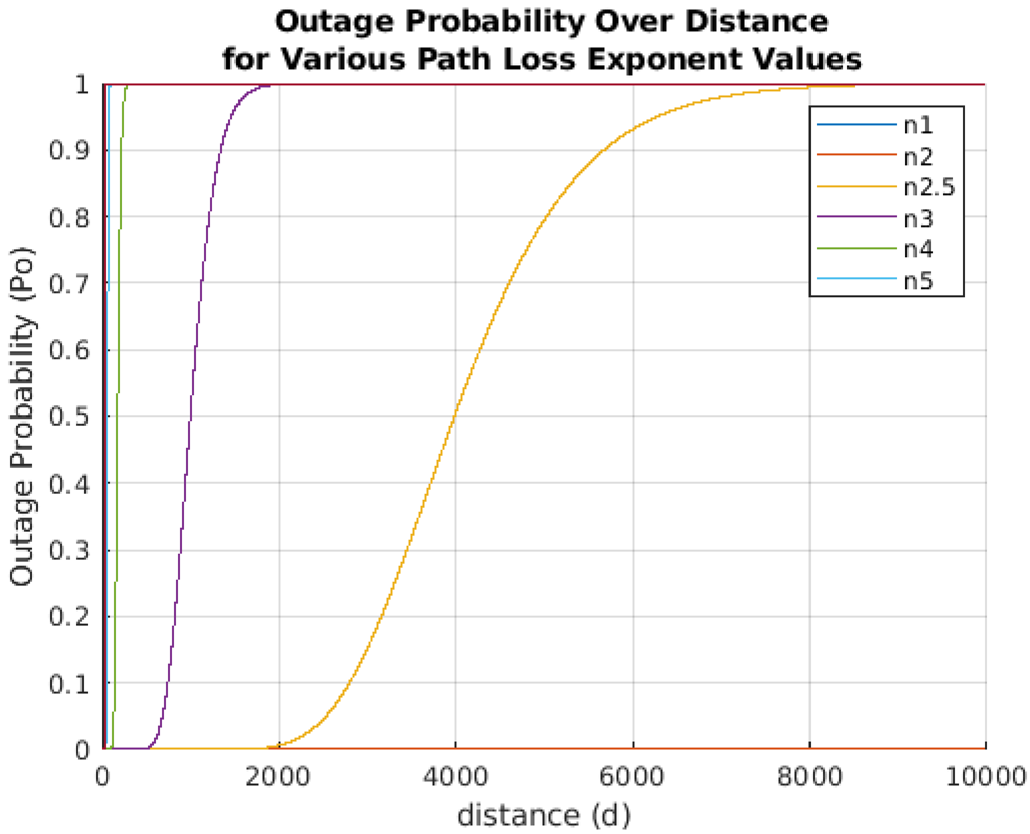
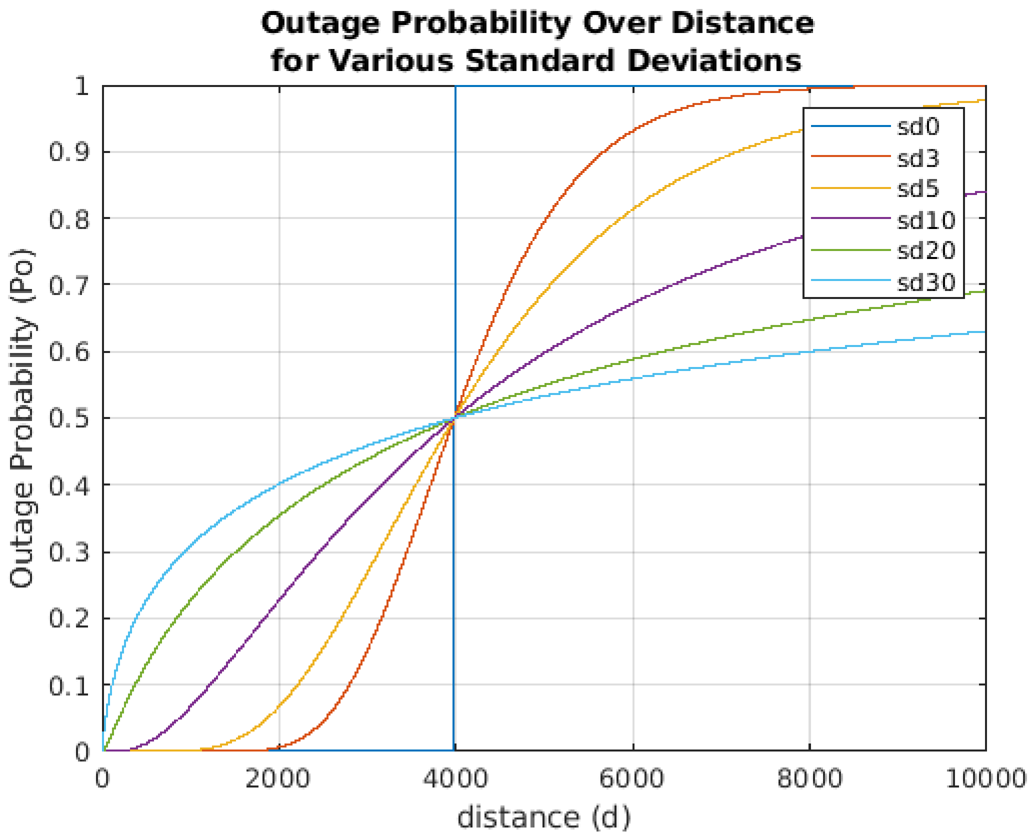
# ee597-assignment2

Determining outage probability as a function of distance for log-normal shadowing, rate adaption for varying ranges of SNR, and modeling Rayleigh Fading as a two-state markov chain.

## Outage Probability as a function of distance for Log-Normal Shadowing

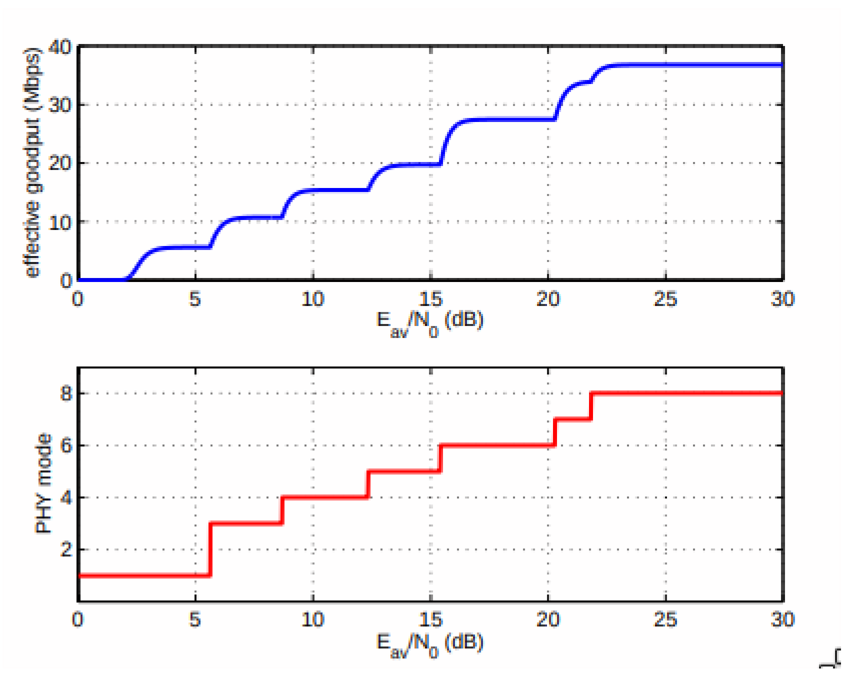


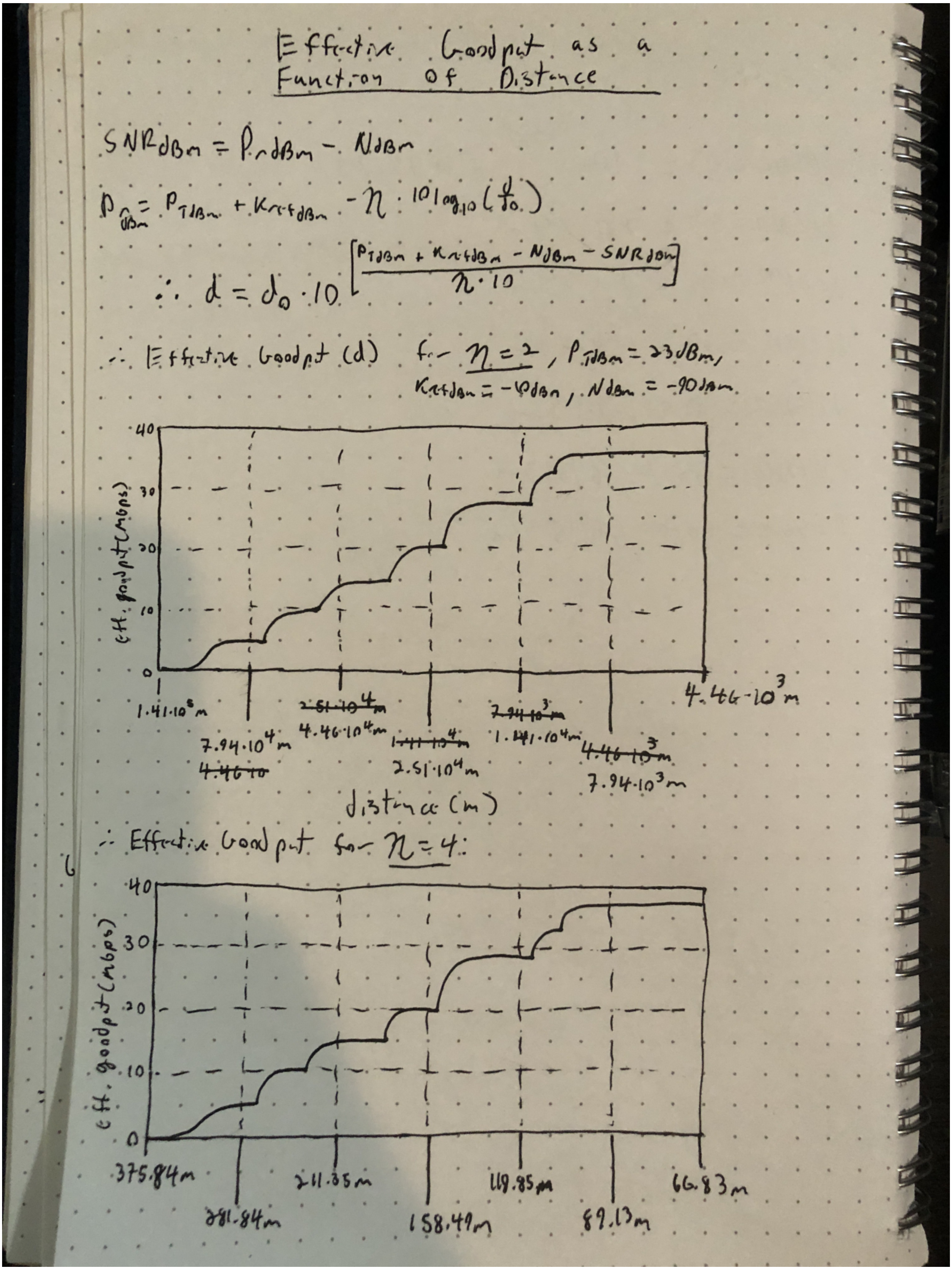

We can see that the probability of outage sigmoid function gets skewed left as we increase the value of the path loss exponent (PLE). This means that the probability of outage increases exponentially by a greater factor when the PLE is increased. This makes sense, as the PLE represents the attenuation due to the nature of the environment (heta > 2 : loss, heta = 2 : vacuum, or no loss, heta < 2 : gain).




We can see that the probability of outage sigmoid function gets shallower as the standard deviation of the path loss exponenent (PLE) increases. This makes sense, as the probability of outage is inversely proportional to the log of the PLE's standard deviation.

## Rate Adaptation






In this exercise, we converted SNR to distance with a known path loss model. $P_T$dBm = 23dBm, $P_{ref}$ = -10dBm, NdBm = -90dBm. We took figure 3 and converted the model from Goodput vs SNR to Goodput vs Distance (m) with heta values 2 and 4. Here is a breakdown of the SNR --> d(m) conversions for clarity: d = d0 * $10^{(PTdbm + Pref - NdBm - SNRdBm)/(heta * 10)}$

heta = 2:
d(SNR = 0) = 1.41E5m
d(SNR = 5) = 7.94E4m
d(SNR = 10) = 4.46E4m
d(SNR = 15) = 2.51E4m
d(SNR = 20) = 1.41E4m
d(SNR = 25) = 7.94E3m
d(SNR = 30) = 4.46E3m

heta = 4:
d(SNR = 0) = 375.84m
d(SNR = 5) = 281.84m
d(SNR = 10) = 211.35m
d(SNR = 15) = 158.49m
d(SNR = 20) = 118.85m
d(SNR = 25) = 89.13m
d(SNR = 30) = 66.83m

## Rayleigh Fading

In this exercise, we generated Markov Chain models to represent the likelihood that a receiver is in the state of "receive" or "outage." The Markov Chain models and their probabilities are associated with received power (in dBm) being above or below a threshold, dictating whether the received signal is strong enough to demodulate or not. We generated 6 models corresponding to mobile speeds [0, 5, 10, 15, 20, 25].

p00 - *the probability that we remain in the "outage" state*
p01 - *the probability that we move from the "outage" state to the "receive" state*
p10 - *the probability that we move from the "receive" state to the "outage" state*
p11 - *the probability that we remain in the "receive" state*

mobile speed = 0:
p00 = 0.0780
p01 = 0.1400
p10 = 0.1395
p11 = 0.6420

mobile speed = 5:
p00 = 0.0775
p01 = 0.1490
p10 = 0.1490
p11 = 0.6240

mobile speed = 10:
p00 = 0.0715
p01 = 0.1430
p10 = 0.1425
p11 = 0.6425

mobile speed = 15:

p00 = 0.0655

p01 = 0.1570

p10 = 0.1575

p11 = 0.6195

mobile speed = 20:

p00 = 0.0750

p01 = 0.1420

p10 = 0.1420

p11 = 0.6405

mobile speed = 25:

p00 = 0.0810

p01 = 0.1485

p10 = 0.1485

p11 = 0.6215