ECS 455: In-Class Exercise #1

Instructions

1. Separate into groups of no more than three persons.
2. The group cannot be the same as your former group.
3. Only one submission is needed for each group.
4. ***Write down all the steps*** that you have done to obtain your answers. You may not get full credit even when your answer is correct without showing how you get your answer.
5. **Do not panic.**

Date: 0 1 / 0 2 / 2017	
Name	ID (last 3 digits)
Prapun	555

1) In the spaces below, indicate the effect on the received power (in dB) when the (carrier/center) frequency is consecutively changed from 2.1 GHz to 1.800 MHz, 900 MHz, and 850 MHz. Put your answers in the provided boxes. Don't forget to show your calculation.

Hint: Use the Friis Equation.

2.1 GHz → 1800 MHz → 900 MHz → 850 MHz

1.3389 dB gain	6.0206 dB gain	0.4965 dB gain

$20\times\log_{10}\frac{2100}{1800}$ $20\times\log_{10}\frac{1800}{900}$ $20\times\log_{10}\frac{900}{850}$

Recall that $\frac{P_r}{P_t}=\left(\frac{\sqrt{G_T G_R}\,c}{4\pi d f}\right)^2$

So, $P_r \propto \frac{1}{f^2}$

$$\frac{P_{new}}{P_{old}}=\left(\frac{f_{old}}{f_{new}}\right)^2$$

Therefore, $10\log_{10}P_{new}-10\log_{10}P_{old}=20\log_{10}\frac{f_{old}}{f_{new}}$

2) Now, let's analyze this change of (carrier/center) frequency from another perspective. Suppose that by operating at f = 2.1 GHz, an operator can cover a circular area of radius r = 1 km around its base station.
If the frequency f is changed to other values listed in the table below, calculate the corresponding radius of the coverage area.

f	r
2.1 GHz	1 km
1800 MHz	1.1667 km
900 MHz	2.3333 km
850 MHz	2.4706 km

A position is inside the coverage area if the received power there is large enough (over some threshold).

At the boundary of the cell, to keep the received power at the threshold level as we change the freqs, we must keep the product "df" constant.

$$d_{new} f_{new} = d_{old} f_{old}$$

$$d_{new} = d_{old}\frac{f_{old}}{f_{new}}$$

$$= 1\,[\text{km}]\times\frac{2100\,[\text{MHz}]}{f_{new}}$$

Note that we double the range by halving the frequency.

Again, $\frac{P_r}{P_t}=\left(\frac{\sqrt{G_T G_R}\,c}{4\pi d f}\right)^2$.

Hint: Use the Friis Equation.