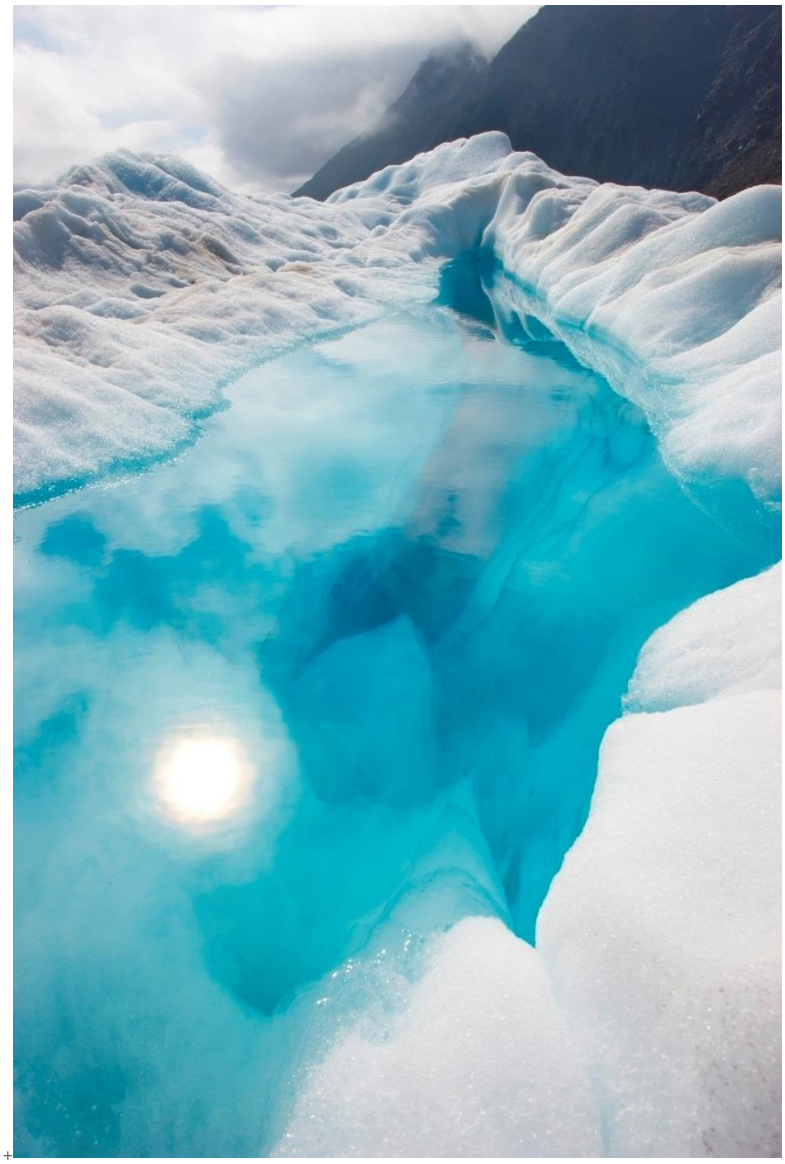

HW#1 Simulations

WIRELESS COMMUNICATIONS

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Part a:

SIMULATING USERS:

For this goal as has been assumed, number of users is set at *100000*. Since their coordinates comes from a uniform distribution, *x* and *y* vectors are created using ***'rand'*** function in ***MATLAB***.

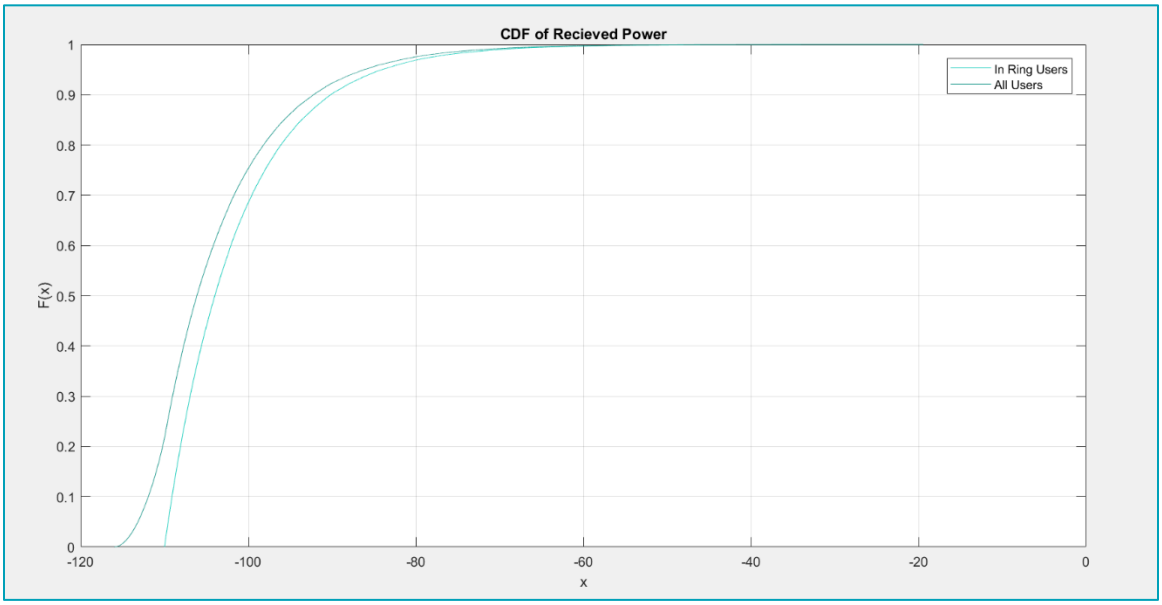
SIMULATING USERS DISTANCES:

Since only users in the radius $10 < r < 1000$ are acceptable, using the below formula *r* is calculated and users with radius more than that are ignored.

$$r = \sqrt{x^2 + y^2}$$

CALCULATING P_R AND PLOTTING ITS CDF:

For this goal first the transmitted power's unit is changed to *dBm*. Then using the given formula received power is calculated. With function ***'cdfplot'*** in ***MATLAB***, *CDF* of P_R is plotted. The result is the below picture:

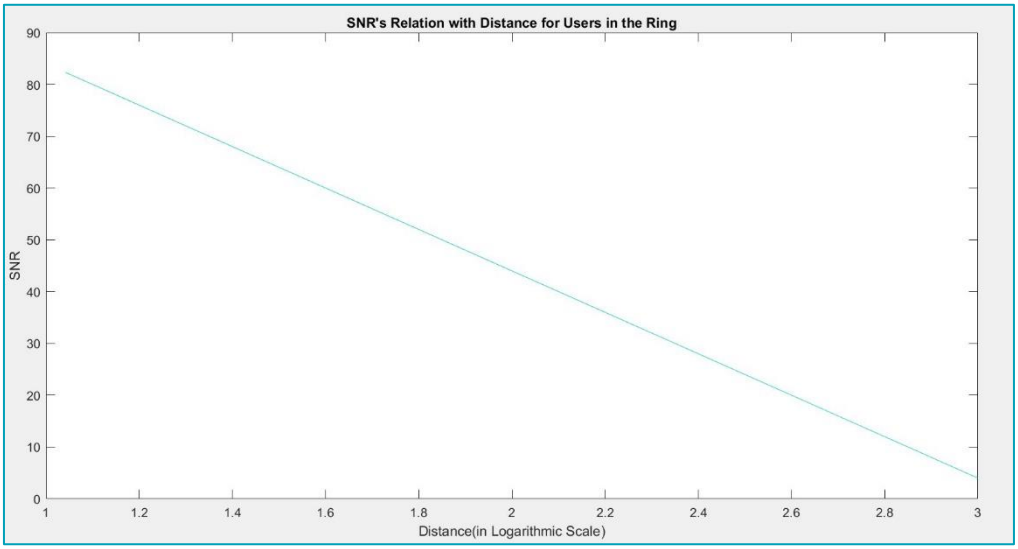


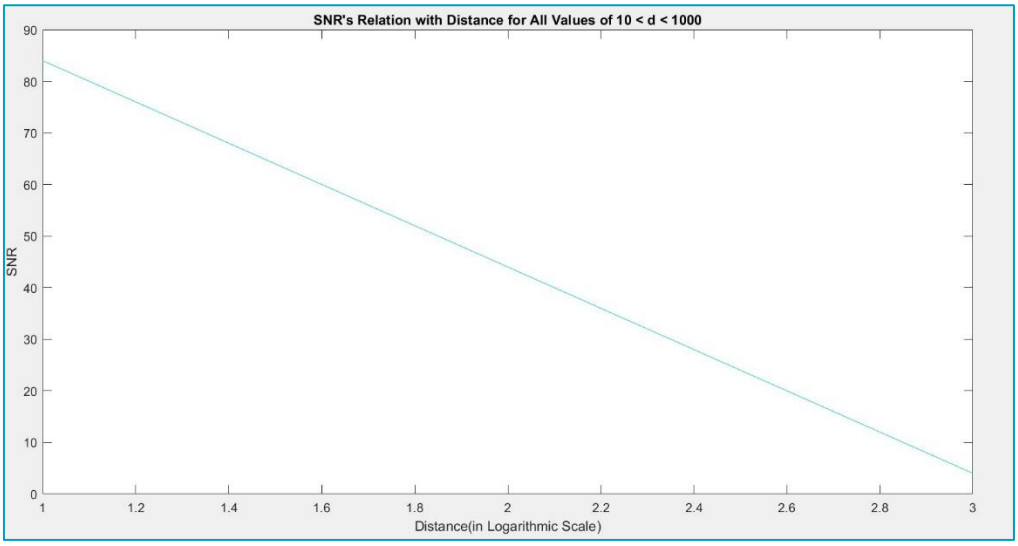
Part b:

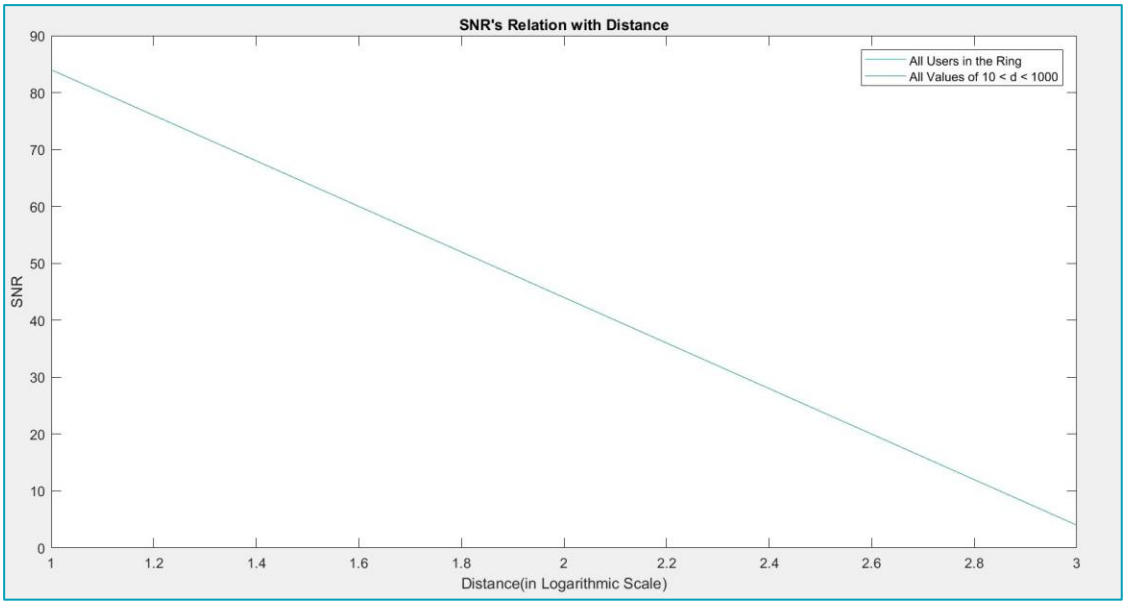
In this part first N_0's is changed to *dBm*. After that *SNR* is calculated for all values of d between 10 and 1000 and is also calculated for all the users' distances found in the last

part. As the third plot suggest the result is not different. (For calculating *SNR*, P_R is calculated as it was in part a.)

The resulting plots can be seen below:





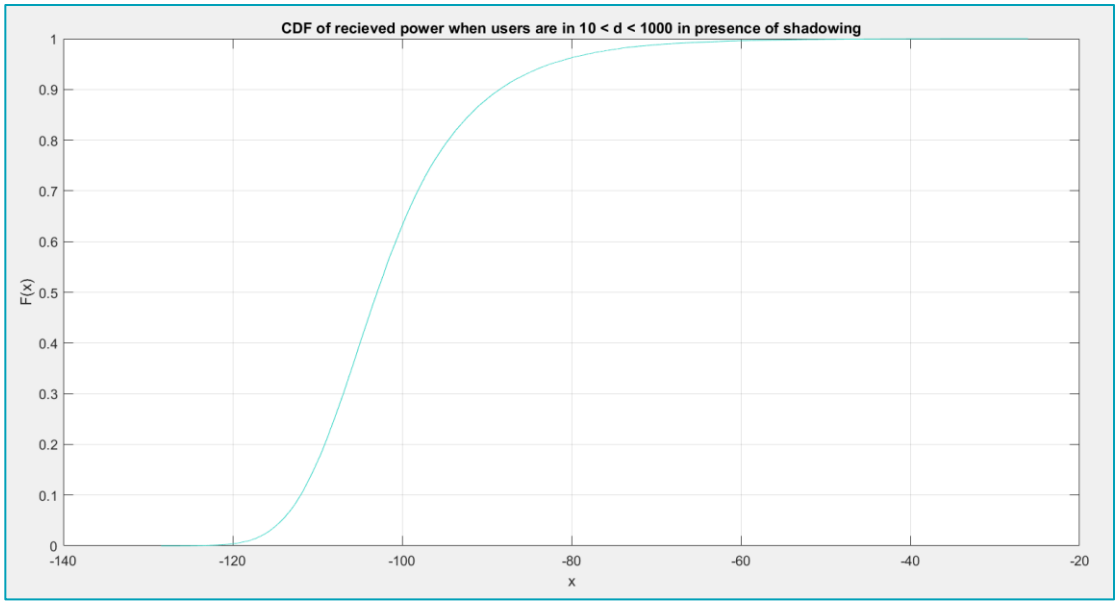


Part c:

In this part result of ***shadowing*** is also added to the received power calculations. In order to model shadowing effect, X (in dB) has normal distribution. It's a zero mean random variable with a standard deviation of $5\ dB$.

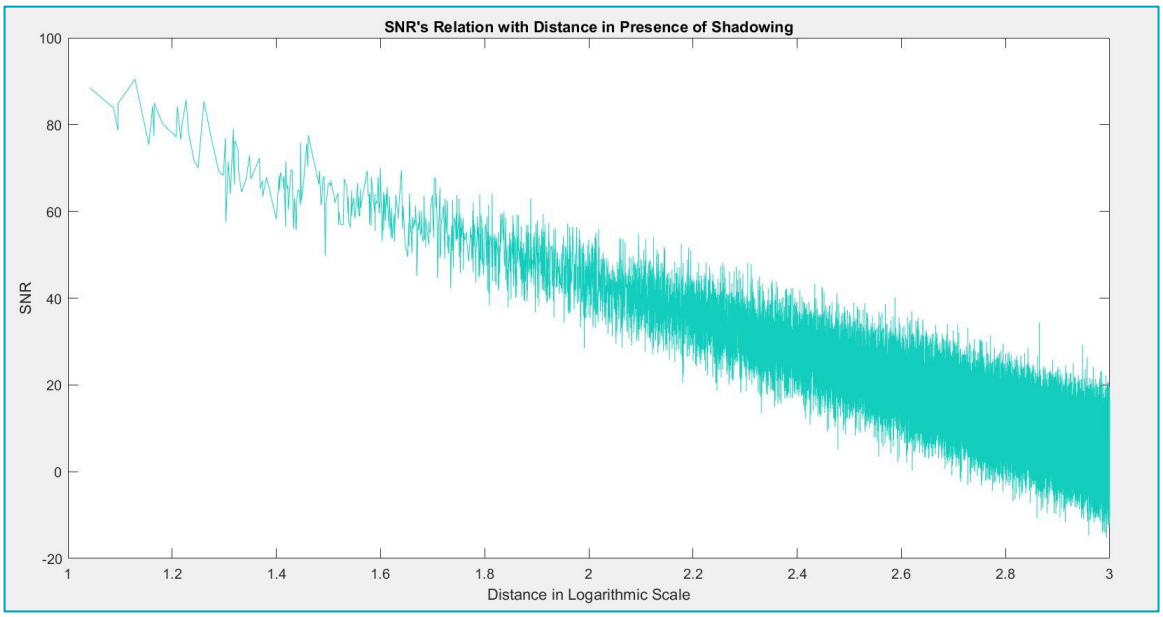
PLOTTING CDF OF RECEIVED POWER:

By using the given formal P_R is calculated and its *CDF* is plotted same as what has been done in part a.



PLOTTING SNR:

Calculating *SNR* is as the same as part b with knowing the fact that the received signal is the received power is now calculated with a parameter representing ***shadowing effect***. The resulting plot is shown below:



As can be seen, as distance increases, *SNR* decreases. Its decrement is approximately linear like it was in part b, but the difference is that it's not a clean line. There are some bounces which are a result of ***shadowing***.

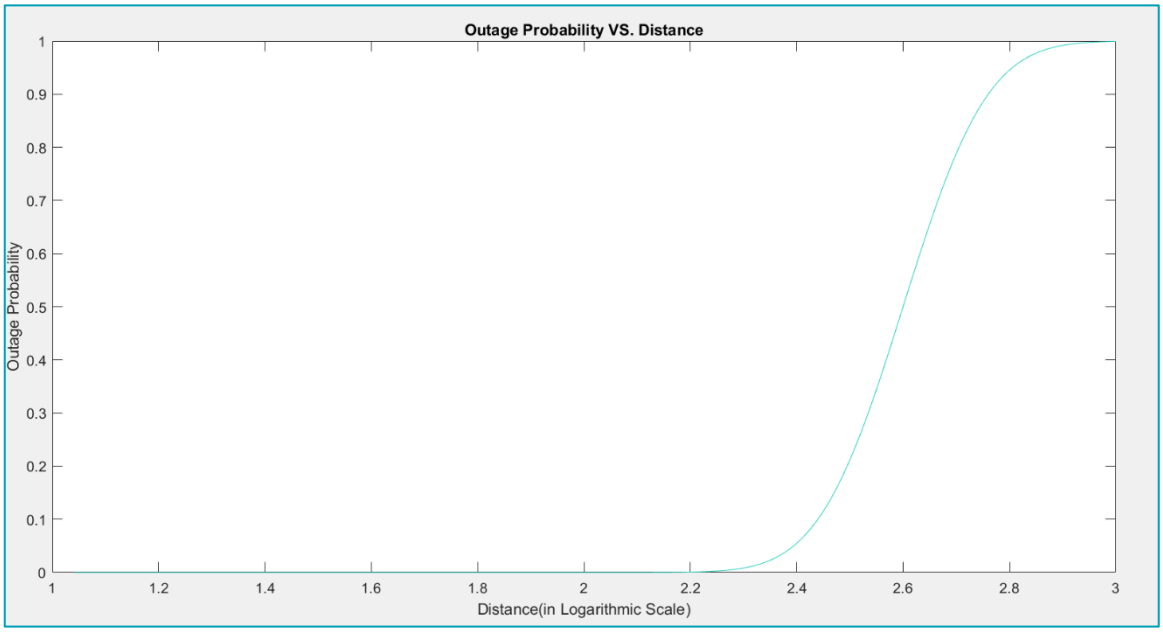
Part d:

Same as what has been done in the other questions, equations written below show how P_{out} is calculated:

$$P_{out} = p\{SNR < SNR_{min}\} = p\{P_R - P_N < ۲۰\} = p\left\{P_o - ۱۰\, n \log_{۱۰}\left(\frac{d}{d_o}\right) + X - P_N < ۲۰\right\}$$

$$= p\left\{X < ۲۰ - P_o + ۱۰\, n \log_{۱۰}\left(\frac{d}{d_o}\right) + P_N\right\} = ۱ - Q\left(\frac{۲۰ - P_o + ۱۰\, n \log_{۱۰}\left(\frac{d}{d_o}\right) + P_N}{\sigma}\right)$$

So the resulting plot for users in the ring is shown in the next page:



Part e:

GOLDSMITH'S FORMULA:

Using the below formulas, a and b are calculated and with them in hand, C is calculated.

$$a = \frac{P_{min} - \overline{P_R}(R)}{\sigma} \, . b = \frac{١٠ \gamma \log_{١٠} e}{\sigma} \rightarrow C = Q(a) + \exp\left\{\frac{٢ - ٢ ab}{b^{٢}}\right\} Q\left(\frac{٢ - ab}{b}\right)$$

If these values are simulated the coverage area will be about %18.6924.

WITHOUT GOLDSMITH FORMULA:

For all the users in the ring, the ones with *SNR* more than *20 dB* are selected. The number of these users divided by all the users in the ring show the coverage area.

If the above algorithm is used the result is about %18.7179.

Both of the above ways of finding the coverage area shows almost the same result.