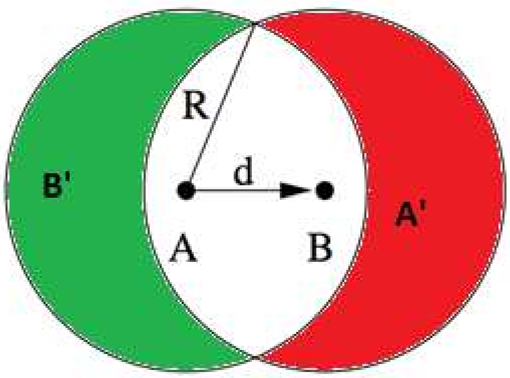
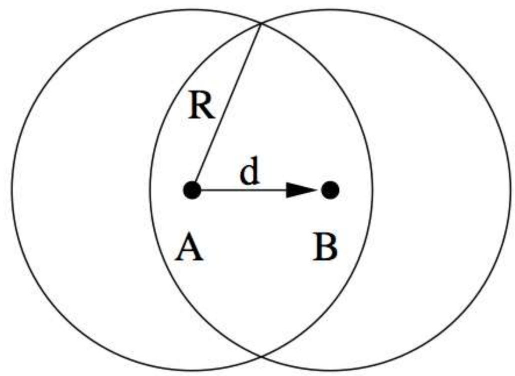
CSC 478/678 Principles of Wireless Networks
Spring 2021
Homework #2

1. Explain why Carrier Sensing Multiple Access will not work directly in WiFi networks, where one Access Point (AP) is serving multiple wireless devices.

   Works generally well in fully connected networks, but has issues with “hidden” terminals that are connected to AP and unknown to the sender. Also collisions may still occur because of propagation delay where channel seems clear because first bit not received yet.

2. Transmission is taking place from node A to node B (see figure below), which are separated by a distance of d. R is the transmission range of each node.
   a. Mark in the figure the regions that could contain hidden terminals and exposed terminals, separately.



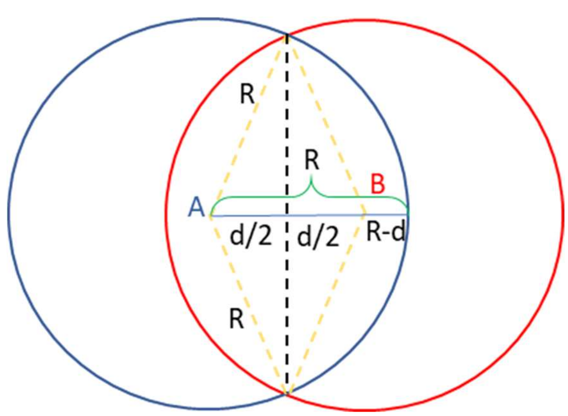


Red area (A’) is space that may contain a hidden terminal for A but exposed to B
Green area (B’) is space that may contain a hidden terminal for B but exposed to A
White area would contain all exposed terminals for both A and B

b. As d increases from 0 to R, do you expect to the sizes of these regions increase or decrease?

As the distance between A and B increases, the regions of potential hidden terminals will increase while the region of exposed terminals will decrease.

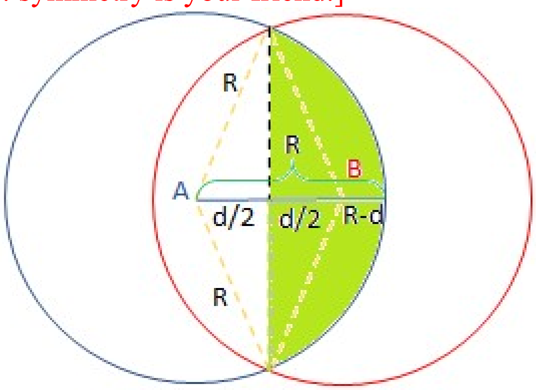
c. Derive the formula that shows the size of hidden terminal region as a function of R and d
   [Hint: some trigonometry is needed.]



Hidden = 2 * Total - Exposed, where $0 \le d \le R$
Total (area of circle) = πR^2
Exposed = 2 * Segment
Segment = Sector – Triangle
Sector = $[2 * \cos^{-1}(d/2R)]/360 * (\pi R^2)$
Triangle = $1/2bh = \sqrt{(R^2 - 0.5d^2)} * (0.5d)$
Segment = $[2 * \cos^{-1}(d/2R)]/360 * (\pi R^2) - \sqrt{(R^2 - 0.5d^2)} * (0.5d)$

Hidden = $2 * \pi R^2 - 2 * ([2 * \cos^{-1}(d/2R)]/360 * (\pi R^2) - \sqrt{(R^2 - 0.5d^2)} * (0.5d))$
Hidden = $2\pi R^2 - 2 * [2 * \cos^{-1}(d/2R) * (\pi R^2) - \sqrt{(R^2 - 0.5d^2)} * (0.5d)]$
Hidden = $2\pi R^2 - 2\pi R^2[2 * \cos^{-1}(d/2R)]/360 - d\sqrt{(R^2 - 0.5d^2)}$
Hidden = $2\pi R^2 (1 - [2 * \cos^{-1}(d/2R)]/360 - d\sqrt{(R^2 - 0.5d^2)})$

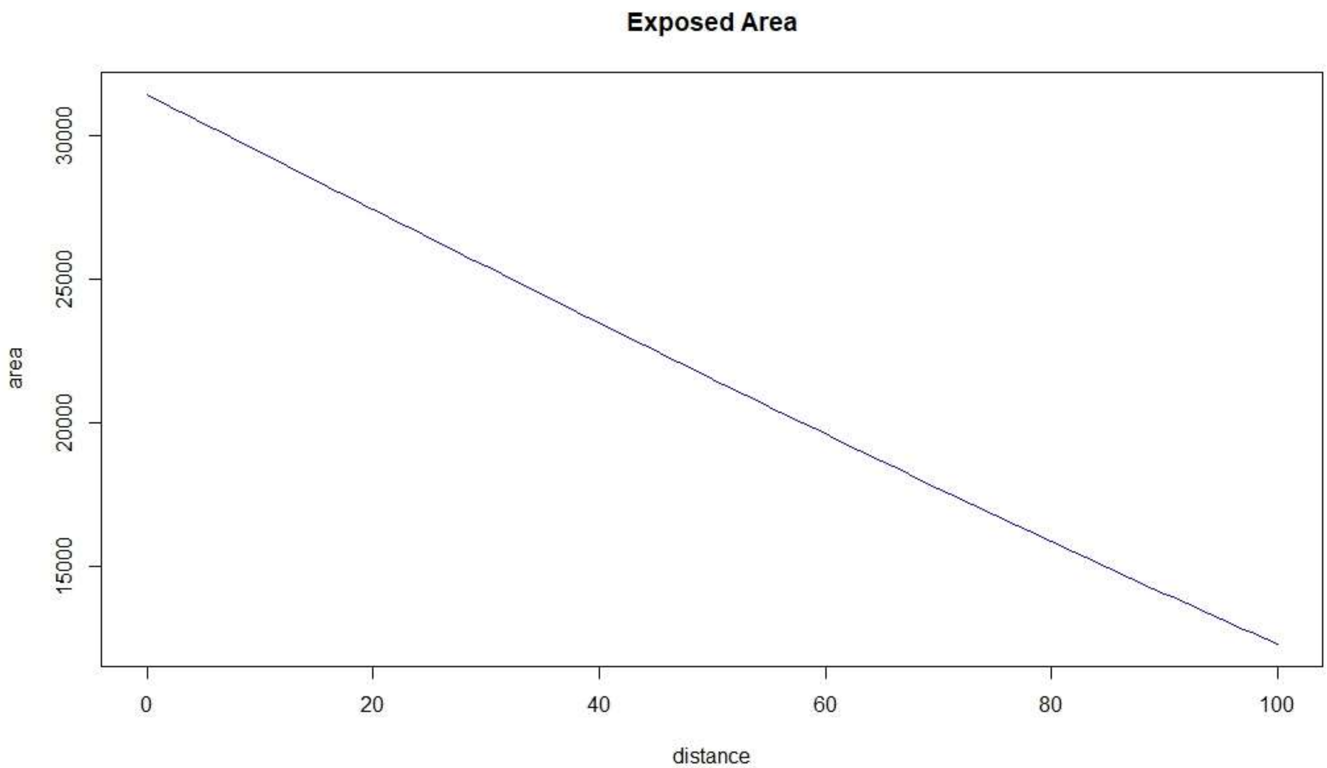
d. Derive the formula that shows the size of exposed terminal region as a function of R and d.
[Hint: symmetry is your friend.]

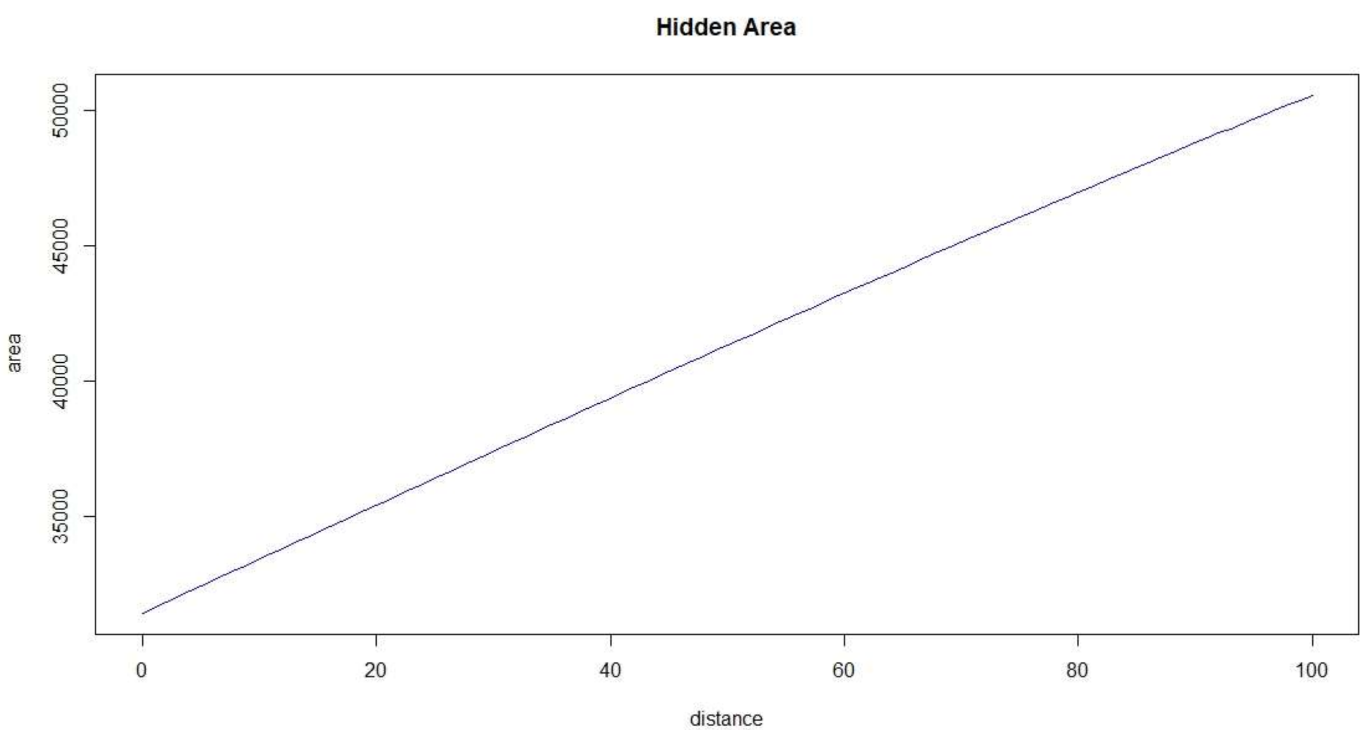


Sector = $[2 * \cos^{-1}(d/2R)]/360 * (\pi R^2)$
Triangle = $1/2bh = \sqrt{(R^2 - (0.5d)^2)} * (0.5d)$
Segment = Sector – Triangle
Segment = $[2 * \cos^{-1}(d/2R)]/360 * (\pi R^2) - \sqrt{(R^2 - (0.5d)^2)} * (0.5d)$

Exposed = 2 * Segment
Exposed = $2 * ([2 * \cos^{-1}(d/2R)]/360 * (\pi R^2) - \sqrt{(R^2 - (0.5d)^2)} * (0.5d))$
Exposed = $2\pi R^2[2 * \cos^{-1}(d/2R)]/360 - d\sqrt{(R^2 - (0.5d)^2)}$

3. Use your favorite programming language to compute the size of hidden terminal regions and exposed terminal regions as a function of d. Assume R = 100 meters and $0 \le d \le R$. Therefore, you should show one figure with region sizes as Y-axis and d as X-axis, two lines with enough details. Since the code is no more than 5 lines, no need to attach your code in your submission.


Exposed Area
area
30000
25000
20000
15000
0
20
40
60
80
100
distance


Hidden Area
area
50000
45000
40000
35000
0
20
40
60
80
100
distance