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.

1. a power ratio of 30:1:

Power ratio(dB)=10log10(p1/p2)

dB=10log10(30/1)

10log10(30)=10\*1.4771

=14.77dB

1. a power of 230 W:

Power absolute(dBW)=10log10(p/1w)

10log10(230)=10\*2.3617

=23.62dBW

1. a bandwidth of 36 MHz:

Bandwidth(dBHZ)=10log1(B[HZ])

36MHZ=36\*10(power6HZ)

10log10(36\*106)=10log10(3.6\*107)

10(log10(3.6)+7)=10(0.5563+7)

=75.56dBHZ

1. a frequency ratio of 2 MHz/3 kHz:

Frequency ratio(dB)=10log10(f1/f2)

(2\*106)/3\*106=2000/3=666.67

10log10(666.67)=10\*2.8239

=28.24dB

1. a temperature of 200 K:

Temperature(dBK)=10log10(T[K})

10log10(200)=10\*2.3010

=23.01dBK

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

Formula for Gain:

G=η(πD/λ)2

In decibels(dBi):

G(dBi)=10log10[η(πD/λ)2]

Where:

D=3m(dish diameter)

f=frequency

λ =c/f, with c=3\*109m/s

η= efficiency

1. 6 GHz:

f=6\*109HZ

λ=(3\*108)/(6\*109)=0.05m

(πD/λ)2=(3.1416\*3/0.05)2=(188.5)2=35,540

G=0.6\*35,540=21,324

G(dBi)=10log10(21,324)=10\*4.328=43.3dBi

1. 14 GHz:

f=14\*109  HZ

λ=(3\*108)/(14\*109)=0.12143m

(πD/λ)2=(3.1416\*3/0.1214)2=(439.8)2=193,400

G=0.6\*=193,400=116,040

G(dBi)=10log10(116,040)=10×5.064=50.6dBi

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

Given:

Gain GdB=46dB

Frequency f=12GHZ=12\*109 HZ

Speed of light c=3\*108m/s

Formula for relating antenna gain and effective area is G=4πAe/λ2

Where G=gain

Ae=effective aperture area

λ=c/f

G=1046/10 =104.6

104.6 =39,810

G=3.98\*104

λ=c/f=(3×108)/(12×109)=0.025m

Ae=(3.98\*104)\*(0.0252)/4π

0.0252=0.000625

(3.98\*104)\*0.000625=24.875

Ae=24.875/12.566

=1.98m2

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.

Given

EIRP=49.4dBW

Range R=40,000km

Frequnecy f=4GHZ

1. the power density at a ground station

Power density R:

S=EIRP/4πR2

SdBW/m2 =EIRPdBW-10log10(4πR2)

4πR2=4π(4.0\*107)2

10log10(4πR2)=163.0333dB

SdBW/m2=49.4-163.03333=-113.6333dBW/m2

S=10(-113.6333/10)=4.33\*10-12 W/m2

1. the power delivered to a matched load at the ground station receiver:

Pr(dBW)=EIRP(DBW)+Grx(dB)-FSPL(dB)

FSPL(dB)=20log10(4πR/λ)

Compute λ=0.075m

FSPC=20log10(4π.4.0\*107/0.075)=196.5242dB

Pr(dBW)=49.4+50−196.5242=−97.1242dBW.

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.

Numbers are

EIRP=49.4 dBW

GRX=50dB

FSPL=196.5242 dB

Pr=-97.1212 dBW

Pr(dBW)=EIRPdBW+Grx,dB−FSPLdB−fadingmargindB−feederlossesdB​.

Fading margin=1.0 dB

Feeder losses=0.5 dB

Pr=49.4+50-196.5242-1.0-0.5=-98.6242 dBW

Pr=10-98.6242/10=1.3727\*10-10W

Pr=-98.6242 dBW=1.37\*10-10W

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.

Given:

Amplifier gain G=10dB

Amplifier noise temperature: Tn=200k

1. the overall gain:

Glinear=10(10/10)=10

Gtotal=Glinear1.Glinear2=10\*10=100

Gtotal,dB=10log10(100)=20 dB

1. the effective noise temperature referred to input:

Teq=T1+T2/G1+T3/G1G2

Now

T1=200k

T2=200k

G1=10

Teq=200+200/10=200+20

Teq=220k

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

Given:

Noise factor:

F=7.1

1. the noise figure:

Noise figure (NF)=10log10(F)

NF=10log10(7)

=10\*0.8451=8.45 dB

1. the equivalent noise temperature:

Te=(F-1)T0

Te=(7-1)(290)=6\*290

Te=1740k