Review of Signals and Systems-1

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Important Instructions

- Check ‘Nalanda’ for useful course material and lab related stuff
- Please bring a dedicated lab note book to do rough work.
- You may leave lab after evaluation.
- You may take a short break for 5-7 minutes after one and half hour.
- Note down all useful commands in your notebook.

Important Instructions

- Try to complete all tasks within 2 hours. After 2 hrs, evaluation starts.
- For each subtask, create mfiles (eg. CT_HT.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'(Size = 10), and, Width '2'.

Task1: Continuous-Time (CT) Fourier Transform

- Understand following commands
  - syms
  - subs
  - simplify
  - dirac
  - heaviside
  - sign
  - fourier
  - sinc
- Question: Write a program to find continuous-time (CT) Fourier transform (FT). Express each FT both in ω and f domain (Hint: Use above commands. You may also use function call concept.). Verify them mathematically.
  1. $\exp(-j\omega_c t)$, where $\omega_c = 2\pi f_c$
  2. $u(t)$ (i.e. heaviside(t))
  3. $\sin(2\pi f_c t)$
  4. $k \exp(-at)\, u(t)$
  5. $\text{sinc}(t)$

Task 2: Fast Fourier Transform (FFT), Autocorrelation

- Understand following commands
  - fft
  - fftshift
  - ifft
  - ifftshift
  - xcorr
  - norm
  - stem
- Question: Let X[k] = [0 0 4 0]. Using MATLAB, compute
  1. IFFT of X[k], denoted by x[n]
  2. Autocorrelation of x[n], $R_{xx}[m]$.
  3. Plot $R_{xx}[m]$ (hint: use 'stem' command with correct lag (or time shift) values)
  4. $R_{xx}[0]$
  5. $(norm(x[n]))^2$

Task 3: Hilbert Transform

- Understand following command
  - hilbert
  - real
  - imag
  - plot
  - hold
  - dot
- Question: Write MATLAB program to plot $m(t)$ and its Hilbert transform $\hat{m}(t)$
  1. m(t) = cos t
  2. plot both m(t), $\hat{m}(t)$ in single figure. Interpret your result.
- Question: Using MATLAB compute Hilbert transform of sequence $\hat{d}[n]$
  1. d[n] = [1 1 -1 -1]
  2. What is the analytic sequence? What are the real and imaginary parts?
  3. Find dot product of d[n] and its Hilbert transform (imaginary part)

Task 4: Random matrix

- Understand following commands
  - rand
  - randn
  - randi
  - randsrc
- Questions: Using above commands,
  1. Create 2*x*2 random matrix where each element is drawn from uniform distribution $\mathcal{U}[0, 1]$
  2. create 2*x*2 random matrix where each element is drawn from normal distribution
  3. Create 3*x*3 matrix whose entries are all 1's
  4. Create 2*x*2 matrix whose entries are drawn from set $\{1, -1\}$