L.EEC025 - FUNDAMENTALS OF SIGNAL PROCESSING

Academic year 2025-2026, week 7
TP (Recitation) exercises

Topics: The Z-Transform applied in practical cases

Exercise 1

Consider a discrete-time system where $x[n]$ represents the number of ***new*** students signing up for the first time a specific university course (in Portuguese: uma UC) in year n, and that $y[n]$ represents the total number of students enrolled in that course, in year n. Moreover, consider that the success rate in that course and affecting all students (i.e. those who are new, those who failed once and, thus, are taking that course for the second time, those who failed twice, and so on) is 70%.

a) Obtain a difference equation that characterizes the system.

b) If the system starts from rest, and if $x[n] = 250u[n]$, what number does the student population tend to when n gets very large ?

c) Repeat the previous question but by considering this time that a limitation regime is enforced which determines that if a student fails three times, he/she is prevented from re-enrolling.

Hint: use Z-Transform analysis.

Exercise 2

A bank rewards its deposits at the (nominal) interest rate of 3% per year (this means that the monthly interest rate is 0.03/12). Determine the monthly payment that guarantees that after 20 years (i.e., after 240 payments) you will have an accumulated balance of €50 000.

Hint: use Z-Transform analysis.