Question 2

$$SINR = 10log_{10}\frac{P_{rx}}{N}$$

$$SINR = P_{rx}[dBm] - N[dBm]$$

$$P_{rx}[dBm] = SINR + N[dBm]$$

$$P_{rx}[dBm] = 20 + (-100) = -80dBm$$

Question 3

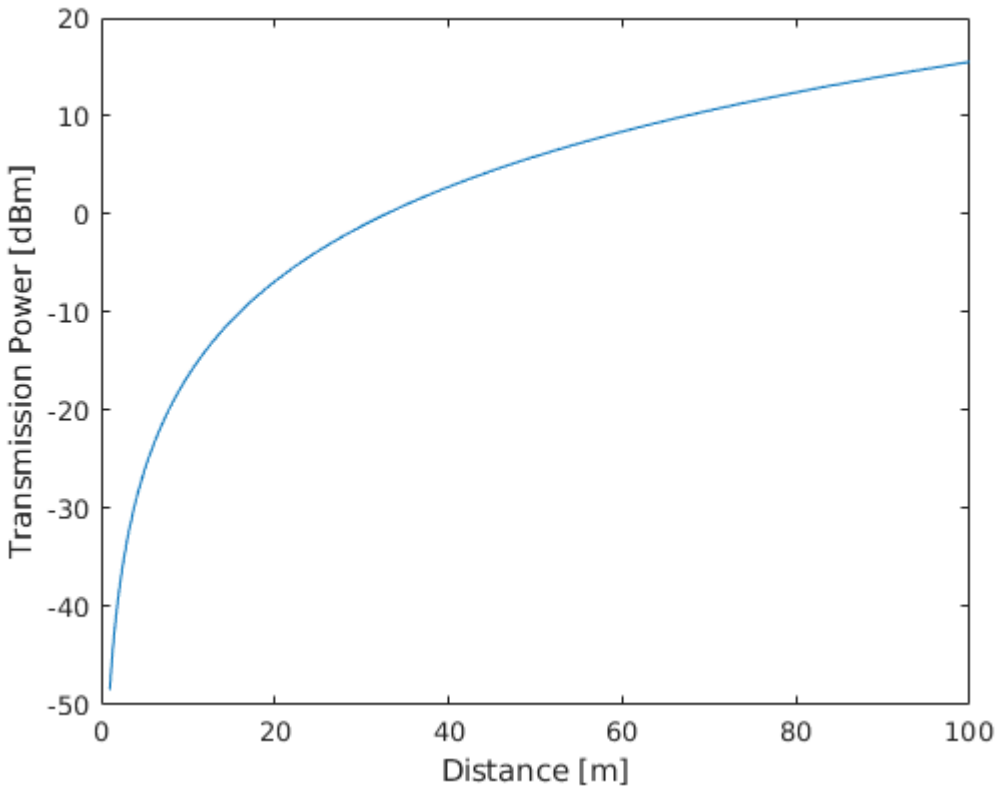
$$P_{rx,min}[dBm] = -80dBm$$

$$P_{tx,min}[dBm] + G_{tx}[dBi] + G_{rx}[dBi] + 20log_{10}(\frac{\lambda}{4\pi d_0}) + 10\gamma log_{10}\frac{d_0}{d} = -80dBm$$

$$P_{tx,min}[dBm] + 0 + 0 + 20log_{10}(\frac{\lambda}{4\pi d_0}) + 10\gamma log_{10}\frac{d_0}{d} = -80dBm$$

$$P_{tx,min}[dBm] = -80 - 20log_{10}(\frac{\lambda}{4\pi d_0}) - 10\gamma log_{10}\frac{d_0}{d}$$

```
c = physconst('LightSpeed');
f = 900 * 1e6;
Gamma = 3.2;
d0 = 1;
lambda = c / f;
power_f = @(d) -80 - 20*log10(lambda/(4*pi*d0)) - 10*Gamma*log10(d0./d);
d = 1:0.1:100;
ptx = power_f(d);
% plot the required transmission power as a function of the distance
% between a node and the BS.
plot(d, ptx);
ylabel('Transmission Power [dBm]')
xlabel('Distance [m]')
```



Question 4

$$P_{tx,min}[dBm] + G_{tx}[dBi] + G_{rx}[dBi] + 20log_{10}(\frac{\lambda}{4\pi d_0}) + 10\gamma log_{10}\frac{d_0}{d} = -80$$

$$P_{tx,min}[dBm] + 20log_{10}(\frac{\lambda}{4\pi d_0}) + 10\gamma log_{10}\frac{d_0}{d} = -80$$

$$\gamma 10log_{10}(\frac{\lambda}{4\pi d}) = -100 - 20log_{10}(\frac{\lambda}{4\pi d_0})$$

$$\gamma log_{10}\lambda - \gamma log_{10}4\pi d = -10 - 2log_{10}\lambda + 2log_{10}4\pi d_0$$

$$log_{10}4\pi d = \frac{10}{\gamma} + (1 - \frac{2}{\gamma})log_{10}\lambda + \frac{2}{\gamma}log_{10}4\pi d_0$$

$$d = \frac{1}{4\pi}(10^{\frac{10}{\gamma}} \times \lambda^{(1-\frac{2}{\gamma})} \times (4\pi d_0)^{\frac{2}{\gamma}}) = 341.79m$$

$$d_{2BS} = 2 \times d = 683.59m$$

```
d_1bs = 1/(4 * pi)*(10^(10/Gamma)*lambda^(1-2/Gamma)*(4*pi)^(2/Gamma))
```

```
d_1bs = 341.7930
```

```
% d_1bs = 10^(10/Gamma) * lambda / (4 * pi)
d_2bs = d_1bs * 2
```

```
d_2bs = 683.5859
x = 3.6330
d_1bs = 341.7930
```

Question 5

$$t_{tx} = \frac{data}{data\ \ rate} = \frac{20 * 8bit}{1.25 \times 10^4 bit/s} = 1.28 \times 10^{-2} s$$

$$P_{tx}[dBm] = 20dBm \Leftrightarrow P_{tx} = 0.1W$$

$$E = P_{tx} t_{tx} = 0.1W \times 1.28 \times 10^{-2} s = 1.28 \times 10^{-3} J = 1.28mJ$$