

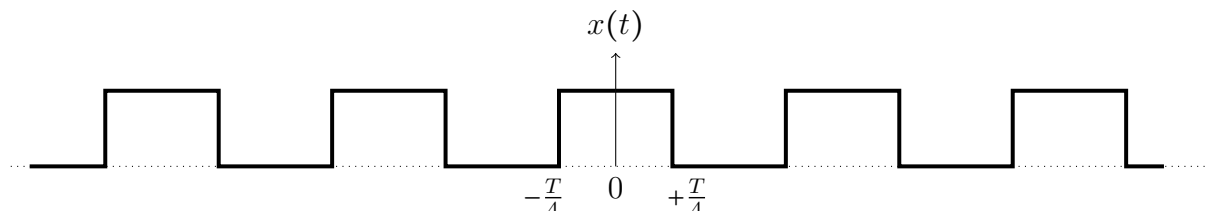
Indian Institute of Technology Bombay

Dept of Electrical Engineering

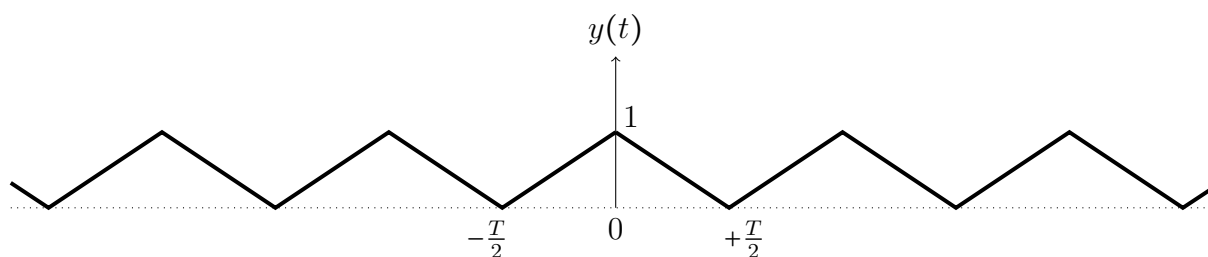
Handout 7
Homework 3

EE 603 Digital Signal Processing and Applications
August 26, 2016

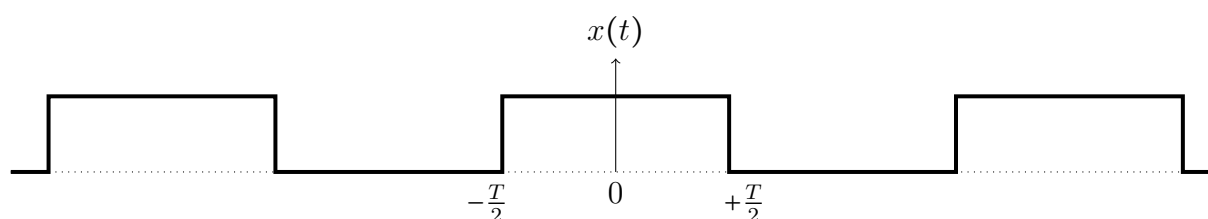
Question 1) Consider a T -periodic signal $x(t)$ shown in figure. This is known as a rectangular train, where the non-zero amplitude is unity.



- a) Find the Fourier Series coefficients of this signal.
- b) Can you find a system $h(t)$ such that $y(t) = x(t) * h(t)$ is the following signal,



- c) Can you find the FS coefficients of $y(t)$ by using parts (a) –(b), and without explicitly performing an additional integration.
- d) Consider the following $2T$ -periodic rectangle train $s(t)$ of height 2 units.



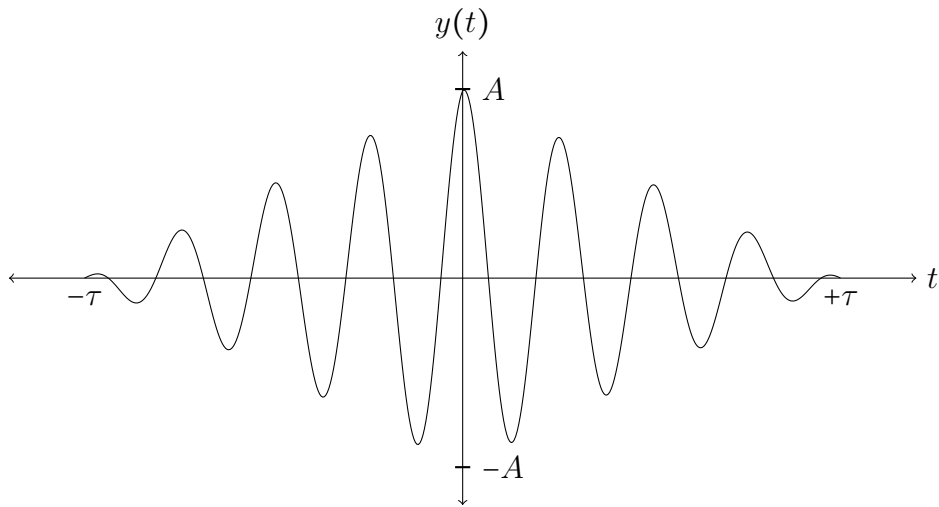
Find the FS coefficients of $y(t)s(t)$, where the multiplication is point-wise for every t .

- e) Plot the FS coefficients for parts (c) and (d), assuming $T = 10$.

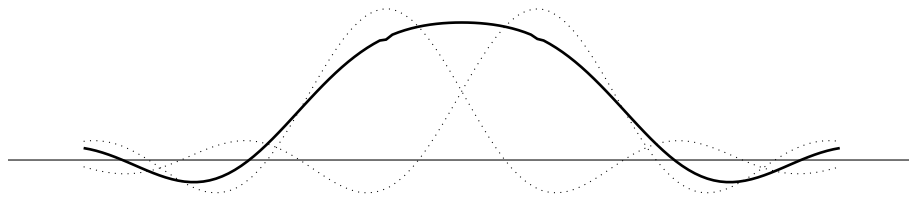
Question 2) Find

$$\int_{\mathbb{R}} \text{sinc}^2(Tt) dt.$$

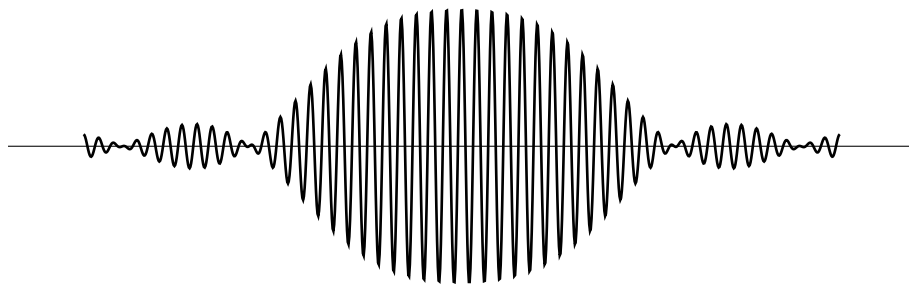
Question 3) Find the Fourier Transform of the following signal $y(t)$.



Question 4) In figure, the thick line is the sum of the two dotted plots, and each dotted line is a $\alpha \text{sinc}(\frac{2}{\pi}t)$ function, shifted by t_0 units to each side of origin.

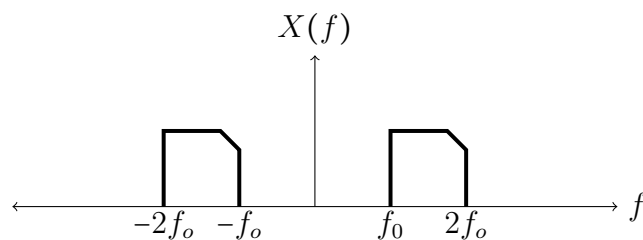


- (a) Compute the Fourier Transform (FT) of this signal.
 (b) Suppose now the plot is of the form,



What do you expect the FT to be?

Question 5) We have seen sampling theorem (also called Shannon-Nyquist Sampling Theorem), let us learn some more details. Consider a signal $x(t)$ whose Fourier transform is as shown in the figure.



(a) What is the maximum frequency present in the system.

(b) Draw the DTFT of the signal $x[n]$ obtained by sampling $x(t)$ at the rate of $4f_o$ samples per second.

(c) Draw the DTFT of the signal $u[n]$ obtained by sampling $x(t)$ at the rate of $2f_o$ samples per second.

(d) Draw the DTFT of the signal $v[n]$ obtained by sampling $x(t)$ at the rate of f_o samples per second.

Question 6) Let

$$x[n] = \frac{\sin(\pi n/8)}{\pi n}$$

and

$$h[n] = \frac{\sin(\pi n/4)}{\pi n}.$$

Compute $y[n] = x[n] * h[n]$.