Extra exercises Modulation

Ex. 1

FM modulation: $m(t) = 2\cos(2\pi 1000t)$, $P_c = 50\,W$, $f_c = 100E6\,Hz$

$\Delta f = 10e3\,Hz$, $A_m = 2V$, $f_m = 1000\,Hz$

a) Waveform express no integral: $s(t) = A_c \cos\left(2\pi\left(f_c t + k_f \int_0^t m(t)\,dt\right)\right)$

Solve integral: $\int_0^t m(t)\,dt = \int_0^t 2\cos(2\pi 1000t) = \frac{\sin(2\pi 1000t)}{1000\pi}$

Solve for A_c, k_f, β: $P_c = \frac{A_c^2}{2} \Leftrightarrow A_c = \sqrt{2 \cdot P_c} = \sqrt{2 \cdot 50} = 10$

$\beta = \frac{\Delta f}{f_m} = \frac{10e3}{1e3} = 10$, $\Delta f = A_m \cdot k_f \Leftrightarrow k_f = \frac{\Delta f}{A_m} = \frac{10e3}{2} = 5\,kHz/V$

Plug all values into $s(t)$ that are missing:

$s(t) = 10\cos\left(2\pi\left(100e6\,t + 5e3\left(\frac{\sin(2\pi 1000t)}{1000\pi}\right)\right)\right)$

b) Approx Bandwidth. Is signal narrowband or wide?

Carsons Rule: $BW \approx 2(\Delta f + f_m) = 2 \cdot (10e3 + 1e3) = 22\,kHz$

β above 1 therefor it is wideband ⇓

If $\beta \gg 1$ = Wide band

c) Digi Signal trans $R_b = 3kbps$, How much bandwidth is needed for BFSK

$f_{space} = 99.95\,MHz$, $f_{mark} = 100.05\,MHz$

$B_{BFSK} \approx f_{mark} - f_{space} + 2R_{sym}$

$R_{sym} = \frac{R_b}{\log_2 M} = \frac{3E3}{\log_2 2} = 3kbauds$ → now put into B_{BFSK}

M for BFSK = 2

$B_{BFSK} = 100.05MHz - 99.95MHz + 2 \cdot 3kbauds$

$= \underline{106\,kHz}$