Review of Signals and Systems-II

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Important Instructions

- Check 'Nalanda' for useful course material and lab related stuff.
- Bring a dedicated lab note book to do rough work.
- Please maintain decency in lab. Mind works faster and better in peaceful atmosphere.
- You may leave lab after evaluation. Make sure that your evaluation is done before you leave lab.
- You may take a short break for 5-7 minutes after one and half hour.
- Note down all useful commands in your notebook.
- Save all your work (e.g., codes, plots) in Google drive or somewhere else for your reference. Delete your work files from your computer.

- You are **NOT** allowed to sleep in the lab. If you do so, you will not get credit for the attendance.

Important Instructions (contd.,)

- Try to complete all tasks within 2 hours. After 2 hrs, evaluation starts. Each lab carries three marks (one mark for attendance, and two marks for successful completion of tasks)
- For each subtask, create mfiles (e.g., Gibbs.m) and save them with suitable name.
- Prepare a word document naming your name and ID. In it, save all results including plots.
- In all plots, put x-label, y-label, legend, font 'Arial' (font size = **10**), and, Width '**2**'. By doing this, visibility of figures will improve.

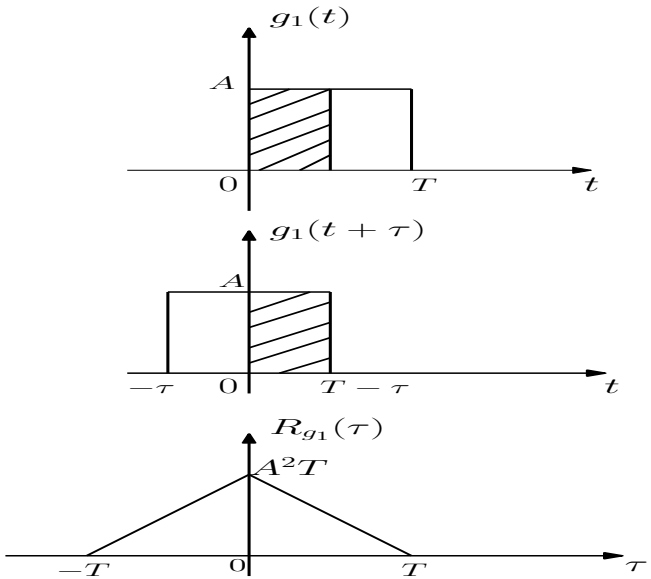
- Makeup policy: There is no makeup for lab. However, if you are absent for the n^{th} lab, you can complete it in the $(n+1)^{\text{th}}$ lab. In this scenario, you will be evaluated only for lab tasks. Note that this is allowed with prior permission from the Instructor-in-charge. You may be asked to show a valid proof.

Autocorrelation Function (ACF) of Shifted Rectangular Pulse

- Problem: Let $g(t) = A\text{rect}\left(\frac{t}{T}\right)$. Consider ACF of $g_1(t) = g\left(t - \frac{T}{2}\right)$ (real signal)

$$\mathcal{R}_{g_1}(\tau) = \int_{t=-\infty}^{\infty} g_1(t) g_1(t+\tau)\, dt$$

- Graphical approach



- Alternatively, correlation problem can be solved using convolution:

$$\mathcal{R}_{g_1}(\tau) = g_1(\tau) \circledast g_1(-\tau)$$

Task 1: ACF & Its Properties

- Understand following commands/operators
  - size, max, zeros, &&
- Question: Let $A = 1$ and $T = 1$. Write a MATLAB program to sketch the ACF of the rectangular pulse $g_1(t)$. Plot $g_1(t)$ and its ACF $\mathcal{R}_{g_1}(\tau)$ in the same figure. Use: axis([-1.5 1.5 0 1.5]). Provide useful remarks on the ACF.
  - Hint: Write a function, say, *rect.m*. Call it in the main program.

Task 2: Magnitude spectrum

- Understand following commands
  - fft, fftshift, length, conj
- Consider a rectangular pulse having constant amplitude A, and defined in the interval $[-\frac{T}{2}, \frac{T}{2}]$. Furthermore, consider a triangular pulse having peak amplitude A, and defined in the interval $[-T, T]$. Determine their magnitude spectra.
- Question: Let $A = T = 1$. Write a MATLAB program to sketch the magnitude spectra of rectangular pulse and triangular pulse. Show both the spectra in the same figure. Use: axis([-9 9 0 1.5]). Make sure that the spectra have peaks at the origin. Comment on the $3-$dB bandwidth of the two pulses.