SNR = \frac{\text{average signal power}}{\text{average noise power}}$$

$$= \frac{5\times10^{-3}}{2.5\times10^{-6}} = \underline{\underline{2000}}$$

? What is the channel capacity for a telephone
(9) channel with a 3000Hz band width & a SNR of
6dB.

Capacity = bandwidth × log2 (1+SNR)

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

$$SNR = \text{antilog}_{10}(6/10)$$

$$= 10^{(.6)} = \underline{3.98}$$

$$Capacity = 3000 \times \log_2(1+3.98)$$
$$= 6948.43\ W$$
$$= 6.948 \times 10^{-3}\ bps$$
$$= 6.948\ \mu bps$$

? What is the channel capacity for a teleprinter

(10) channel with 300 Hz bandwidth and a SNR of 3 dB.

Bandwidth = 300 Hz

$SNR_{dB} = 3$

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

$SNR = antilog_{10}(.3)$

$= 10^{-3}$

$= 1.995$

$$Capacity = 300 \times \log_2(1+1.995)$$
$$= 474.76\ bps$$

? A digital signaling system is required to

(11) operate 9600 bps. If a signal elt encode a 4 bit / 8 bit words. What is the minimum required Bandwidth of the channel?

· Bit Rate / Capacity = 9600 bps

$\log_2 L = 4 / 8$

Bit rate $= 2 \times bandwidth \times \log_2 L$

4 bit word ($\log_2 L = 4$)

$$\text{Bandwidth} = \frac{\text{Bitrate}}{2 \times \log_2 L}$$

$$= \frac{9600}{2 \times \cancel{\log}4} = \underline{\underline{1200}}\ Hz$$

8 bit word ($\log_2 L = 8$)

$$\text{Bandwith} = \frac{9600}{2 \times 8} = \underline{\underline{600}}\ Hz$$

Minimum required bandwidth of the channel is 600 Hz. (8 bit word).