6.15.

For 256-QAM

$$B_{256} = \frac{2}{T_{256}} = \frac{2}{(\log_2 256) T_b} = \frac{1}{4T_b}$$

$$E_{ave}^{256} = \frac{2(256-1)}{3} E_0 = 170 \cdot E_0$$

For 64-QAM

$$B_{64} = \frac{2}{T_{64}} = \frac{2}{(\log_2 64) T_b} = \frac{1}{3T_b}$$

$$E_{ave}^{64} = \frac{2(64-1)}{3} E_0 = 42 E_0$$

$$\Rightarrow B_{64} - B_{256} = \frac{1}{12T_b}$$

$$\frac{E_{ave}^{256}}{E_{ave}^{64}} = \frac{85}{21} \approx 6(dB)$$

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6.16.

For 16-PSK

$$10^{-3} = \operatorname{erfc}\left(\sqrt{\frac{E_p}{N_0}}\sin\left(\frac{\pi}{16}\right)\right)$$

$$\Rightarrow \frac{E_p}{N_0} = \left(\frac{\operatorname{erfc}^{-1}(10^{-3})}{\sin\left(\frac{\pi}{16}\right)}\right)^2 \approx 21.5\,(\text{dB})$$

For 16-QAM

$$10^{-3} = 2\left(1-\frac{1}{\sqrt{16}}\right)\operatorname{erfc}\left(\sqrt{\frac{3E_{ave}^{Q}}{2(16-1)N_0}}\right)$$

$$\Rightarrow 10^{-3} = \frac{3}{2}\operatorname{erfc}\left(\sqrt{\frac{E_{ave}^{Q}}{10N_0}}\right)$$

$$\Rightarrow \frac{E_{ave}^{Q}}{N_0} = 10\left(\operatorname{erfc}^{-1}\left(\frac{2}{3}\cdot 10^{-3}\right)\right)^2 \approx 17.6\,(\text{dB})$$

$$\Rightarrow SNR_P - SNR_Q \approx 3.9\,(\text{dB})$$

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