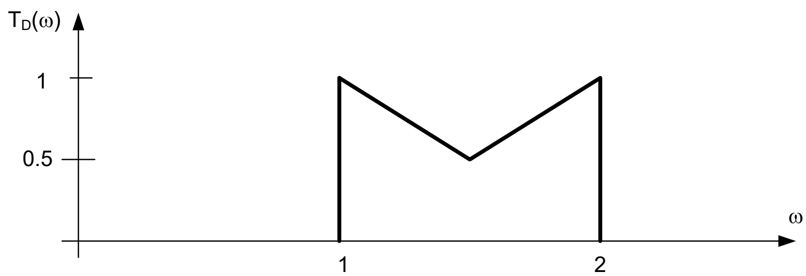
EE 508
HW 1
Fall 2024

Short Assignment – due Friday Aug 30

The seemingly simple problem of obtaining a rational fraction that approximates a desired transfer function can become quite involved and, with the exception of a few standard approximations, there is still often no known technique for obtaining a transfer function. In this assignment, you will be asked to use whatever techniques you have available to obtain a transfer function that approximates a given magnitude response. A metric defined below will be used to assess how good your approximation is for this assignment.

Consider the desired "M" transfer function shown below where the frequency axis is linear.



Mathematically, the desired transfer function magnitude is characterized by the function

$$T_D(\omega)=\begin{cases}0 & 0\le\omega\le1\\ 2-\omega & 1<\omega\le1.5\\ \omega-1 & 1.5<\omega\le2\\ 0 & \omega>2\end{cases}$$

Obtain a rational fraction approximation with real coefficients, T(s), to this transfer function magnitude. Your approximation is constrained to $m+n\le6$ where m is the degree of the numerator polynomial, n is the degree of the denominator polynomial, and m and n satisfy the inequality $n\ge m$. That is

$$T(s)=\frac{\sum_{i=0}^{m}a_i s^i}{\sum_{i=0}^{n}b_i s^i}$$

The "goodness" of your approximation should be assessed by the L_2 norm defined by

$$\varepsilon = \int_{\omega=0}^{4} \left\| T(j\omega) \right| - T_D(\omega) \Big|^2 \, d\omega$$

You should include your approximation T(s), a plot of the magnitude of your transfer function along with that of $T_D(\omega)$ with a linear frequency axis for $0 < \omega < 5$, the value you obtain for ε, and a brief description of how you obtained your approximation.

Keep track of your time and spend at most 3 hours on this assignment. The major purpose of this assignment is to establish an appreciation for the approximation problem.