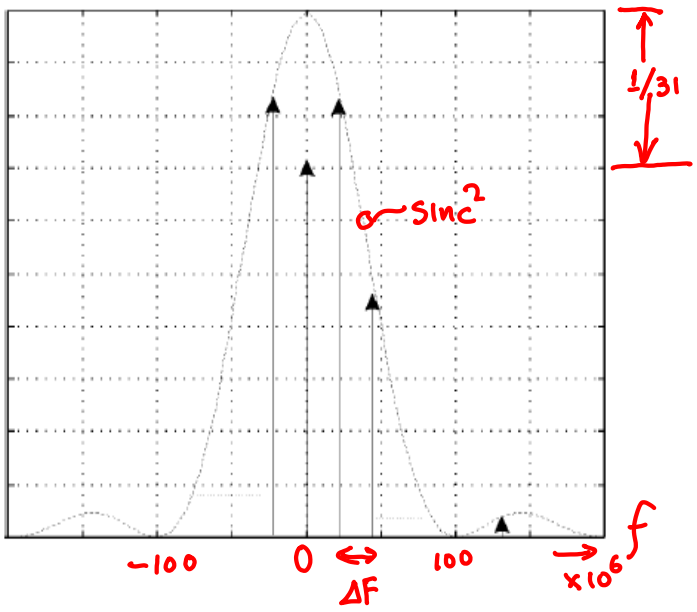
SSS: PN-Codes, Direct Sequence and Frequency Hopping

32. A pseudo random (PN) signal $b(t)$ is generated by using a maximal length shift register of m-stages and has the following double-sided Power Spectral Density.

PSD$_b(f)$:



(a) Find the number m of shift register stages. 5%

(b) Find ΔF. 5%

33. Sketch the feedback shift register whose feedback connections are represented by the primitive polynomial $x^{24} + x^7 + x^2 + x + 1$ and find the length N of this sequence. [6 marks]

If the clock rate is 2.7 chips/s, find the period of this sequence in minutes. [4 marks]

34. Sketch the feedback shift register whose feedback connections are represented by the primitive polynomial $D^{24} + D^7 + D^2 + D + 1$ and operates with a clock rate 1Mb/sec. 5%

Find the period of the output sequence in minutes. 15%

35. A 'short-code' BPSK DS/SSS uses an m-sequence and a data rate 9.6 kbits/sec. If it is required that the spread spectrum signal will have bandwidth no larger than 25MHz, what is the largest period of the m-sequence that can be used?

(a) 255

(b) 511

(c) 1023

(d) 2047

(e) None of the above

36. Consider a binary message signal of rate 8 kbits/s at the input of a fully synchronized BPSK direct sequence spread spectrum system (DS/SSS-BPSK). The system operates in the presence of both additive white noise, $n(t)$, and a broadband noise jammer, $j(t)$, of power 1 Watt. The double sided power spectral density of the noise is 10^{-12} Watts/Hz and the processing gain of the system is 10^5. The bit error probability at the output of the receiver is equal to 4×10^{-6} while the protection probability is equal to 4×10^{-2}.

    (a) What is the amplitude A of the sinewaves which are used by the binary PSK modulator? 15%

    (b) What is the bit error probability if the jammer switches to a "pulse jammer" mode, which is "on" for 40% and "off" for 60% of the time? 10%

    (c) What is the Anti-jam Margin, in dBs, when the jammer switches to the above-mentioned mode? 10%

37. A speech signal having a maximum frequency of 4kHz is sampled at twice the Nyquist rate and then fed through an 8-bit uniform quantizer. The generated binary sequence is then fed through a binary PSK direct sequence spread spectrum system which operates in the presence of a broadband jammer of power 1.6 Watts and in the presence of additive white Gaussian noise with double-sided power spectral density 0.5×10^{-12} Watts/Hz. The amplitude of the BPSK signal is 0.5V.

    For this system, the spread spectrum bandwidth B_{ss} is 32 MHz and the system is fully synchronised.

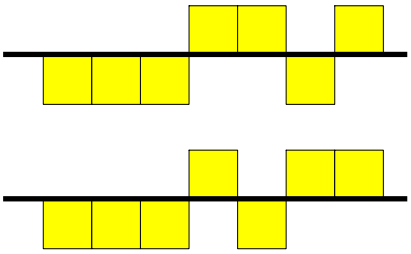
    Find:

    (a) the power of the code noise, 5%

    (b) the power of the noise at the output of the correlator, 5%

    (c) the power of the jammer at the output of the correlator. 10%

38. Two m-sequence PN-signals, generated by two 3-stage shift registers, are shown below.



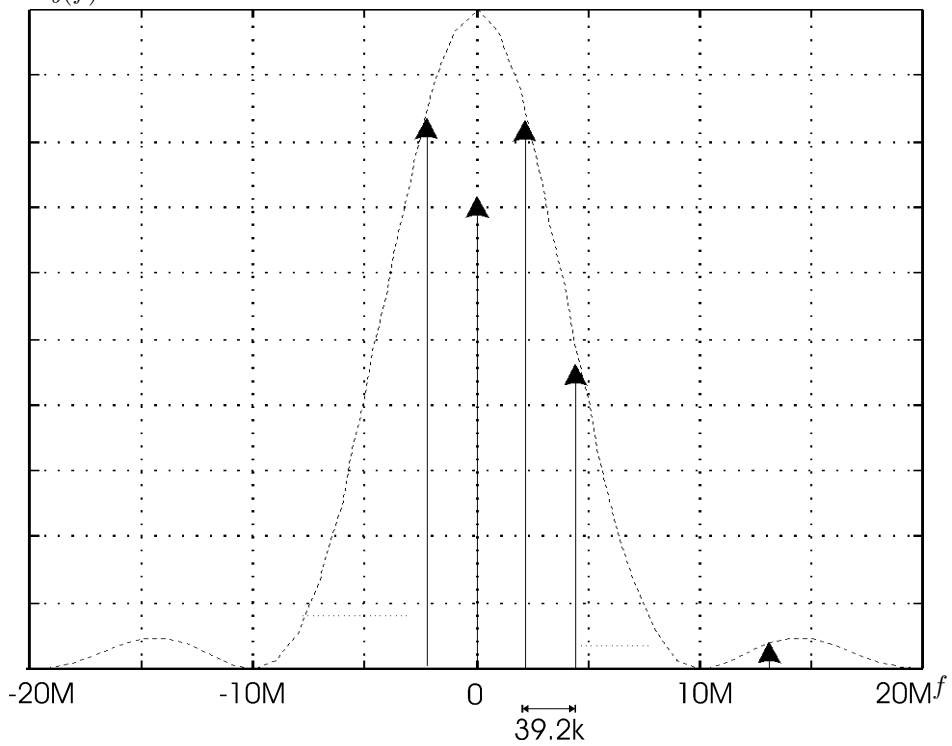
    Construct a Gold code signal from these two PN-signals. 10%

39. Consider a feedback shift register whose feedback connections are represented by the primitive polynomial $D^4 + D^1 + 1$. Give one period of its output sequence - starting with all 1's (initial condition). 15%

40. A DS/SSS uses an m-sequence for spreading the spectrum with a processing gain equal to one period of the m-sequence. If the data rate is 28 kbits/sec and it is required that the spread-spectrum signal has a bandwidth no larger than 25 MHz, what is the largest period of the m-sequence that can be used? 15%

41. A pseudo random (PN) signal $b(t)$ is generated by using a maximal length shift register of m-stages and has the following double-sided Power Spectral Density.

$\text{PSD}_b(f)$:



Find the number m of shift register stages. 15%

42. An analogue message signal having a maximum frequency of 4kHz is sampled at the Nyquist rate and then is fed through a 4-level quantizer where each level is encoded using 2 bit codewords. The binary sequence is then fed through a fully synchronized Binary PSK Direct Sequence Spread Spectrum System (BPSK/DS-SSS) of processing gain 10^8. The system operates in the presence of white Gaussian noise having a double-sided power spectral density of 10^{-12} W/Hz and its Energy Utilization Efficiency is 40 (i.e. EUE= $\frac{E_b}{N_0}$ =40). What would be the power P_J of a jammer which, if it was distributed over 50% of the spread spectrum signal bandwidth, would provide a bit error probability p_e of 3×10^{-5} ? 25%