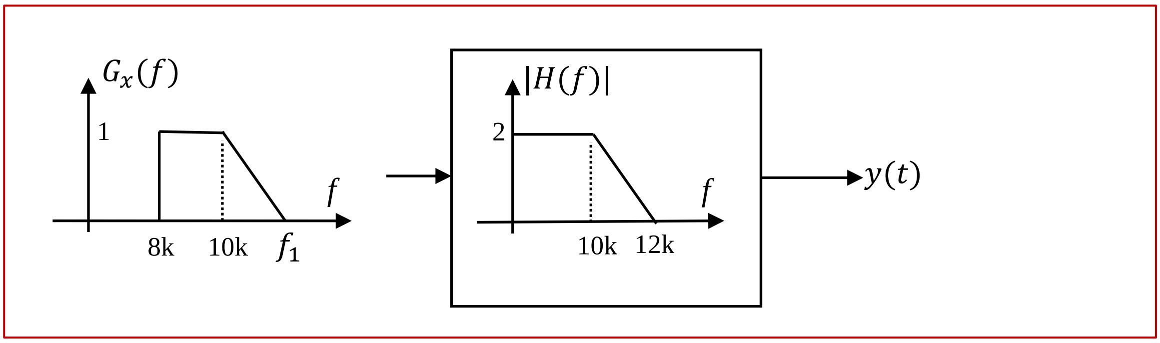
No : Answer **Name : Solution**

Eskişehir Osmangazi University, Faculty of Engineering and Architecture

Department of Electrical Engineering & Electronics, "*Communications*" Midterm 25.04.2023

Upload until : 13:59

The signal $x(t)$ is fed to the filter whose frequency response is shown in the figure below. Power spectral density of $x(t)$ is also given.



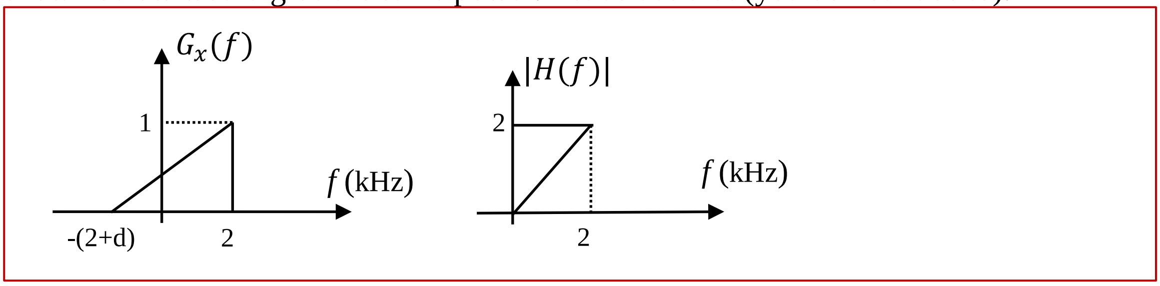
In the figure, f_1 is given by a formulation that includes part of your student id; f_1=14+d where d is 11$^{\text{th}}$ digit (2$^{\text{nd}}$ from the last digit) of your student id. Calculate the power of the output signal $y(t)$.

A solution:

We split the power into two; power between 8k and 10k, power between 10k and 12k (since 14+d is always larger than 12). First one is easier;

$P_1 = \int_{8k}^{10k} G_x(f)|H(f)|^2 df = 2000 \times 4 = 8000$

Second part is requires the construction of line equations. Moving the curves to origin and inverting the slope of both curves would not affect the total power. That is, using the curves shown below would give the same power. Let us use that (you do not have to).



From these new graphs, we find that $\acute{G}(f) = mf + c$ where $m = \frac{1}{(4+d)k}$ and $c = \frac{2+d}{4+d}$.

Similarly $\acute{H}(f) = \frac{1}{k} f$. Therefore, $P_2 = \int_0^{2k} (mf + c) \frac{1}{k^2} f^2 df$

$P_2 = \frac{1}{k^2} \int_0^{2k} (mf^3 + cf^2) df = \frac{1}{k^2} \left[\frac{m}{4} f^4 + \frac{c}{3} f^3 \right]_0^{2k} = \left[4mk^2 + \frac{8}{3} ck \right]$. Replacing m and c, we find that $P_2 = \frac{4}{4+d} k + \frac{8}{3} \frac{2+d}{4+d} k = \frac{(24+8d)k}{3(4+d)}$. The total power is then

$P = P_1 + P_2 = 8000 + \frac{(24+8d)k}{3(4+d)}$ where k is 1000 and d is 11$^{\text{th}}$ digit of your *studentid*.

You need to calculate a specific power value for your particular d value. For example, if d=0, then

$P = P_1 + P_2 = 8000 + \frac{24000}{12} = 10000$ W.

If d=9, then $P = 8000 + \frac{(24+72)1000}{3(4+9)} \cong 10462$ W.