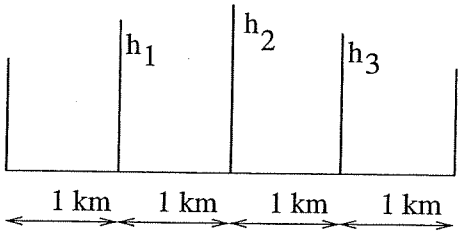
S-96.3311 Radioaaltojen eteneminen — Syksy 2007

Exam — 25.10.2007

1. Calculate the transmission loss caussed by the obstacles in 4 km radio link shown in the figure. The frequency is 1 GHz, the transmitter and the receiver antennas are at the height of 20 m. The obstacles' heights are $h_1 = 27$ m, $h_2 = 30$ m and $h_3 = 25$ m.



2. Determine the height of the transmitter and receiver antennas (equal height) when there is one obstacle in the middle of the 50 km path whose height is 30 m. It is required that the transmission loss due to this obstacle should not exceed 10 dB. Frequency is 3 GHz and the K factor of the troposphere varies between 1.2 ... 1.6 .

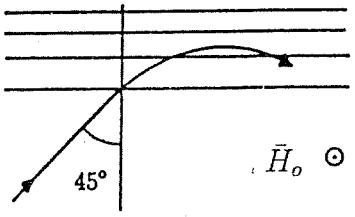
3. The value of the refraction index $n(r)$ on the surface of the earth is a constant n_o , $(n_o > 1)$ and above the height $h = 5$ km it is $n(r) = 1$. In between it is a linear function. What is the value for n_o when it is required that the ray send at an elevation angle $\gamma = 1°$ from the earth is refracted back to the surface of the earth.

4. The radio wave is coming into the ionosphere at an angle 45° as shown in the figure. The frequency is 6 MHz and the magnetic field $|\bar{H}_o| = 40$ A/m is perpendicular to the wave direction. Calculate the electron density at the turning point where

a) ordinary wave

b) extraordinary wave

is returning back.



5. Show that in the isotropic plasma the product of the phase velocity and the group velocity is $v_p v_g = c^2$.

You can have a calculator and the allowed literature in exam.