Antenna Numericals

Q. A parabolic reflector antenna having antenna efficiency of 85% is designed for 3 GHz resonant frequency with 2.5 dB waveguide loss. What will be the antenna diameter if EIRP is calculated 46 dBW and transmitting power is 500 Watt?

- Solution:
- Given
- Antenna efficiency,(η) = 85% = 0.85
- Resonant frequency, f= 3 GHz = 3×10^9 Hz
- So, operating wavelength, (λ) = c/f =$(3 \times 10^8)/(3 \times 10^9) = 10^{-1}$ m= 0.1m= 10 cm
- Waveguide loss, L_{wg} =2.5dB
- EIRP = 46 dBW
- Transmitting power, P_t =500 W.
- Antenna diameter, d =?
- Transmitted power in dB, $P_{t,dB} = 10 \log_{10} 500 = 26.99$ dB.

- Hence,
- Power radiated, $P_{\mathbf{Rd}} = P_{t,\mathbf{dB}} - L_{wg}$ = [26.99 – 2.5] dB =24.49 dB.
- Antenna gain, $G_{\mathbf{A}} = EIRP/P_{\mathbf{Rd}}$ = 46/24.49 = 1.878
- We have,
- $G_t = 4\boldsymbol{\pi} A_e/\lambda^2$
- Effective antenna aperture, $A_e = G_t \lambda^2 / 4\boldsymbol{\pi}$
- $A_e = 0.0015\ m^2$
- Antenna efficiency(η) = 0.85 = A_e/A_p
- ∴ Physical aperture, $A_p = A_e/0.85 = 0.00175\ m^2$
- We have,
- $A_p = \frac{\pi d^2}{4}$

Q. A 100 megahertz circuit consists of a transmitting and receiving antenna of 30 dB and 25dB gains respectively. The power radiated by the transmitting antenna is 120 watts Using Friis transmission equation find the received power at a distance of 0.75 km over a free space.

- Given,
- Operating frequency, f = 100 MHz = 10^8 Hz
- Operating wavelength, $\lambda = (3x10^8)/10^8 = 3m$
- Transmitter gain, G_T = 30 dB
- Receiver gain, G_R =25 dB
- Power radiated, P_T = 120 watts
- Distance of separation, D = 0.75 km = 750m
- So,
- Received power, $P_R = P_T .\lambda^2.G_T .G_R /(4\pi r)^2 = 120*9 *30 *25/(4\pi*750)^2 = 0.00912$ watt = 9.12 mwatts

Q. Find out the line of sight distance between the transmitting antenna and receiving antenna if the transmitting antenna height is 45m and the receiving antenna height is 25m.Given: Radius of the earth is equals to 6,378 kilometres.

Solution:
Height of receiving antenna, h_r =25m.
Height of transmitting antenna, h_t =45m.
Line of sight distance, $d = 4.12\ [h_t^{0.5} + h_r^{0.5}] = 48.237$ Km

8. Calculate free space path loss for 6 GHz frequency if transmitter and receiver are 10,500 Km line of sight apart.

- Given,
- Operating frequency, $f = 6x10^9$ Hz
- Operating wavelength, $\lambda = (3x10^8)/(6x10^9) = 0.05m = 5$ cm
- Distance between transmitting antenna and receiving antenna =10,500 Km

  $= 10.5x10^6$ **m**
- **Free space path loss, $F_{PL} = [4\pi d/\lambda]^2$** $= 6.964 \times 10^{18}$
- Free space path loss in dB, $F_{PL,dB} = 20 \log_{10}[4\pi d/\lambda]$ dB $= 188.42$ dB
- Note:
- **Free space path loss in dB, $F_{PL,dB} = 20 \log_{10}[4\pi d/\lambda]$ dB $= 32.45 + 20 \log_{10} f_{MHz} + 20 \log_{10} d_{km}$**

Q. Assume that reflection take place at a height of 400 km and that the maximum density in the ionosphere corresponds to 0.8 refractive index at 15 MHz. What will be the range (assume flat Earth) for which the MUF is 20 MHz?

- Solution
- Given information are as follows :
- Height at which reflection occurs(h) = 400 Km
- Refractive index(n) = 0.8
  Frequency (f) = 15 MHz
  So, $n = [1 - 81N_{max}/f^2\ ]^{1/2}$
  $0.8 = [1 - 81N_{max}/(225*10^{12})]^{1/2}$
  $N_{max} = 10^{12}$ electrons per cubic meter
  Critical frequency $(f_c) = 9\ [N_{max}]^{1/2}$
  $f_c = 9[10^{12}]^{1/2}$
  $f_c = 9MHz$
  Skip distance = $2h\ [\ (f_{MUF}/f_c)^2 - 1]^{1/2} = 622.22$ Km

Example

- A silica optical fiber with a core diameter large enough to be considered by ray theory analysis has a core refractive index of 1.50 and a cladding refractive index of 1.47.*Determine:* (a) the critical angle at the core–cladding interface; (b) the *NA* for the fiber; (c) the acceptance angle in air for the fiber.
- *Solution:* (a) The critical angle φ_c at the core–cladding interface is given by

We know that,

- $\varphi_c = sin^{-1}\frac{n_2}{n_1} = sin^{-1}\frac{1.47}{1.50} = 78.5°$

(b) From equation the *NA* is:

- $NA = \sqrt{{n_1}^2 - {n_2}^2} = \sqrt{1.50^2 - 1.47^2} = 0.30$

(c) The acceptance angle in air θ_a is given by:

$\theta_a = sin^{-1} NA = sin^{-1} 0.30 = 17.4°$