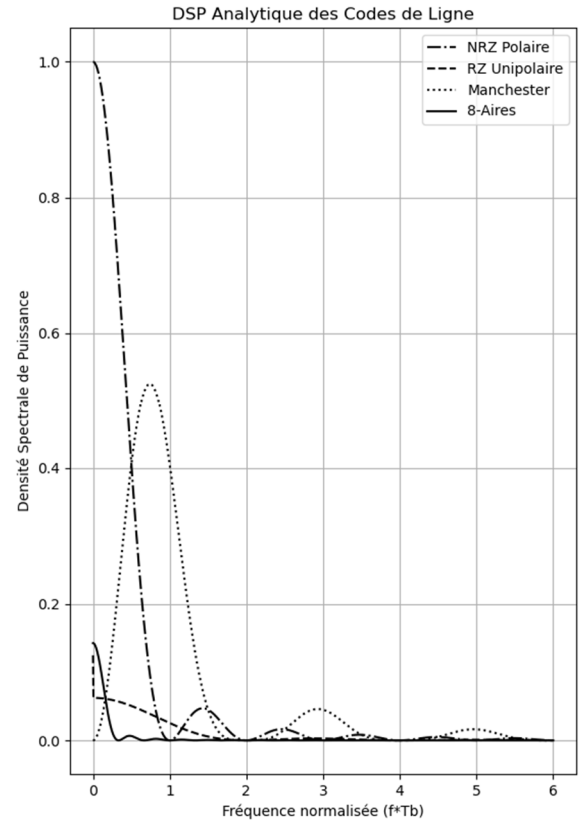


**Exercice 1 / 10 points**

The Power Spectral Densities (PSD) of several independent line codes are given below.

1. Identify the PSDs on the graph.
2. Determine the spectral efficiency of each code.
3. State one advantage and one disadvantage for each code.
4. Draw the line code waveform for the following binary sequence 111000011011 for the Bipolar (AMI) and HDB3 codes.
5. Why are these 2 codes said dependent ?
6. What is their main advantage compared to the previous ones ?



1. → 2 pts

2. Spectral Efficiency → 2 pts
- NRZ polar → 1 bit/s/Hz
  - RZ unipolar → 0.5 bit/s/Hz
  - Manchester → 0.5 bit/s/Hz
  - 8-Ary → 3 bit/s/Hz

3. Pros and cons → 2 pts

- NRZ polar
  - Advantages: Simple, no DC component (with equal probability), good bandwidth efficiency.
  - Disadvantages: No built-in clock; long runs of identical bits cause synchronisation problems.
- RZ unipolar
  - Advantages: Contains clock information because each bit returns to zero.
  - Disadvantages: Larger bandwidth, DC component present
- Manchester
  - Advantages: Self-clocking (transition in every bit), no DC component.
  - Disadvantages: Requires twice the bandwidth of NRZ.
- 8-Ary
  - Advantages: High spectral efficiency (3 bits per symbol).
  - Disadvantages: More susceptible to noise and interference; needs more complex circuitry.

- 4.
- Bipolar (AMI) : +V -V +V 0 0 0 0 -V +V 0 -V +V → 1 pt
- HDB3 : +V, -V, +V, 0, 0, 0, +V, -V, +V, 0, -V, +V → 1 pt

5. The encoding of a bit depends on the previous bits (polarity alternation for AMI and substitution rules for HDB3) → 1 pt

6. They have inherent error-detection capability (any violation of the alternate-mark rule indicates a transmission error) → 1 pt

**Exercise 2** /5 points

The constellations of a digital modulation scheme are given in the figure below.

1. Identify the modulation scheme used.
2. What do the points represent? Add the grey code on the plot.
3. Define the quadrature components  $a_k$  et  $b_k$
4. Why does the first point not start at 0.
5. Why is phase modulation replaced by an I/Q decomposition?

1. 8-PSK → 0.5 pt

2. Symbols values to be emitted → 0.5 pt 1 pt

3.  $a_k = \cos(\varphi_k)$  et  $b_k = \sin(\varphi_k)$  → 1 pt

4. to avoid 0 values that can confused with signal absence. → 1 pt

5. It becomes 2 independent amplitude modulations on orthogonal carrier (cheaper) → 1 pt

