Lecture 33, Wednesday, March 23, 2022

- The energy content of $f(t)$ is given by

$$W = \int_{-\infty}^{\infty} |f(t)|^2 dt = \frac{1}{2\pi}\int_{-\infty}^{\infty} |F(\omega)|^2 d\omega$$

- $|F(\omega)|^2$ is called the *energy spectrum* of $f(t)$
- Energy bandwidth
  - Lowpass signals
    * 3dB bandwidth (Ω_{3dB}): smallest $\omega > 0$ such that

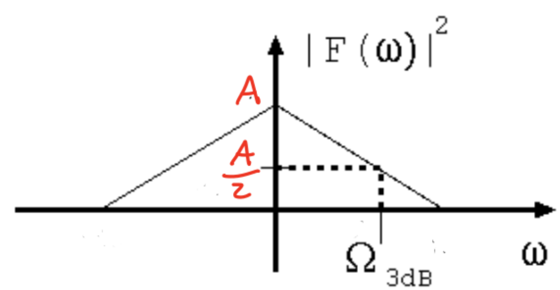
$$10\log_{10}\left(\frac{|F(\omega)|^2}{|F(0)|^2}\right) = -3$$

or equivalently

$$\frac{|F(\omega)|^2}{|F(0)|^2} = \frac{1}{2}$$

or equivalently

$$\frac{|F(\omega)|}{|F(0)|} = \frac{1}{\sqrt{2}}$$



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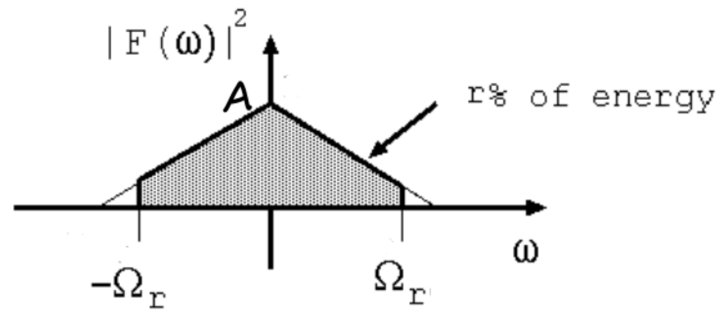
* r% bandwidth: $\Omega_r > 0$ such that

$$\frac{1}{2\pi}\int_{-\Omega_r}^{\Omega_r} |F(\omega)|^2 d\omega = \frac{r}{100}W$$

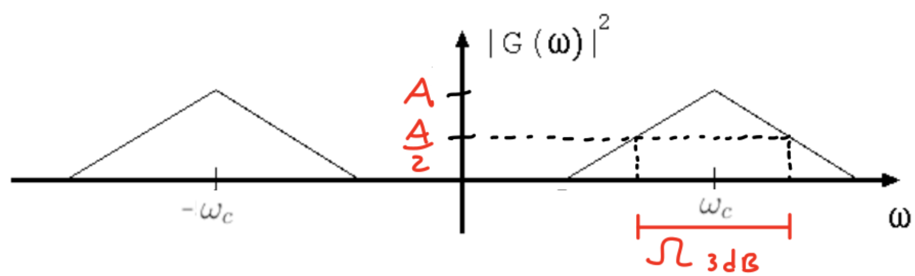
or

$$\frac{1}{2\pi}\int_{0}^{\Omega_r} |F(\omega)|^2 d\omega = \frac{r}{100}\frac{W}{2}$$



- Energy bandwidth
  - Bandpass signals
    * Assume the energy spectrum, $|F(\omega)|^2$, is symmetric around a center frequency ω_c
    * 3dB bandwidth (Ω_{3dB}):
      · First find smallest $\hat{\omega} > 0$ such that

$$\frac{|F(\omega_c + \hat{\omega})|^2}{|F(\omega_c)|^2} = \frac{1}{2}$$



      · Then $\Omega_{3dB} = 2\hat{\omega}$