BLG 354E Homework - 3

Due Date: 16.04.2017 22:00

Policy: Please do your homework on your own. The code and the report you submitted must be your own work. Cheating is highly discouraged for it could mean a zero or negative grade from the homework.

Only the problem parts denoted by [MATLAB] should be solved using Matlab. The rest is to be solved manually.

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1. Give definition of the following terms: *unit impulse*, *unit impulse response*.

   $$DONOTFORGET$$

   Side note: The impulse response provides a complete characterization of the filter, because the convolution sum gives a formula for computing the output from the input when the unit impulse response is known.

2. Derive the convolution sum formula step by step using LTI system properties. Explain each step shortly.

   (a) What is the intuition behind the convolution? Explain. (*Hint:* Use linearity and time-invariance of systems)

3. Show that FIR filter is a LTI system.

4. Use linearity and time-invariance to convolve the following continuous-time input and filter:

   $$x(t) = 5e^{-0.5(t-3)}[u(t-3) - u(t-11)] + 4\delta(t-2) + u(t-5)$$
   $$h(t) = e^{-0.25t}[u(t) - u(t-8)] + u(t-3)$$

   Use the graphical method and convolution properties of impulse and step function in appropriate cases.

5. Determine whether each of the following LTI systems are Casual and Stable.

   (a) $y(t) = x(t-4) + x(t+2) + 5\frac{d(x)}{dt}$

   (b) $y(t) = \int_{-\infty}^{t} x(\tau)d\tau$

   (c) $h(t) = e^{-(t-5)}u(t-5)$

   (d) $h(t) = u(t) - e^{-3t}u(t)$

6. **[MATLAB]** Implement *MyConv* function without using built-in function of MATLAB such as *conv*. Test your function using signal $x[n] = \{2, 4, 6, 4, 2\}$ and impulse response $h[n] = \{3, -1, 2, 1\}$.

7. $x[n] = \{2, 4, 6, 4, 2\}$ and $h[n] = \{3, -1, 2, 1\}$. Calculate $y[n] = x[n] * h[n]$ using matrix-vector multiplication.

8. **[MATLAB]** Explain briefly *conv2* built-in function of MATLAB. Convolve noisy-Cameraman.png image with 3x3 smoothing box filter using *conv2*. Discuss the resulting image briefly.
   (*Hint:* For 3x3 box filter look at `http://docs.opencv.org/3.0-beta/_images/math/473c8ab13c1d8f502158420bdd25be6b7ac7dfe1.png`)

9. Discuss briefly the result graphics of the following code script:

```
u = ones(1,10);
u_c = conv(u,u);
subplot(2,2,1)
stem(u_c);
for i=1:3
   u_c = conv(u_c,u);
   subplot(2,2,i+1)
   stem(u_c);
end
```