(a) $\bar{\gamma} = \sum_{i=1}^{4} \gamma_i (p\gamma_i)$

$= 15 \text{ dB}$

$C_{AWGN} = B \log_2 (1+\bar{\gamma}) = 55.4518$ Mbps

(b) $C_1 = \sum_i B \log_2 (1+\gamma_i) P(\gamma_i)$

$= 46.3905$ Mbps

(c) $C_0 = (1-P_{out}) B \log_2 (1+\gamma_{min})$, $P_{out} = p(\gamma < \gamma_{min})$

$\gamma_{min} > 30\text{dB}$	$P_{out} = 1$	$C_0 = 0$
$20\text{dB} < \gamma_{min} \le 30\text{dB}$	$P_{out} = 0.8$	$C_{0\text{-}max} = C_0(\gamma_{min} = 30\text{dB}) = 13.7359$ Mbps
$10\text{dB} < \gamma_{min} \le 20\text{dB}$	$P_{out} = 0.5$	$C_{0\text{-}max} = C_0(\gamma_{min} = 20\text{dB}) = 30.4452$ mbps
$0 < \gamma_{min} \le 10\text{dB}$	$P_{out} = 0.2$	$C_{0\text{-}max} = C_0(\gamma_{min} = 10\text{dB}) = 38.3663$ mbps
$\gamma_{min} = 0$	$P_{out} = 0$	$C_0 = 0$

consider water-filling

$$\max \quad C = \sum_i B \log_2 \left(1 + \frac{\gamma_i P_i}{\bar{P}}\right) P(\gamma_i)$$

$$\text{s.t.} \quad \sum_i P_i \, P(\gamma_i) = \bar{P}$$

so. $$\frac{P_i}{\bar{P}} = \begin{cases} \frac{1}{\gamma_0} - \frac{1}{\gamma_i} & \gamma_i \ge \gamma_0 \\ 0. & \gamma_i < \gamma_0 \end{cases}$$

$\gamma_0 > 0.$ $$\frac{0.8}{\gamma_0} = 1 + \sum_{i=1}^{3} \frac{p(\gamma_i)}{\gamma_i}$$

$\gamma_0 = 0.7607 > \gamma_4 = 0$

so. $C = \sum_{i=1}^{5} B \log_2 \left(\frac{\gamma_i}{\gamma_0} \right) p(\gamma_i)$

$= 50.5350$ Mbps

(d). so. $C_{water\text{-}filling} > C_1$, both. transmitter and receiver
$C_{water\text{-}filling} < C_{AWGN}$. have CSI, we can use
water-filling method. the. performance of the communication
system will be improved. but it can't reach C_{AWGN}.