S-72.232 RADIO COMMUNICATION SYSTEMS
EXERCISE 7/2005, 8.4.2005

27. A radio sounder performs meteorological measurements up to 25 km height and transmits the data to a ground station with 1 W power at 4.5 GHz frequency using a dipole antenna with 2.1 dBi gain in the direction of the station. The antenna feeder loss is 5.0 dB. The ground station receiver noise figure is 4.0 dB and its antenna feeder loss is 3.0 dB. The receiver antenna gain in the sounder direction is 12.0 dBi. The receiver IF bandwidth is 25 kHz, and the minimum SNR for reliable transmission is 12.0 dB. To combat fading a 10 dB fade margin is used.

a) Calculate the minimum receive level (dBm) with the above system parameters.
b) Calculate the needed average receive level (dBm) with the given fade margin.
c) Calculate the average radio path loss (dB) allowed by the radio link budget.
d) How far away from the meteorological station (along the Earth surface) the wind may move the sounder, when the propagation model is free space propagation?

28. A DAB system uses 200 MHz carrier frequency and 1.5 MHz bandwidth. The modulation method is coherent 4PSK, the receiver noise figure is 10 dB. The SNR-requirement for high quality reception is 12.0 dB and the co-channel protection ratio is 15.0 dB.

a) Calculate the required field strength when the receiver input impedance is 75 Ω and the receiver $\lambda/2$ dipole antenna has a 2.1 dB gain.
b) What is the radius of the coverage area, when the transmitter EIRP is 3.0 kW, the transmitter and receiver antenna heights are 300m and 10 m respectively, and i) 50 % location probability, ii) 95 % location probability is required at the coverage edge? The terrain height variations $\Delta h = 50$ m.
c) What is the shortest distance a co-channel transmitter with identical parameters and radiating another set of programs can be used without violating the PR requirement?
d) How large is the maximum reduction of the radius of the coverage area if the distance is reduced to 100 km?

29. The maximum distance between Pluto and Earth is 7.5 Tm. A space vehicle investigating Pluto has a 10 W transmitter and the carrier frequency is 2 GHz. The Earth station has a 64 m parabolic antenna and the total receiver noise temperature is 16 K. The transmitted data rate is 300 bit/s and BPSK-modulation is used. What must the space vehicle antenna diameter be, if a bit error probability of 10^{-6} is required and the efficiency of both antennas is $\eta = 0.6$?

30. The downlink characteristics of a GEO-satellite located at 10° western longitude are investigated.

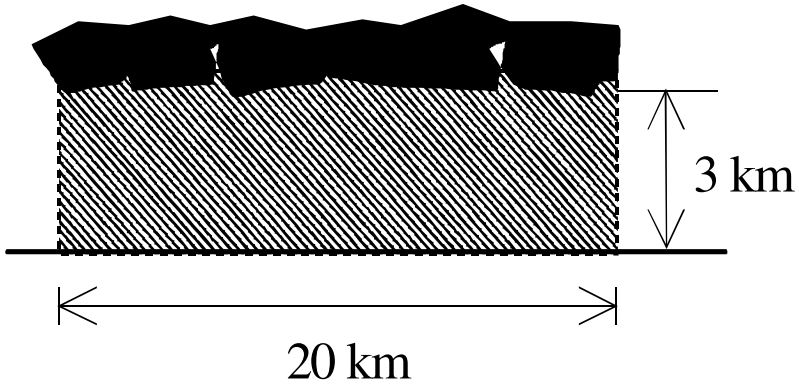
Transmitter parameters:	- frequency 12 GHz - transmitter power 100 W - antenna feeder loss 1.5 dB - antenna diameter 2.4 m, efficiency η=0,55.
Receiver parameters:	- location: (1) Hanko; 59°50' N, 23°00' E (2) Utsjoki; 69°50' N, 27°00' E - antenna feeder 10 m, α = 30 dB/km - other losses 0.5 dB

a) Determine the receiver $G/T=10\lg(g_{rx}/T_{tot})$ needed to achieve the SNR-value 20 dB, when the channel bandwidth is 30 MHz. (Clear air is assumed, and the atmospheric loss and equivalent noise temperature are obtained from the attached figure. The sky temperature is assumed to be 10 K).

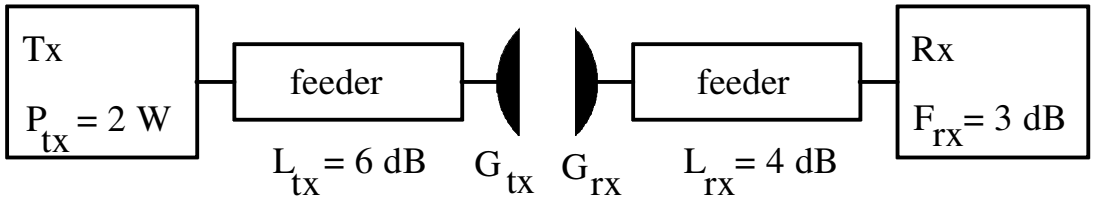
b) Determine the required receiver antenna diameter (η=0.55), when the receiver noise temperature is 200 K.

c) Calculate the rain attenuation with the rain shower in the figure, when the rain rate is R = 20 mm/h.

d) Determine the G/T-degradation caused by the rain shower assuming the rain temperature to be 290 K. How large receiver antenna diameter is needed to compensate the impact of the shower?



HOMEWORK 7. Return time 1 month, at latest before the May 2005 exam



The 155.2 Mbit/s MQAM-SDH-radio link above (M = 4, 16, 64 or 256) is used on a 42 km hop in the 6.1 GHz frequency band, where are allocated 8 channels with 29.65 MHz channel spacing (ITU-R Rec. 383). Now the 8×29.65 MHz band will be used with a new channel spacing.

a) How many radio channels can be used without spectrum overlapping in the actual frequency band on different M-values, when the ideal raised cosine spectrum roll-off parameter is $\alpha = 0.3$?

b) Determine system gain and flat fade margin at BEP = 10^{-5}, when 3 m parabolic reflector antennas with the efficiency $\eta = 0.65$ are used.