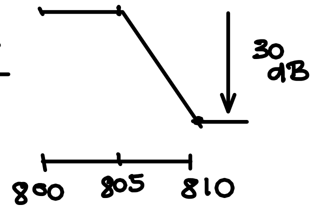
ELEX 3525 Assignment 2 Solutions

Q1.



When is the response -10dB?

$$H(f) = \begin{cases} 0 \text{ dB} & 800 < f < 805 \\ Y_0 + \frac{\Delta Y}{\Delta X}(X - X_0) \Rightarrow 0 + \frac{-30}{5}(f - 805) & \end{cases}$$

- solve for f when $H(f) = -10 = -6(f - 805)$

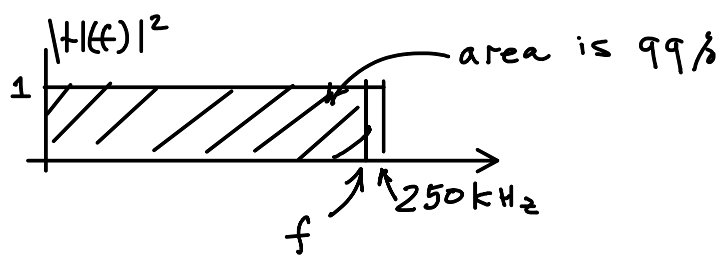
$$f = \frac{10}{6} + 805 = 806\tfrac{2}{3} \text{ MHz}$$

- since the response is symmetrical it will also ~~be~~ -10dB at $800 - 6.7$ MHz.
- the -10 dB bandwidth is thus $2 \times \left(5 + \frac{10}{6}\right)$

$$= 10 + \frac{20}{6} \approx \underline{\underline{13.3 \text{ MHz}}}$$

- This is a <u>bandpass</u> channel

Q.2



shaded area $= f \cdot 1 = 0.99 \cdot 250 \cdot 1$

$$f = 0.99 \cdot 250 = \underline{\underline{247.5 \text{ kHz}}}$$

Q.3

$f = 1$ MHz $\qquad \theta = 35^\circ \qquad VF = 0.66 \qquad d = ?$

$$\theta = 360 f \tau = 360 \cdot f \cdot \frac{d}{VF \cdot c}$$

$$d = \frac{\theta}{360} \cdot \underbrace{\frac{VF \cdot c}{f}}_{\lambda} = \frac{35}{360} \cdot \frac{0.66 \cdot 3 \times 10^8}{1 \times 10^6} = \frac{35}{360} \cdot 200 = \underline{\underline{19.4 \text{ m}}}$$

wavelength is 200m

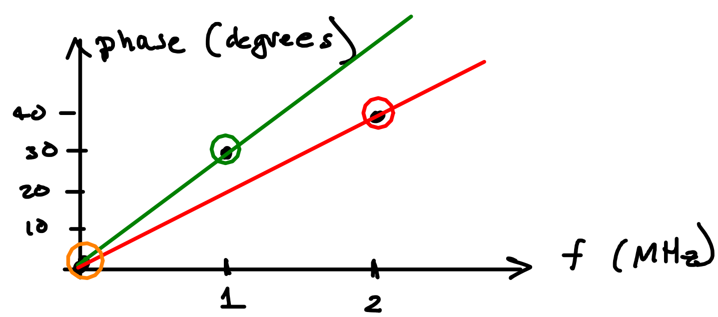
a phase shift of $35° +$ any multiple of 2π (360 degrees) is indistinguishable from a phase shift of $35°$.

thus the next longest possible length is the one that results in a phase shift of $360 + 35 = 395^\circ$

$$d = \frac{395}{360} \cdot 200 \approx \underline{\underline{220\ m}}$$

Q. 4 To avoid linear distortion the channel must be "linear phase" which implies all frequencies are delayed by the same amount.

However for this channel the phase vs. frequency function contains two points that could not fall on the same straight line:



thus the channel is <u>NOT linear phase</u> and <u>will distort</u> signals passed through it that have frequency components in this range (for example, a $1\mu s$ pulse).

Q.5 the intermodulation products produced by non-linear distortion will be at frequencies of:

$\pm n 1 \pm m \cdot 1.1$ kHz

the frequecies closest to 1 and 1.1 kHz

will be the "third-order" products where $n+m=3$:

$n=2,\ m=1$; $\pm 2\times 1 \ \pm\ 1.1$ kHz

and $n=1,\ m=2$ $\pm 1\times 1 \ \pm\ 2.2$ kHz

the results at positive frequencies are:

$+2-1.1 = \underline{\underline{0.9 \text{ kHz}}}$

$-1+2.2 = \underline{\underline{1.2 \text{ kHz}}}$

Q.6

$F = 2\,\text{dB}$

$N = kTBF$

$kT = -176\ \text{dBm/Hz}$ (at 290K)

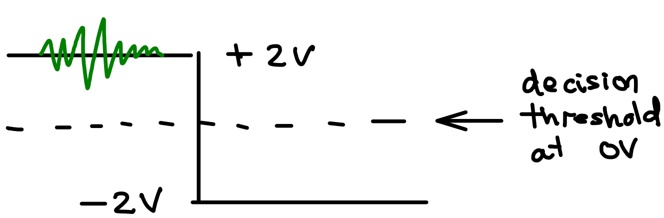
$B = 10\times 10^6\ \text{Hz} = 70\ \text{dB}\cdot\text{Hz}$

$N = -174 + 70 + 2 = -102\ \text{dBm}$

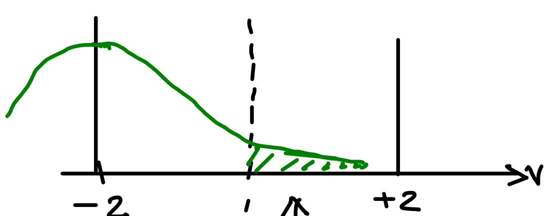
$S = -100\ \text{dBm}$

$S/N = -100 - (-102) = 2\ \text{dB}$

Q.7



noise margin is voltage required to cause an error $= \underline{\underline{2V}}$



shaded area is probability of error when transmit -2V

because of the symmetry of the voltages the probability of error is the same when transmit +2V.

The probability of error is given by $P(v > 2V)$ for a noise waveform with an rms voltage of 0.8 V. The rms voltage is the standard deviation (σ) of a Gaussian noise voltage (random variable).

Using the notation in the lecture notes,

sharp calculator output

DEG

1−P(2.5)=

N1 0.00621

$$\bar{x} = -2$$

$$v = 0$$

$$\sigma = 0.8$$

$$t = \frac{v - \bar{x}}{\sigma} = \frac{0-(-2)}{0.8} = 2.5$$

this is the Gaussian CDF function, not the probability

Probability of error $= P(x > 0) = 1 - P(2.5) = \underline{\underline{0.62\,\%}}$

Could also use logistic function approximation:

$$P(\text{error}) = 1 - \frac{1}{1 + e^{-1.7t}} = \underline{\underline{1.4\,\%}}$$

DEG W-VIEW

$1 - \dfrac{1}{1+e^{-1.7\times2.5}} =$

N1 0.014063627

Q.8

interference between circuits is the likely cause. Since the pairs are run next to each other, <u>crosstalk</u> is the likely explanation.

Q.9

- RTS & DTR are outputs on a DTE
  this interface is likely a <u>DTE</u>.
- a typical PC is a DTE as well, so, <u>no</u>
  you would have to use a <u>null modem</u>.

Q.10

Capital 'E' has Unicode (ASCII) value 0x45 which is binary 0100 0101 (big-endian order) or 1 010 0 0 01 (little-endian order, 7 bits). With the addition of one start & one stop bit, it would be transmitted using the following waveform: