CHALMERS – Space, Earth and Environment

RRY100 – Satellite Communications 2024

Homework 1

Deadline 2024-09-13, 07:59

A scientific mission on the Moon sends research data to Earth via a communication link using a parabolic antenna of diameter $d = 1$ m with aperture efficiency of $\eta = 0.6$. The transmitter on the Moon has an output power of $P_t = 1$ W and uses a frequency of $f = 2.4$ GHz.

Questions:

1. Calculate $G_{\max}$, the maximum gain of the transmitting antenna on the Moon, and its half-power beam width (HPBW), often also called $\theta_{3\text{dB}}$.
2. What is the power flux density F on the Earth surface when the transmitter on the Moon is
   (a) operating with full output power?
   (b) with 3 dB output back off (OBO)?

   Do these calculations for both the minimum and maximum distance between the Earth and Moon, i.e. $R_{\min} = 362570$ km and $R_{\max} = 405410$ km.
3. Calculate the path loss L_{path} in dB for an average Earth–Moon distance, i.e. $R = 400000$ km. What would the pathloss be if the transmitting frequency was changed from 2.4 GHz to 6.3 GHz?
4. Assume that you can achieve a system noise temperature of $T_{\text{sys}} = 200$ K for a receiving system at $f = 2.4$ GHz at a receiving station on Earth and that can build a parabolic reflector with an aperture efficiency of $\eta = 0.7$. What is the necessary diameter d of a parabolic reflector at the Earth station in order to achieve a minimum carrier-to-noise-ratio (C/N) of 6 dB for a bandwidth of $B = 10$ MHz?