Ratio to max radiation to the average rad. intensity

o) Directivity: It is how much it concentrates the energy in one direction in preference to radiation in other directions.
This parameter is useful to describe the performance of an antenna. Where to orient the antenna

$$D = \frac{U_m}{U_{ave}} = \frac{P/\Omega_A}{P/4\pi} = \frac{4\pi}{\Omega_A} = \frac{4\pi}{\iint_{4\pi} |F(\theta,\varphi)|^2 \, d\Omega} = \frac{4\pi}{\int_0^{2\pi}\int_0^{\pi} |F(\theta,\varphi)|^2 \sin\theta \, d\theta \, d\varphi}$$

$$D = \frac{U_m/r^2}{U_{ave}/r^2} = \frac{\max\{Re(\bar{S}\cdot\hat{r})\}}{P/4\pi r^2}$$

o) Gain:

① → Ratio of radiation intensity in the max. direction to radiation intensity that would be obtained if the power radiates isotropically

② → Ratio power density in max direction at dist. r to power density that would be obtained at the same dist. if antenna radiates isotropically.

This parameter useful to describe antenna's performance.

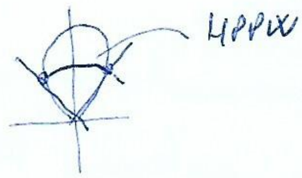
$$G = \frac{U_m}{P_{in}/4\pi} = \frac{U_m/r^2}{P_{in}/4\pi r^2}$$

o) Radiation efficiency: The input power P_{in} is not equal to radiated power P. due to losses. It is the portion of input power that does not appear as radiated power. This parameter describes antenna's performance

$$e_r = \frac{P}{P_{in}} \longrightarrow G = e_r D$$

- **Half-power beamwidth:** HPBW. In the plane containing the max. lobe is the angular separation of the points with power pattern $P(\theta,\varphi)$ equal to -3 dB

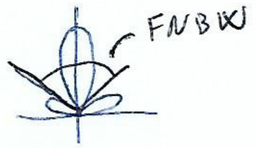
  Half of max. value.



$P(\theta,\varphi) \triangleq 0{,}5$

$|F(\theta,\varphi)| = \frac{1}{\sqrt{2}}$

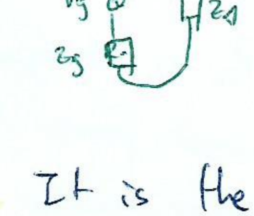
- **First-null beamwidth:** FNBW. In the plane containing the direction of max. lobe it is the angular separation between the first nulls

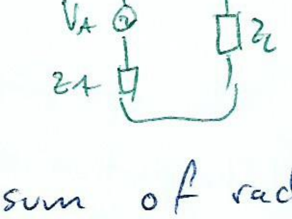


- **Far-field:** The far-field is the region where the radiation pattern is well formed and doesn't depend on the distance

  $\beta r \gg 1$

- **Input impedance:** It is the impedance offered by the antenna at its terminals $Z_A = R_A + j X_A$





- **Input resistance** It is the sum of radiation resistance and loss resistance

$$R_A = R_R + R_\Omega$$

②

- Radiation resistance: Is the electrical resistance caused by emission.

$$P_R = \frac{1}{2} R_R |I|^2$$

- Radar cross section of an electromagnetic scatterer
  Measured in [m^2]. The area that interceps that amount of power P_i which when scattered isotropically producos at receiving a power density S_R that is equal to that scattered by actual target.

  $P_i = \sigma S_i$

- Radiation pattern It is the description of the angular variation of the far-field radiation of an antenna.

- Isotropic pattern: Spherical radiation pttern due to antenna radiates equally in all directions

- Omnidirectional pattern: In a selected plane a circular rad. pattern.

- H-plane: 2D rad. patter that contains $\vec{H}$ in the maximum rad. direction

- E-plane: $\vec{E}$

- Beam solid angle: Ω_A The solid angle through all power would flow if rad. intensity was constant and equal to max.

$$\Omega_A = \iint_{4\pi} |F(\theta,\varphi)|^2 \, d\Omega = \int_0^{2\pi}\int_0^{\pi} |F(\theta,\varphi)|^2 \sin\theta \, d\theta \, d\varphi$$

- Effective Area — The area where the power density is collected and then we get power.

$$P = A_e S$$

- Effective length — The ratio ~~of~~ open circuit voltage to incident electric field.