HW # 4 SOLNS

1. $x(t) = \underbrace{\cos(2\pi \times 10^6 t)}_{1\,MHz} + \underbrace{\sin(2\pi \times 10^7 t)}_{10\,MHz} + N(t)$

a) Technical minimum is 20 MHz, but ~100MHz might be more appropriate.

b) MAXIMUM IS LIMITED BY ANTIALIAS - NO POINT SAMPLING HIGHER THAN CUTOFF GIVEN BY RC FILTER.

c) Let's choose $f_{SAMP} = 100MHz$

We want $A(100MHz) = 0.5$ ← GAIN

$$A(f) = \frac{1}{\sqrt{1+(f/f_0)^2}}$$

where $f_0 = \frac{1}{2\pi RC}$

$$0.5 = \frac{1}{\sqrt{1+\left(\frac{100}{f_0}\right)^2}} \Rightarrow 1+\left(\frac{100}{f_0}\right)^2 = \frac{1}{(.5)^2}$$

$$\left(\frac{100}{f_0}\right) = \sqrt{\frac{1}{(.5)^2} - 1}$$

$$f_0 = \frac{100}{\left(\frac{1}{(.5)^2}-1\right)^{1/2}} = 57.7\,MHz$$

$$C = \frac{1}{2\pi R f_0} = \frac{1}{(2\pi)(100)(57.7\times10^6)}$$

$$= 2.7\times10^{-11}\ F$$

$$= \underline{\underline{27\ pF}}$$

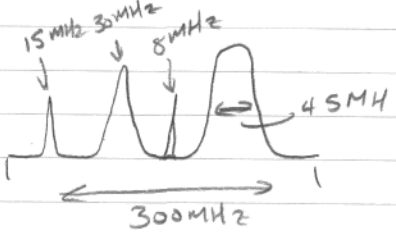
QUICK CHECK - WHAT IS $A(10\,MHz)$?

$$A = \frac{1}{\sqrt{1+\left(\frac{10}{57.7}\right)^2}} = 0.985 \Rightarrow \text{largely unaffected}$$

$\underline{\underline{\checkmark}}$

2. laser scanned @ $1\,GHz/_{min} = \frac{16.67\ MHz}{s}$

300 MHz range → ∴ it takes 18 seconds to span range.



Clearly 8 MHz peak is traversed the fastest

$$t_{8MHz} = \frac{8\ MHz}{16.67\ MHz/s} = 0.48\ s \sim 0.5s$$

a) To get good detail sampling rate should be

$$f_{samp} \gg \frac{1}{0.5_s}$$

$$f_{samp} \simeq \frac{10}{.5s} \simeq \underline{\underline{20\ Hz}}$$

b) $f_0 \simeq 20\ Hz$ $\quad f_0 = \frac{1}{2\pi RC}$

If $C = 0.1\ \mu F \Rightarrow R = \frac{1}{(2\pi)(20)(.1\times10^{-6})}$

$\simeq \underline{\underline{80\ k\Omega}}$