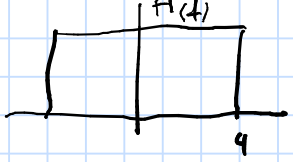
4.50.

$B = 4kHz$



$P_{s\,dB} = -10\,dBm$

$N_0 = -80\,dBm/Hz \quad = 30 + 10\log_{10} N_0$

$G_{ubitak} = 10\,dB$

$N_0 = 1 \cdot 10^{-11}\,W$

$P_N = N_0 \cdot B = -320000\,dBm$

$$\frac{C}{B} = \log_2\left(1 + \frac{E_B C}{B}\right) = \log_2\left(1 + \frac{S}{N_0 B}\right)$$

S-na izlazu — gubitak

$S = -10\,dBm - 10\,dB = -20\,dBm$

$P_{s\,W} = 1 \cdot 10^{-5}\,W$

$$\frac{C}{B} = \log_2\left(1 + \frac{10^{-5}}{10^{-11} \cdot 4000}\right) = 7.965784285\ bit\,s^{-1}/Hz$$

4. 51.

$E[N_1] = E[N_2] = 0$

$E[N_1^2] = E[N_2^2] = \sigma^2$

$Y_1 = X + N_1 \Rightarrow Y_1^2 = X^2 + 2XN_1 + N_1^2$

$Y_2 = X + N_2 \quad Y_2^2 = X^2 + 2XN_2 + N_2^2$

$Var(Y) - Var(Z)$

$= E[Y^2] - (E[Y])^2 - E[Z^2] + (E[Z])^2$

$E[Y] = \frac{1}{2}E[Y_1] + \frac{1}{2}E[Y_2] = \frac{1}{2}E[X + N_1] + \frac{1}{2}E[X + N_2] = E[X]$

$E[Y^2] = E\left[\frac{1}{4}Y_1^2 + \frac{1}{2}Y_1Y_2 + \frac{1}{4}Y_2^2\right] = \frac{1}{4}E[X^2 + 2XN_1 + N_1^2] + \frac{1}{2}E[X^2 + XN_1 + XN_2 + N_1N_2]$

$+ \frac{1}{4}E[X^2 + 2XN_2 + N_2^2]$

$= \frac{1}{4}E[X^2] + \frac{1}{2}\cancel{E[X]E[N_1]} + \frac{1}{4}E[N_1^2] + \frac{1}{2}E[X^2] + \frac{1}{4}E[X^2] + \frac{1}{4}E[N_2^2]$

neodvisni $\longrightarrow E[N_1]E[N_2] = 0$; tj. prestaćemo sve nule

$= E[X^2] + \frac{1}{4}\sigma^2 + \frac{1}{4}\sigma^2 = \frac{1}{2}\sigma^2 + E[X^2]$

$Z = X + N_1$

$E[Z] = E[X]$

$E[Z^2] = E[X^2] + \sigma^2$

$D[Y] - D[Z] = \frac{1}{2}\sigma^2 + \cancel{E[X^2]} - \cancel{E^2[X]} - \cancel{E[X^2]} - \sigma^2 + \cancel{E^2[X]}$

$\boxed{= -\sigma^2/2}$

4.52.

i) $P = 250\ kW$

Snaga za radio izvore energije i snaga polja

$$P_{dB} = 30 + 10\log_{10}\frac{P}{1\,W_{watt}} \quad ili \quad \boxed{P_{dB} = 10\log_{10}\frac{P}{1\,mW}}$$

$$P = 10\cdot\log_{10}P\cdot 10^3 = 30 + 10\log_{10}P = 30 + 10\cdot\log_{10}250 = 83.9794\ dB_m$$

ii) $L_A(d) = 30\log_{10}\left(30\frac{d}{km}\right) = 30\log_{10}(30\cdot 250) = 116.2518379\ dB$

iii)

$$P_{250} = P_{dBm} - L_A(250) = 83.9794\,dB_m - 116.2518379\,dB = -32.2724379\,dB_m$$

4.53.

$$s_{AM}(t) = \left[A + \cos(2\pi \cdot 10000\, t) + \cos(2\pi\, 20000\, t)\right] \cos(2\pi\, 1000000\, t)$$

- može se umjesto trigonometrijskih identiteta koristiti $e^{j\omega}$ zapis cosinusa

$$= A\cos(2\pi\, 1000000\, t) + \underbrace{\cos(2\pi \cdot 10000 t) \cdot \cos(1000000 \cdot 2\pi t)}_{} + \cos(2\pi\, 20000\, t) \cdot \cos(2\pi\, 1000000\, t)$$

$$\mathcal{F}\{s_{AM}(t)\} \qquad \frac{1}{2}\left(\cos(990000 \cdot 2\pi t) + \cos(1010000\, 2\pi t)\right) + \frac{1}{2}\left(\cos(980000\, 2\pi t) + \cos(1020000\, 2\pi t)\right)$$

↳ možemo samo iščitati frekvencije, sve će biti δ, a amplitude $\frac{1}{2}A$.

$\frac{1}{2}A \rightarrow 1000000 ; -1000000$ itd.