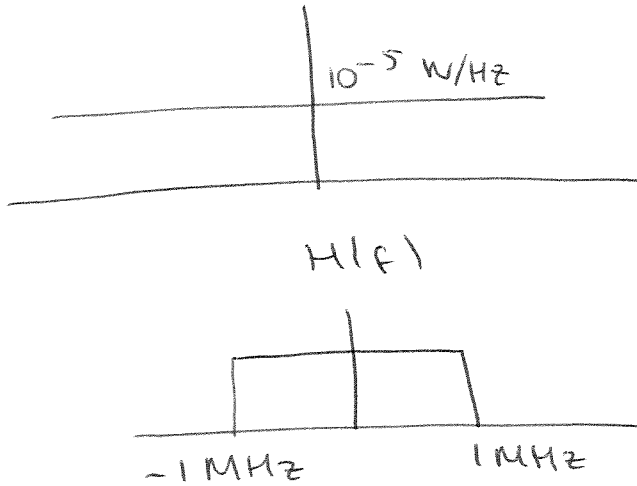
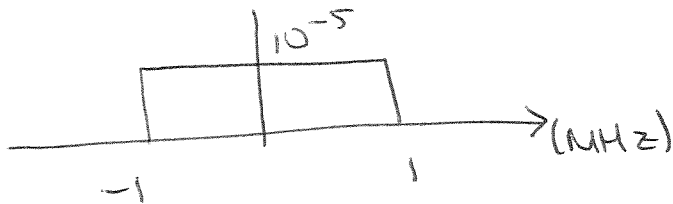


ECE 457
HW #9
Solutions

① 5.18



a) $S_y(f) = S_n(f) |H(f)|^2$



$= 10^{-5} \pi(f/2\text{MHz})$

c) $\int S_y(f) df = 2 \times 10^6 \times 10^{-5}$
 $= 20 \text{ W} //$

~~1~~ 5.20a

2 $|H_{2bu}(f)| = \frac{1}{\sqrt{1 + (f/f_3)^4}}$

$$S_n(f) = \frac{N_0}{2}$$

$$S_y(f) = |H(f)|^2 \cdot \frac{N_0}{2}$$
$$= \frac{1}{1 + (f/f_3)^4} \cdot \frac{N_0}{2} //$$

~~2~~ 5.21 $S_y(f) = \frac{(2\pi f)^2}{(2\pi f)^4 + 5,000}$

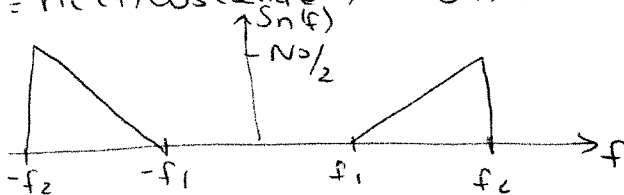
3

$$S_n(f) = 1 \text{ W/Hz}$$

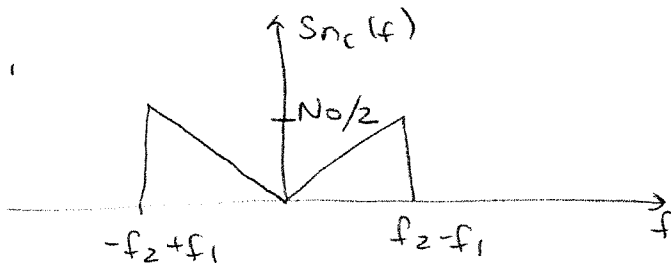
$$|H(f)|^2 = \frac{(2\pi f)^2}{(2\pi f)^4 + 5000}$$

$$|H(f)| = \frac{(2\pi f)}{\sqrt{(2\pi f)^4 + 5000}}$$

~~4~~ 5.29 $n(t) = n_c(t) \cos(2\pi f_0 t) - n_s(t) \sin(2\pi f_0 t)$

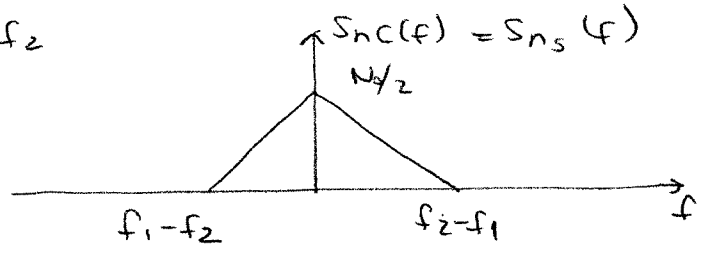


a) $f_0 = f_1$

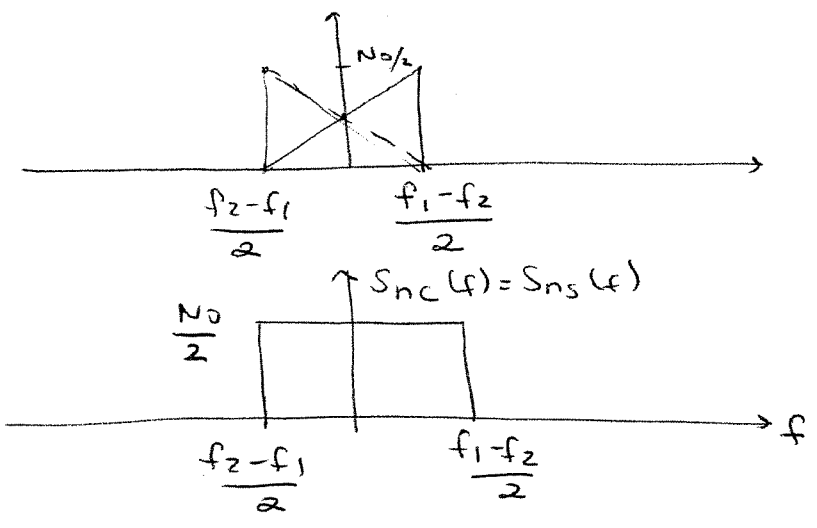


$$S_{nc}(f) = S_{ns}(f)$$

b) $f_0 = f_2$

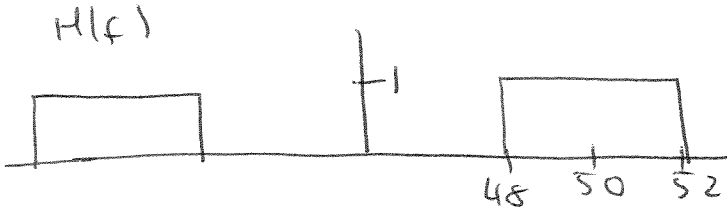
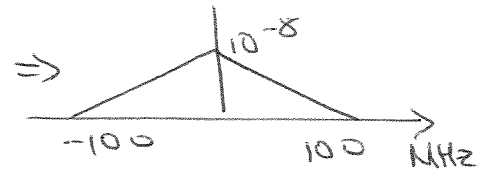


c) $f_0 = \frac{1}{2}(f_2 + f_1)$

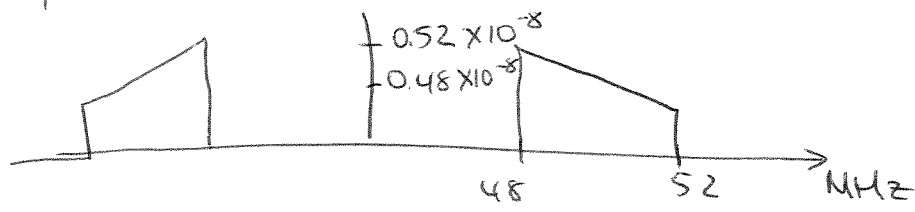


5

$$S_n(f) \begin{cases} 10^{-8} \left(1 - \frac{|f|}{10^8}\right), & |f| < 10^8 \\ 0, & |f| > 10^8 \end{cases}$$



a) $S_y(f) = S_n(f) |H(f)|^2$

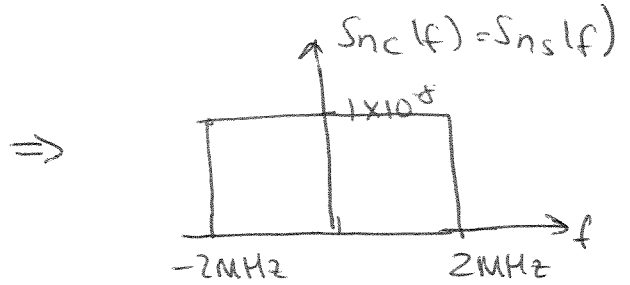
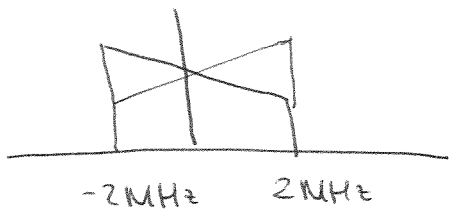


$$\int S_y(f) df = (2) (4 \times 10^6) \left(\frac{0.52 \times 10^{-8} + 0.48 \times 10^{-8}}{2} \right)$$

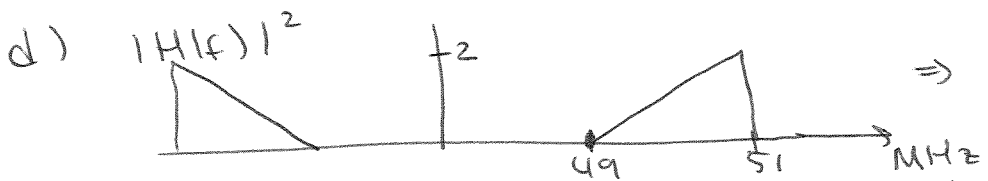
$$= 4 \times 10^{-2} = 0.04 \text{ W}$$

b) $n_{bp}(t) = n_c(t) \cos(2\pi f_c t) + n_s(t) \sin(2\pi f_c t)$
 c) $f_c = 50 \text{ MHz}$

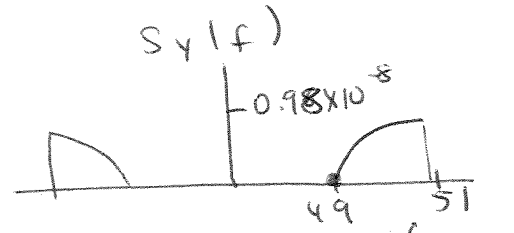
$S_{nc}(f) = S_{ns}(f)$



$$\overline{n_c^2(t)} = \overline{n_s^2(t)} = 1 \times 10^{-8} \times 4 \times 10^6 = 0.04 \text{ W}$$



$$\left(\frac{|f| - 49 \times 10^6}{10^6} \right) = 10^{-8} \left(1 - \frac{|f|}{10^8} \right)$$



$$= 10^{-14} \left(|f| - 49 \times 10^6 - \frac{|f|^2}{10^8} + 491f \right) \times 10^6$$

$$\text{Power} = 2 \int_{49 \times 10^6}^{51 \times 10^6} 10^{-14} \left(f - 49 \times 10^6 - \frac{f^2}{10^8} + \frac{49 \times f}{10^2} \right) df$$

$$(2 \times 10^{-14}) \left[\frac{f^2}{2} - 49 \times 10^6 f - \frac{f^3}{3 \times 10^8} + \frac{49 \times f^2}{2 \times 10^2} \right] \Bigg|_{49 \times 10^6}^{51 \times 10^6}$$

$$= (2 \times 10^{-14}) \left[\frac{2601 \times 10^{12}}{2} - 49 \times 10^6 \times 51 \times 10^6 - \frac{132651 \times 10^{18}}{3 \times 10^8} \right.$$

$$+ \frac{49 \times 2601 \times 10^{12}}{2 \times 10^2} - \frac{2401 \times 10^{12}}{2} + \frac{2401 \times 10^{12}}{2} + \frac{117649 \times 10^{18}}{3 \times 10^8}$$

$$\left. - \frac{117649 \times 10^{18}}{2 \times 10^2} \right] = 2 \times \left[\frac{26.01}{2} - 24.99 - 4.4217 \right.$$

$$\left. + 6.37245 - \frac{24.01}{2} + 24.01 + 3.9216 - 5.88245 \right] = 0.0198 \text{ W}$$

Power in the baseband components $\overline{n_c^2(f)} = \overline{n_s^2(f)} = 0.0198 \text{ W}$ too

