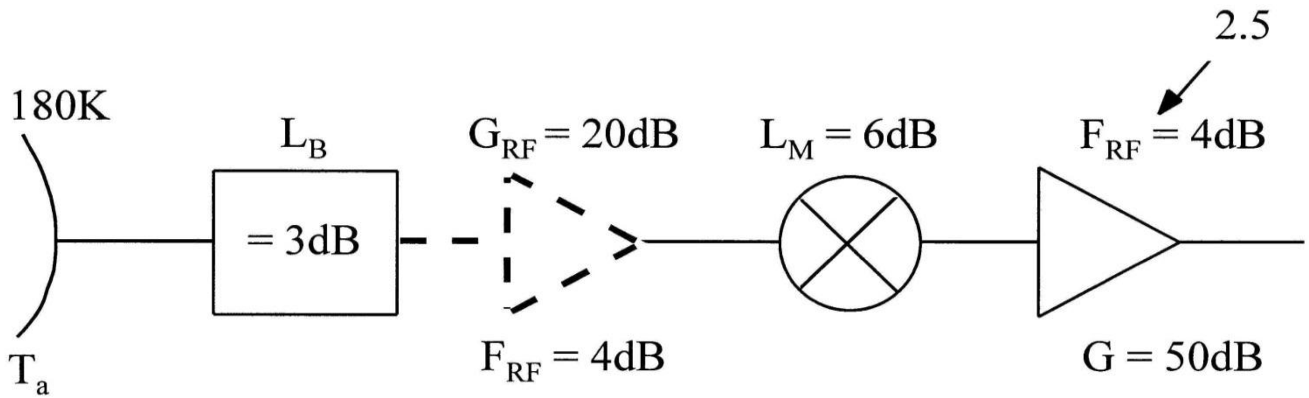
Satellite Communications Tutorial Solutions

Question 1



$$T_e = T_a + (L_B - 1)290 + L_B(F_{RF} - 1)290 + \frac{L_B(L_M - 1)290}{G_{RF}} + \frac{L_B L_M (F_{IF} - 1)290}{G_{RF}}$$

Without *RF* amp ($F_{RF} = 1$, $G_{RF} = 1$).

$$T_e = 180 + 290 + 1740 + 3480 = 5690°\,\mathrm{K}$$

$$\therefore \quad \underline{F_0 = \frac{T_e}{290} + 1 = 20.62 = 13.14\mathrm{dB}}$$

(b) If an RF amplifier, with a gain of 20 dB and a noise figure of 4 dB, is added before the mixer what is the new noise figure of the receiver?

$T_e = 180 + 290 + 870 + 17 = \underline{1357^{o}K}$

$\underline{F_0 = 5.68 = 7.5 \text{ dB}}$

(c) If the feeder loss is reduced to 1 dB, what is the new noise figure?

If $L_B = 1 \text{ dB} = 1.26$

$Te = 180 + 75.4 + 548 + 17 = \underline{814^{o}K}$

$\underline{F_0 = 3.8 = 5.8 \text{ dB}}$

Solution Question 2

Downlink: $$\left(\frac{C}{T}\right)_D = E_s - L_D - M + \frac{G_e}{T_e} \quad \text{dBW/K}$$

P_S = 10 W = 10 dBW, and $E_S = G_S + P_S$ = 25 + 10 = 35 dBW

T_e = 70 K = 18.45 dBK Hence G_e/T_e = 56 – 18.45 = 37.55 dB/K

C/T_D = -130.45 dBW/K = 9.016 x 10^{-14} W/K

Overall C/N_T = 22 dB

$C/T_T = C/N_T$ + 10log k + 10log B = 22 – 228.6 + 67.78 = -138.82 dBW/K
= 1.312 x 10^{-14} W/K

Now $$\left(\frac{C}{T}\right)_T = \frac{1}{\frac{1}{(C/T)_U} + \frac{1}{(C/T)_D}}$$

$C/T_U = 1.537 \times 10^{-14}$ W/K = -138.14 dBW/K

Now $$\left(\frac{C}{T}\right)_U = E_e - L_U - M + \frac{G_s}{T_s}$$

G_s/T_s = 25 - 10log1420 = 25 - 31.52 = -6.52 dB/K

M = 3, L_U = 202 dB

Hence E_e = -138.14 + 202 + 3 – (-6.52) = 73.38 dBW

$E_e = G_e + P_e$,

hence P_e = 73.38 – 56 = <u>17.78 dBW = 60 W</u>

Question 3

Transmitting antenna gain = 20 dB

f = 2295 MHz,   = 0.1307 m

d = 9.4 x 108 km = 9.4 x 1011 m

Path loss = 20 $\log_{10}$ [4d/λ] = 20 log10 [4 x 9.4 x 1011/0.1307] = 279.1 dB

Transmitter output power = 30 W = +14.8 dBW

Receiver noise floor = kTB = 1.38 x 10-23 x 25 x 100 = **-**194.6 dBW

Gain of receiving antenna = 10 $\log_{10}[4\pi A_e/\lambda^2]$
=10 $\log_{10}$ [4π x 0.56 x π x 64 x 64/(4 x 0.1307 x 0.1307)] = 61.2 dB

S/N = 61.2 + 20 + 14.8 **-** 279.1 + 194.6 = 11.5 dB = **14.125 dB**