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EE 444 HW 3

I pledge on my honor that I have abided by the Stevens Honor System.

1 $P_{noise} = 0.2\ mW$ $P_{total} = 24\ mW$

$B = 15\ MHz$

a $C = B\log_2\left(1 + \frac{S}{N+I}\right) = 15\times10^6 \log_2\left(1 + \frac{24}{0.2+24}\right)$

$= \boxed{14.9104\ Mbps}$

b $C = B\log_2\left(1 + \frac{S}{N+I}\right) = 15\times10^6 \log_2\left(1 + \frac{24}{0.2+0}\right)$

$= \boxed{103.7829\ Mbps}$

2 $B = 20\ MHz$

$\gamma_1 = 20dB$	$\gamma_2 = 15dB$	$\gamma_3 = 10dB$
$P_1 = 0.1$	$P_2 = .15$	$P_3 = .25$
$\gamma_4 = 5dB$	$\gamma_5 = 0dB$	$\gamma_6 = -5dB$
$P_4 = .15$	$P_5 = .25$	$P_6 = 0.1$

a) $C = \left(\sum_{i=1}^{6} \log_2(1+\gamma_i)P_i\right)B$

$\log_2(1+10^{20/10})0.1(20e6) = 1.3316\ Mbps$

$\log_2(1+10^{15/10}).15(20e6) = 1.5083\ Mbps$

$\log_2(1+10^{10/10}).25(20e6) = 1.7297\ Mbps$

$\log_2(1+10^{5/10}).15(20e6) = 0.6172\ Mbps$

$\log_2(1+10^{0/10}).25(20e6) = 0.5000\ Mbps$

$\log_2(1+10^{-5/10}).1(20e6) = 0.0743\ Mbps$

$C = \sum_i(\text{above}) = \boxed{57.6619\ Mbps}$

b) chart on last page

The maximum average rate is $C = 57.6619$ Mbps

3 $\gamma_1 = 30$ dB $= 1000$, $\gamma_2 = 20$ dB $= 100$, $\gamma_3 = 10$ dB $= 10$, $\gamma_4 = 0$ dB $= 1$

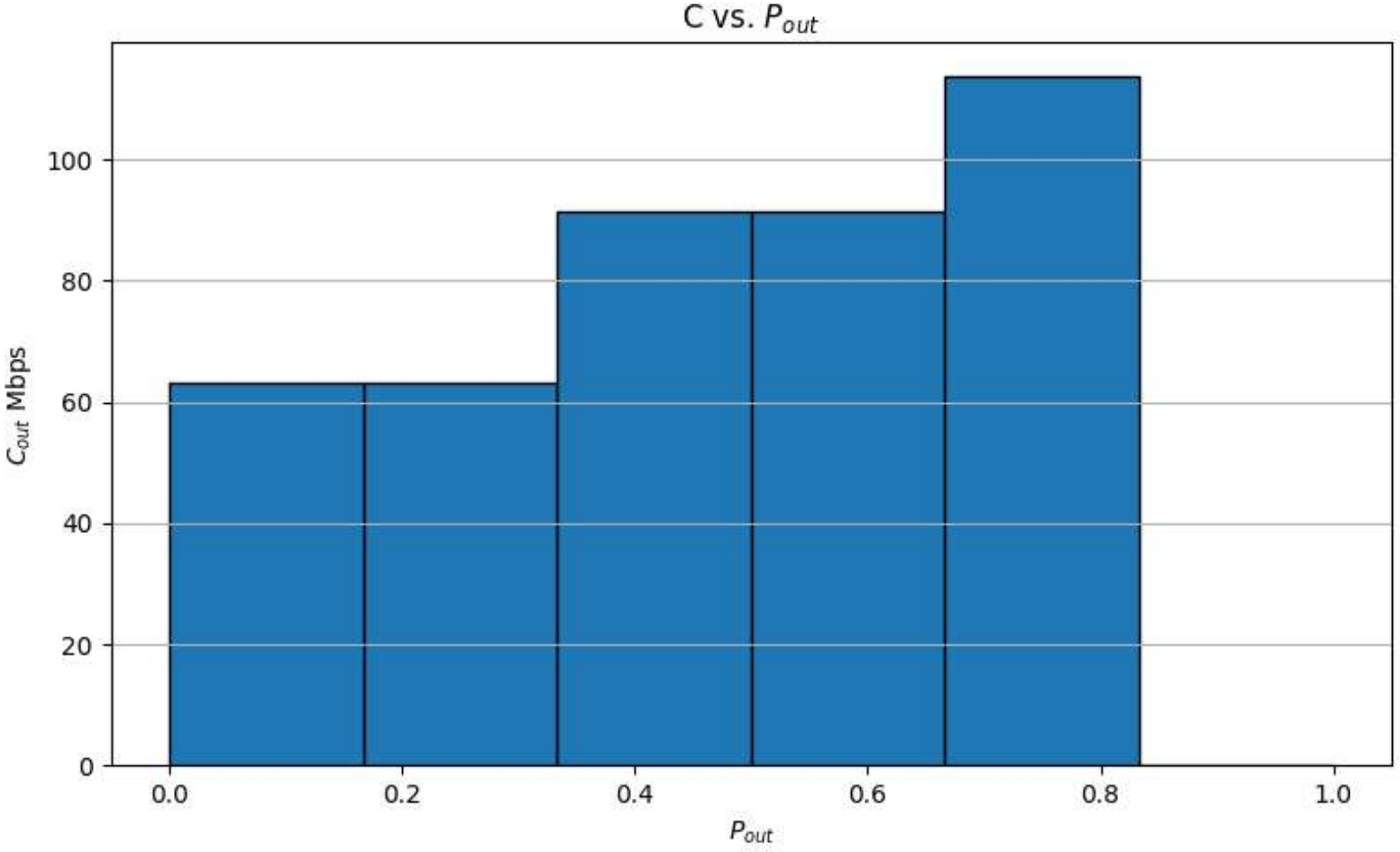
$p_1 = .2$, $p_2 = .3$, $p_3 = .3$, $p_4 = .2$

$$\frac{1}{\gamma_0} = \frac{1}{1000}\cdot.2 + \frac{1}{100}\cdot.3 + \frac{1}{10}\cdot.3 + \frac{1}{1}\cdot.2$$

$$\Rightarrow \boxed{\gamma_0 = 0.8109}$$

$$\frac{1}{\gamma_0} - \frac{1}{\gamma_i} = \begin{cases} 1.2322 & \text{for } \gamma = \gamma_1 \\ 1.2232 & " = \gamma_2 \\ 1.1332 & " = \gamma_3 \\ 0.2332 & " = \gamma_4 \end{cases}$$

$$\frac{C}{B} = \sum_i \log_2\left(\frac{\gamma_i}{\gamma_0}\right) p_i = \boxed{5.2853 \ \frac{\text{bps}}{\text{Hz}}}$$


C vs. P_{out}
100
80
60
40
20
0
C_{out} Mbps
0.0
0.2
0.4
0.6
0.8
1.0
P_{out}