EES 351: In-Class Exercise # 3 - Sol

Instructions

1. Work alone or in a group of no more than three students. For group work, **the group cannot be the same as any of your former groups in this class.**
2. [ENRE] = Explanation is not required for this exercise.
3. Only one submission is needed for each group.
4. You have two choices for submission:
   (a) Online submission via Google Classroom
   - PDF only.
   - Only for those who can directly work on the posted files using devices with pen input.
   - Paper size should be the same as the posted file.
   - No scanned work, photos, or screen capture.
   - Your file name should start with the 10-digit student ID of one member.
     (You may add the IDs of other members, exercise #, or other information as well.)

   (b) Hardcopy submission
5. **Do not panic.**

Date: 28 / 8 / 2020			
Name	ID (last 3 digits)		
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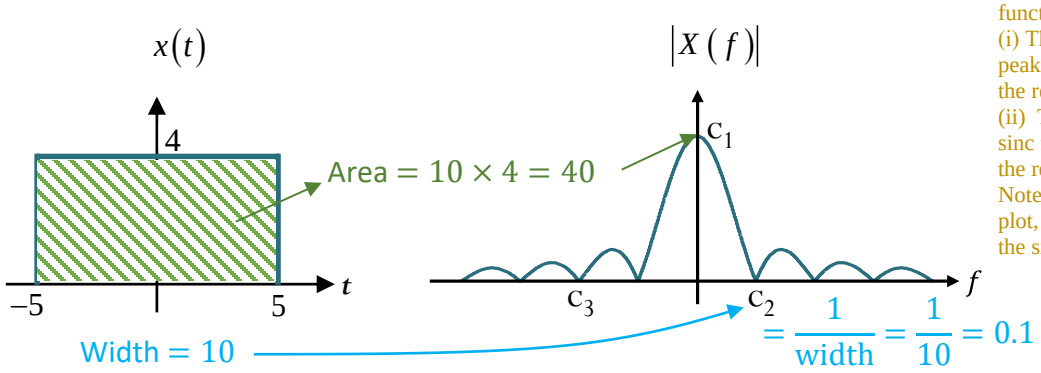
1. A signal and its magnitude spectrum are plotted below.

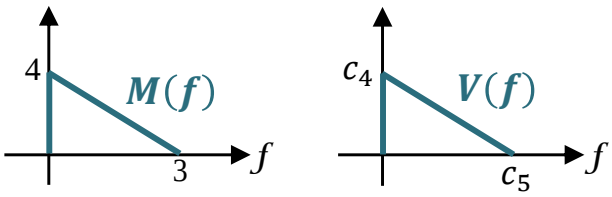


For this question, we apply observation discussed in the lecture notes [2.13]:
(0) The Fourier transform of a rectangular function is a sinc function.
(i) The height of the sinc function's peak is the same as the area under the rectangular function.
(ii) The first zero crossing of the sinc function occurs at 1/(width of the rectangular function).
Note also that in the magnitude plot, the negative-valued parts of the sinc function are flipped up.

Find the values of the constants (corresponding to some zeroes and the peak value) shown in the plots.

$c_1 =$ 40 $, c_2 =$ 0.1 $, c_3 = -2c_2 = -0.2$.

2. Consider a signal $m(t)$ and another signal $v(t) = m(5t)$.
Their corresponding Fourier transforms are plotted below.



Caution: The relationship between the two signals is given in the time domain. However, the plots are given in the frequency domain.

Find the values of the constants in the plot of $V(f)$:

$c_4 = \frac{4}{5} = 0.8, c_5 = 15$

For $v(t) = m(5t)$, by the scale-change theorem [2.32 eq. (21)], we have

$$V(f) = \frac{1}{|5|} M\left(\frac{f}{5}\right) = \frac{1}{5} M\left(\frac{f}{5}\right).$$

In the previous exercise, we worked on time manipulation. Note that, back then, "time" was our dummy variable. Here, it's the frequency f. We can get $M\left(\frac{f}{5}\right)$ from $M(f)$ by replacing f by $\frac{f}{5}$; therefore, graphically, this is a horizontal expansion by a factor of 5. This implies $c_5 = 5 \times 3 = 15$.

Finally, the $\frac{1}{5}$ in the front simply scales the height of graph by a factor of $\frac{1}{5}$. This implies $c_4 = \frac{1}{5} \times 4 = \frac{4}{5} = 0.8$.