Istanbul Technical University
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Computer Engineering Department

# BLG 354E
# Signals & Systems for Computer Engineering
# Homework II

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# Contents

# 1 Question I

CFT $X(jw) = \int_{-\infty}^{\infty} x(t)e^{-jwt}dt$
$X(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} xjwe^{jwt}dt$
Now when we work on discrete elements we use sum formula and approximation so. $X(e^{jw}) = \sum_{n=-\infty}^{\infty} x[n]e^{-jwn}$
$X(e^{jw+2\pi}) = \sum_{n=-\infty}^{\infty} x[n]e^{-j(w+2\pi)n}$
$\sum_{n=-\infty}^{\infty} x[n]e^{-jwn}e^{-jw\pi n}$
$\sum_{n=-\infty}^{\infty} = x[n]e^{-jwn}$

# 2 Question II

Code is added but I am not sure I did it correctly. My accuracy did not increase as I expected when I incresed the dimensions and number of coefficietns.

# 3 Question III

Unit impulse functions is derivative of unit step function.Also we can think that as a building block of signals. We can represent any signal in terms of unit impulse signals. It is infinite when t = 0, otherwise 0.

The unit impulse response $h[n]$ of the FIR filter is simply the sequence of difference equation coefficients. System response.

# 4 Question IV

LTI systems(Linear Time Invariant) have linearity and time invariant properties as we can see it from its name. We can represent a signal as unit impulses as we stated above.
$x[n] = \sum_{k=-\infty}^{\infty} x[k] * S[n-k]$ $x[n]$ through system T and output is $y[n] = Tx[n]$
$T\{\sum_{k=-\infty}^{\infty} x[k] * S[n-k]\} = \sum_{k=-\infty}^{\infty} T\{x[k] * S[n-k]\} = \sum_{k=-\infty}^{\infty} x[k] * T\{S[n-k]\}$ due to time invariant property of LTI system $y[n] = \sum_{k=-\infty}^{\infty} x[k] * h[n-k]$ so that $y[n] = x[n] * h[n]$ convolution star.

# 5 Question V

## 5.1 a

This system is not casual, because it depends on future. It is stable.

## 5.2 b

This systems is casual, because it does not depends on future. Also it isn't stable because it does not converge.

## 5.3 c

This system is not casual, because it depends on future.Depends on past and present. It is stable, because it is bounded by one.

## 5.4 d

This system is not casual, because it depends on future. It is stable, because it is bounded by one.

# 6 Question VI

With matrix operations it is more easy to do convolution. So I wrote code like that.

```
import numpy as np

basex = [2,4,6,4,2]
baseh = [3,-1,2,1]

x = np.array(basex)
h = np.array( [ [0 for t in basex]]*(len(baseh)+len(basex)-1))

#settingg values
for i in range(len(baseh)+len(basex)-1):
    for j in range(len(baseh)):
        try:
            h[i+j][i] = baseh[j]
        except:
            pass

#matrix product
y = h.dot(x)
#result
print(y)
```

# 7 Question VII

$$\begin{bmatrix} 3 & 0 & 0 & 0 & 0 \\ -1 & 3 & 0 & 0 & 0 \\ 2 & -1 & 3 & 0 & 0 \\ 1 & 2 & -1 & 3 & 0 \\ 0 & 1 & 2 & -1 & 3 \\ 0 & 0 & 1 & 2 & -1 \\ 0 & 0 & 0 & 1 & 2 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} 2 \\ 4 \\ 6 \\ 2 \\ 4 \end{bmatrix} = \begin{bmatrix} 6 \\ 10 \\ 18 \\ 16 \\ 18 \\ 12 \\ 8 \\ 2 \end{bmatrix}$$

# 8 Question VIII

```
import numpy as np
from scipy.signal import convolve2d as cn2
from scipy.misc import imread, imsave
kernel = np.array([[1/9]*3]*3)
base = imread("noisyCameraman.png")[:,:,0]
last = cn2(base, kernel, "same")
imsave('last.png', last)
```

**Figure 1:** Original Image

**Figure 2:** Manipulated Image