

Problem 9.6 The signal $m(t) = \cos(2000\pi t)$ is transmitted by means of frequency modulation. If the frequency sensitivity k_f is 2 kHz per volt, what is the Carson's rule bandwidth of the FM signal. If the pre-detection SNR is 17 dB, calculate the post-detection SNR. Assume the FM demodulator includes an ideal low-pass filter with bandwidth 3.1 kHz.

Solution

The Carson Rule bandwidth is $B_T = 2(k_f A + f_m) = 2(2(1) + 2) = 8 \text{ kHz}$. Then from Eq.(9.59),

$$\text{SNR}_{\text{post}}^{\text{FM}} = \frac{3A_c^2 k_f^2 P}{2N_0 W^3} = \frac{A_c^2}{2N_0 B_T} \left(\frac{3k_f^2 P}{W^3} B_T \right)$$

We observed that the first factor is the pre-detection SNR, and we may write this as

$$\begin{aligned} \text{SNR}_{\text{post}}^{\text{FM}} &= \text{SNR}_{\text{pre}}^{\text{FM}} \left(\frac{3 \cdot 2^2 \cdot \frac{1}{2} \cdot 8}{(3.1)^3} \right) \\ &= \text{SNR}_{\text{pre}}^{\text{FM}} \times 1.61 \\ &\sim 19.2 \text{ dB} \end{aligned}$$

(There is an error in the answer given in the text.)