Problem 1 (10 pts.) A hill of height h is located midway between a transmitter of height h_t = 300m and a receiver of height h_r = 150m. If d = 4000m, f = 1 GHz, and assuming knife-edge diffraction model:

(a) Find the height of the hill h such that the diffraction loss is 6 dB.
(b) What should be the height of the receiver to have a diffraction loss of 14 dB?

(Hint: for $v > -0.7$, $F_d \approx 6.9 + 20\log(\sqrt{(v-0.1)^2+1} + v - 0.1)$ dB)

Problem 2 (12 pts.)
We want to determine the received signal level 1000 m from a BS operating at 900 MHz given the following: h_{bs} = 300 m, G_{bs} = 100, P_t = 10 W, h_m = 10 m, G_m = 1.5 in a large city:

(a) Estimate the path loss using the Hata model (the equations)
(b) Estimate the path loss using the Okumura model (the graphs).
(c) Determine the received power using the estimated path losses.
(d) What would be the distance if the received power is now half the value found in part (c) above?

Problem 3 (8 pts.) Four received power measurements in an urban environment were taken as given in the following table:

Distance r (m)	100	200	400	1000
Received power (dBm)	0	-11	-18	-33

Assume that we want to fit these measurements to the following theoretical model:

$$p_r = p_{r0}\left(\frac{r_0}{r}\right)^n, \quad \text{where } r_0 = 100 \text{ m.}$$

(a) Find the path loss exponent n that gives the minimum mean square error (MMSE) between the measurements and the theoretical model values (**Hint: convert the equation above to dB**).
(b) Calculate the standard deviation about the mean value.
(c) Estimate the received power at r = 2 km.

Problem 4 (10 pts).
(a) A half-wave dipole radiates 175 W continuously at 465 MHz. Find the minimum distance at which the exposure level will be in compliance with 1996 FCC standard for controlled and uncontrolled environments.
(b) Measurements were made in a controlled environment at a point near several electrical sources. The values shown in columns 2, 3, and 4 in the table below represent the measured frequency and the electric and magnetic field strengths as averaged over an area equivalent to the vertical cross section of an adult. Check compliance of these sources with the FCC standards for a controlled environment or not.

Source	f (MHz)	E (V/m)	H (A/m)	Duty-factor (%)
1	25	70	0.2	100
2	150	100	0.1	50
3	950	300	0.1	25