

A bandpass filter has center (or resonant, or characteristic) frequency  $\omega_0 = 80 \text{ krad/s}$  and quality factor  $Q = 8$ .

Find bandwidth,  $\beta$ , upper cutoff frequency,  $f_{c2}$ , and lower cutoff frequency,  $f_{c1}$ . All answers in kHz.

ans:  $\beta = 1.59 \text{ kHz}$ ,  $f_{c2} = 13.6 \text{ kHz}$ ,  $f_{c1} = 12.0 \text{ kHz}$

sol'n:  $Q \equiv \left( \frac{\omega_0}{\beta} = \frac{80 \text{ k/s}}{\beta} \right) = 8 \Rightarrow \beta = \frac{80 \text{ k/s}}{8} = 10 \text{ k/s}$

$$\beta = \frac{10 \text{ k/s}}{2\pi} = 1.59 \text{ kHz}$$

From p. 726 we have  $\omega_{c1,2} = \mp \frac{\beta}{2} + \sqrt{\left(\frac{\beta}{2}\right)^2 + \omega_0^2}$

$$\omega_{c2} = \frac{10 \text{ k/s}}{2} + \sqrt{\left(\frac{10 \text{ k/s}}{2}\right)^2 + (80 \text{ k/s})^2} = \frac{10 \text{ k/s}}{2} \left[ 1 + \sqrt{1 + 16^2} \right]$$

$$= 85.2 \text{ k/s}$$

$$f_{c2} = 13.6 \text{ kHz}$$

$$\omega_{c1} = \frac{-10 \text{ k/s}}{2} + \sqrt{\left(\frac{10 \text{ k/s}}{2}\right)^2 + (80 \text{ k/s})^2} = \frac{10 \text{ k/s}}{2} \left[ -1 + \sqrt{1 + 16^2} \right]$$

$$= 75.2 \text{ k/s}$$

$$f_{c1} = 12.0 \text{ kHz}$$