The University of New Mexico

School of Engineering

Electrical and Computer Engineering Department

ECE 535 Satellite Communications

Student Name: Alex Hostick

Student SN: 2O1

Module # 12: 12.1, 12.3, 12.5, 12.7, 12.9, 12.11, 12.13

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Prof. Tarief Elshafiey

12.1 Give the decibel equivalents for the following quantities: (a) a power ratio of 30:1; (b) a power of 230 W; (c) a bandwidth of 36 MHz; (d) a frequency ratio of 2 MHz/3 kHz; (e) a temperature of 200 K.

(a) Power ratio of 30:1

$P_{Ratio30:1} = 10\log(30) = 14.8dB$

(b) Power of 230W

$P_{230W} = 10\log(230W) = 23.6dBW$

(c) Bandwidth of 36MHz

$P_{36MHz} = 10\log(36x10^{6}) = 75.6dBHz$

(d) Frequency Ratio of 2MHz/3kHz

$$P_{2E6/3E3} = 10\log\left(\frac{2MHz}{3kHz}\right) = 28.2dB$$

(e) Temperature of 200K

$P_{Temp} = 10\log(200K) = 23.01dBK$

12.3 Calculate the gain of a 3-m parabolic reflector antenna at a frequency of (a) 6GHz; (b) 14GHz.

$Apperature\ Efficiency(\eta) = 0.55;\ Constant = 10.472;\ Diameter = 3m$

(a) At f = 6Ghz

$[G] = \eta(10.472 * f * D)^2$

$[G] = 0.55(10.472 * 6 * 3)^2 = 42.9dB$

(b) At f = 14Ghz

$[G] = \eta(10.472 * f * D)^2$

$[G] = 0.55(10.472 * 14 * 3)^2 = 50.3dB$

12.5 An antenna has a gain of 46 dB at 12 GHz. Calculate its effective area.

G = 46dB

c = 299,792,458 m/s

f = 12Ghz

Wavelength (λ) = c/f = 0.0249827m

$$A_{eff} = \frac{G*\lambda^2}{4\pi}$$

$$A_{eff} = \frac{(10^{\frac{46}{10}})*(\frac{299{,}792{,}458 m/s}{12x10^9 Hz})^2}{4\pi} = 1.98m^2$$

12.7 The EIRP from a satellite is 49.4 dBW. Calculate (a) the power density at a ground station for which the range is 40,000 km and (b) the power delivered to a matched load at the ground station receiver if the antenna gain is 50 dB. The downlink frequency is 4 GHz.

(a) Power Density at Ground Station 40,000km away

$$P_{Density} = \frac{EIRP}{4\pi r^2}$$

$$P_{Density} = \frac{10^{49.4/10}}{4\pi(40{,}000x10^3 m)^2} = 4.33pW/m^2$$

(b) Power Delivered to matched load at ground station with ant gain = 50dB, f = 4GHz

$$[FSL] = 32.4 + 20\log(40{,}000) + 20\log(4000) = 196.48dB$$

$$P_{Delivered} = 49.4dB + 50dB - 196.48dB = -97.08dBW\ or\ 195.78pW$$

12.9 Repeat the calculation in Prob. 12.7b allowing for a fading margin of 1.0 dB and receiver feeder losses of 0.5 dB.

(b) Power Delivered to matched load at ground station with ant gain = 50dB, f = 4GHz

$[FSL] = 32.4 + 20\log(40{,}000) + 20\log(4000) = 196.48dB$

$P_{Delivered} = 49.4dB + 50dB - 196.48dB - 0.1dB - 1.0dB = -98.58dBW\ or\ 138.6pW$

12.11 Two amplifiers are connected in cascade, each having a gain of 10 dB and a noise temperature of 200 K. Calculate (a) the overall gain and (b) the effective noise temperature referred to input.

G1 = 10dB; G2 = 10dB

T1 = 200K; T2 =200K

(a) Overall Gain

$G_{ALL} = G1 + G2 = 10dB + 10dB = 20dB$

(b) Effective Noise Temp Referred to Input

$$T_{eff} = T1 + \frac{T2}{G1}$$

$$T_{eff} = 200K + \frac{200K}{10dB} = 220K$$

12.13 The noise factor of an amplifier is 7:1. Calculate (a) the noise figure and (b) the equivalent noise temperature.

(a) Noise Figure

$NF = 10\log(7) = 8.45dB$

(b) Equivalent Noise Temperature

$N_{Temp} = (7 - 1) * 290 = 1740K$