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$$\begin{aligned} 3. R_b &= 100 \text{ kbps} = 10^5 \text{ bps} \\ r &= 0,4 \\ f_c &= 800 \text{ MHz} = 8 \times 10^8 \text{ Hz} \\ A &= 10 \text{ mV} = 0,01 \text{ V} \end{aligned}$$

$$\begin{aligned} a. S_i(t) &= A \cos \left(\omega_c t + \frac{2\pi i}{M} \right) \\ &= A \cos \left(\omega_c t + \frac{2\pi i}{2} \right) \\ &= 0,01 \cos \left(2\pi \cdot 8 \times 10^8 t + \frac{2\pi i}{2} \right) \\ &= 0,01 \cos \left(16\pi \times 10^8 t + \frac{2\pi i}{2} \right) \end{aligned}$$

$$S_0(t) = 0,01 \cos(16\pi \times 10^8 t)$$

$$S_1(t) = 0,01 \cos(16\pi \times 10^8 t + \pi)$$

$$BW = (1+r)R_b = (1+0,4) \cdot 100 \text{ kbps} = 140 \text{ kHz}$$

$$\begin{aligned} b. S_i(t) &= A \cos \left(\omega_c t + \frac{(2i-1)\pi}{M} \right) \\ &= 0,01 \cos \left(2\pi \cdot 8 \times 10^8 t + \frac{(2i-1)\pi}{M} \right) \\ &= 0,01 \cos \left(16\pi \times 10^8 t + \frac{(2i-1)\pi}{M} \right) \end{aligned}$$

$$S_1(t) = 0,01 \cos(16\pi \times 10^8 t + 45^\circ)$$

$$S_2(t) = 0,01 \cos(16\pi \times 10^8 t + 135^\circ)$$

$$S_3(t) = 0,01 \cos(16\pi \times 10^8 t + 225^\circ)$$

$$S_4(t) = 0,01 \cos(16\pi \times 10^8 t + 315^\circ)$$

$$BW = (1+r) R_b / 2$$

$$= \frac{1,4 \cdot 100 \text{ kbps}}{2} = 70 \text{ kHz}$$

$$c. \quad s_i(t) = A_i \cos(\omega_c t + \phi)$$

$$= A_i \cos(2\pi \cdot 0,4 \times 10^8 t + \phi)$$

$$= A_i \cos(16\pi \times 10^7 t)$$

$$s_o(t) = 0$$

$$s_1(t) = 0,01 \cos(16\pi \times 10^7 t)$$

$$BW = \frac{(1+r) R_b}{2} = \frac{(1+0,4) \cdot 100 \text{ kbps}}{2} = 70 \text{ kHz}$$

$$d. \quad s_1(t) = 0,01 \cos(2\pi \cdot f_1 \cdot t)$$

$$= 0,01 \cos(2\pi \cdot 0,1 \times 10^8 t)$$

$$= 0,01 \cos(16,2\pi \times 10^7 t)$$

$$s_2(t) = 0,01 \cos(2\pi \cdot f_2 \cdot t)$$

$$= 0,01 \cos(2\pi \cdot 7,9 \times 10^7 t)$$

$$= 0,01 \cos(15,8\pi \times 10^7 t)$$

$$\Delta f = \frac{|810 \text{ MHz} - 790 \text{ MHz}|}{2} = 10 \text{ MHz} = 10^7 \text{ Hz}$$

$$BW = (1+r) \cdot 2 (\Delta f + R_b)$$

$$= (1+0,4) \cdot 2 (10^7 + 10^5) = 20,20 \text{ MHz}$$