無線通訊網路作業三

系級：_____ 組別：_____ 學號：_____ 姓名：_____

1. A BS has a 900 MHz transmitter and a vehicle is moving at the speed of 50 mph. Compute the received carrier frequency if the vehicle is moving.

$f_c = 900\ MHz$

$\lambda = \frac{c}{f_c} = 0.333\ m$

$v = 50\ mph = 22.22\ m/s$

a. Directly toward the BS.

$\theta = 180^\circ$

$f_d = \frac{v}{\lambda}\cos\theta = -67.06$

$f_r = f_c - f_d = 900\times10^6 + 67.06 = 900.000067\times10^6\ MHz.$

b. Directly away from the BS.

$\theta = 0^\circ$

$f_d = \frac{v}{\lambda}\cos\theta = 67.06$

$f_r = f_c - f_d = 900\times10^6 - 67.06 = 899.99993\times10^6\ MHz.$

c. In a direction which is 60 degree to the direction of arrival of the transmitted signal.

$\theta = 60^\circ$

$f_d = \frac{v}{\lambda}\cos\theta = -33.53$

$f_r = f_c - f_d = 900\times10^6 + 33.53 = 900.000033\times10^{10}\ MHz.$

2. A wireless receiver with an effective diameter of 250 cm is receiving signals at 20 GHz from a transmitter that transmits at a power of 30 mW and a gain of 30 dB.

$de = 250\ cm$

$fc = 20\ GHz$

$Pt = 30\ mW$

$Gt = 30\ dB = 1000$

$d = 5\ km$

$Ae = \left(\frac{\pi de^2}{4}\right) = 4.91\ m^2$

$\lambda = \frac{c}{fc} = \frac{3\times10^8\ m/s}{2\times10\times10^9\ Hz} = 0.015\ m$

a. What is the gain of the receiver antenna?

$Gr = \frac{4\pi Ae}{\lambda^2} = 2.74\times10^5 \doteq 54.38\ dB.$

b. What is the received power if the receiver is 5 km away from the transmitter?

$Pr = \frac{Ae\,Gr\,Pt}{4\pi d^2} = 4.69\times10^{-9}$

3. Consider an antenna transmitting at 900 MHz. The receiver is traveling at a speed of 40 km/h. Calculate its Doppler shift.

$fd = \frac{v}{\lambda}\cos\theta = \frac{\left(\frac{4\times10^4}{3600}\right)}{\left(\frac{3\times10^8}{9\times10^8}\right)} \times 1 \doteq 33.67\ Hz.$

4. Consider an antenna transmitting a power of 5 W at 900 MHz. Calculate the received power at a distance of 2 km if propagation is taking place in free space.

$P_t = 5\,W$

$f_c = 900\,MHz$

$\lambda = \frac{c}{f_c} = \frac{3\times10^8}{9\times10^8} = 0.33\,m$

$d = 2\,km$

$G_t = G_r = 1$

$P_r = \frac{G_t G_r P_t}{(\frac{4\pi d}{\lambda})^2} = 8.8\times10^{-10}\,W$

5. The transmission power is 40 W, under a free space propagation model.
   a. What is the transmission power in unit of dBm?

$10\times\log(40\times1000) = 46\,dBm$

   b. The receiver is in a distance of 1000 m; what is the received power, assuming that the carrier frequency f_c = 900 MHz and $G_t = G_r$ = 1 dB?

因課本習題題目敘述有誤. 題目應為 $G_t = G_r = 1\,dB$.

$P_r = \frac{G_t G_r P_t}{(\frac{4\pi d}{\lambda})^2} = \frac{40\times1\times1\times(\frac{1}{3})^2}{(4\pi\times1000)^2} = 2.82\times10^{-8}\,W$

   c. Express the free space path loss in dB.

$L_f(dB) = 32.45 + 20\log_{10} f_c + 20\log_{10} d$

$\fallingdotseq 91.5349\,dB$