5. [2+3+4+1=10 marks] A 8-point FFT is used to define an OFDM system which can use $P = 1.5$ Joules per symbol. After excluding the zero-tones for n=4 and -3, and the DC subcarrier at n=0, we are left with 5 tones over which data can be sent. The magnitude response of the channel is known to the transmitter, and is as follows: $|H(3)| = 0.5$; $|H(2)| = 0.8$; $|H(1)| = 0.1$; $|H(-1)| = 0.5$; and $|H(-2)| = 0.4$. Find the rate R (in number of bits/sec) that can be supported by each of the following 3 different power allocation schemes given that the noise variance in every sub-carrier is No=0.1.

(a) Uniform power allocation – R_{UNI}

(b) Zero-forcing power allocation where the power allocated on the nth subcarrier is proportional to $\kappa/|H(n)|^2$ where is κ the factor which ensures that the total power does not exceed P per symbol -- R_{ZF}

(c) Water-pouring based power allocation giving the capacity – C

(d) Compare R_{UNI}, R_{ZF}, and C and comment. For what condition(s) will all the 3 schemes give an identical allocation result?