WN1 - Quiz-1

1. a. Signal power = 1 watt $= 1 \times 10^3$ mW
in dBm i.e., wrt to 1mW $= 10\log_{10}\frac{10^3}{1}$

$= 30$ dBm

b. Thermal noise power $= -100$ dBm

$$-100 = 10\log_{10}\frac{P_{thN}}{1}$$

$$\Rightarrow P_{thN} = 10^{-10} \text{ mW}$$

$\Rightarrow$ Noise power in watt $= 10^{-13}$ watt.

c. SNR now $= 10\log_{10}\frac{P_S}{P_{thN}}$

$$= 10\log_{10}\frac{1}{10^{-13}}$$

$= 130$ dB

It now faces a path loss of 20dB, so
resultant SNR $= 130 - 20 = 110$ dB

d. Channel Bw $= 40$ MHz.

Shannon's capacity $C = B * \log_2\left(1 + \frac{P_S}{P_N}\right)$

our resultant SNR = 110dB,

$$110 = 10\log_{10}\frac{P_S}{P_N}$$

$$\Rightarrow \frac{P_S}{P_N} = 10^{11}$$

$$C = 40M\log_2(1+10^{11})$$

$$= 1461.64\,Mbps.$$

2. Channel's coherence BW = 2MHz.
Since channel's BW > coherence BW, it will have frequency selective fading. Diff. frequency components will experience uncorrelated fading. Same simple channel equalization techniques won't work.

3. OFDM, # of sub-carriers = 64
data " " = 48

Since the channel BW = 40MHz,
40M timesamples are sent 1 sec

64 sub-carriers = 64 time samples

64 time samples take $\frac{64}{40M}$

$= 1.6\mu s$

Guard band = 800 ns

So, OFDM symbol duration = $1.6 + 0.8$

$= 2.4\mu s$

effective # of data bits = $10 \times 48 \times \frac{3}{4}$

$= 360$ bits

1024 QAM $\rightarrow 2^{10}$.

Thus in $2.4\mu s \rightarrow$ 360 bits are transmitted

$10^6 \mu s$ $\frac{360}{2.4} \times 10^6$

$= 150$ Mbps

b. This modulation scheme can't utilize the network capacity well as it is much lesser than the Shannon's capacity

c. Coherence BW = 2MHz.

Now, Channel BW = 40MHz

There are 64 Subcarriers

Thus BW of each Sub-carrier = $\frac{40}{64}$

= 0.625MHz

Since Sub-Carrier BW < Coherence BW,

there will be flat fading.

d. [Correct timing diagram[3] + correct CW value[1]]