**Digital Signal Processing**

Labwork 1

**Frequency & Time Representation**

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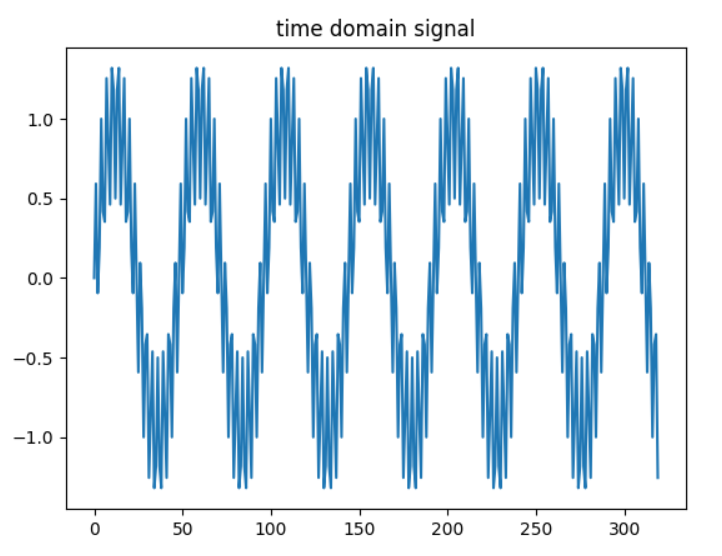
Name: Đào Hải Long

ID: BA9-041

University of Science and Technology of Hanoi

1 Signal and System

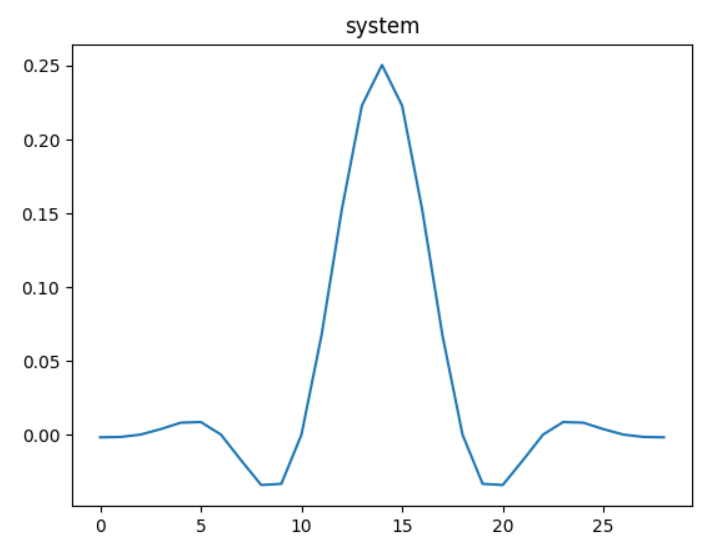
1. **Time domain**



- This picture is discrete-time signal: n=320, x(n)= Input\_1kHz\_15kHz

-The x axis is transferred to the domain from 0 to 2pi

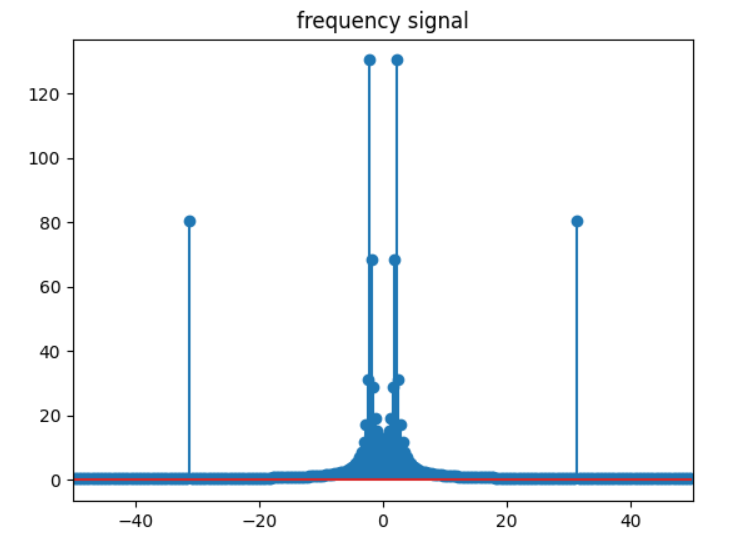
-A time-domain graph shows how a signal changes over time.

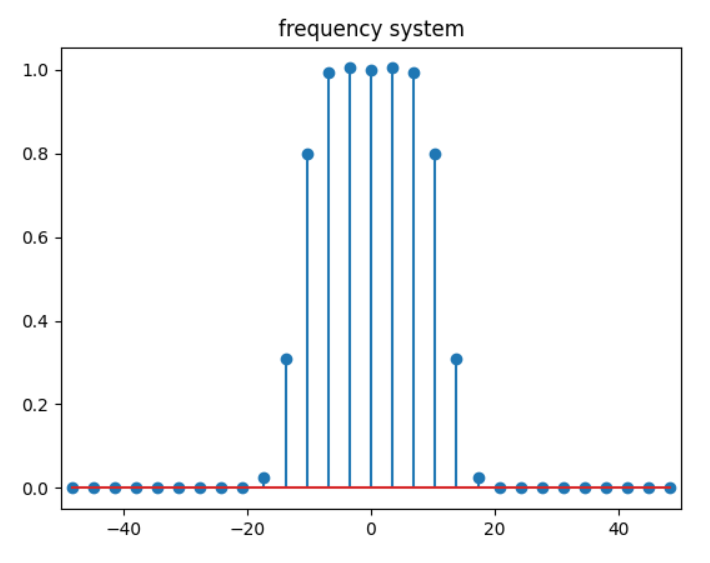


-This picture is discrete-time system:n=29, h(n) = Impulse\_response

-The x axis is transferred to the domain from 0 to 2pi

**b) Frequency**

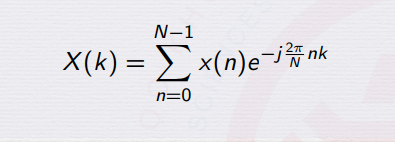




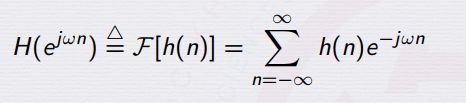
-The x axis is transferred to the domain from -pi to pi.(-40 to 40)

-Sampling rate, or number of measurements per second are: 100

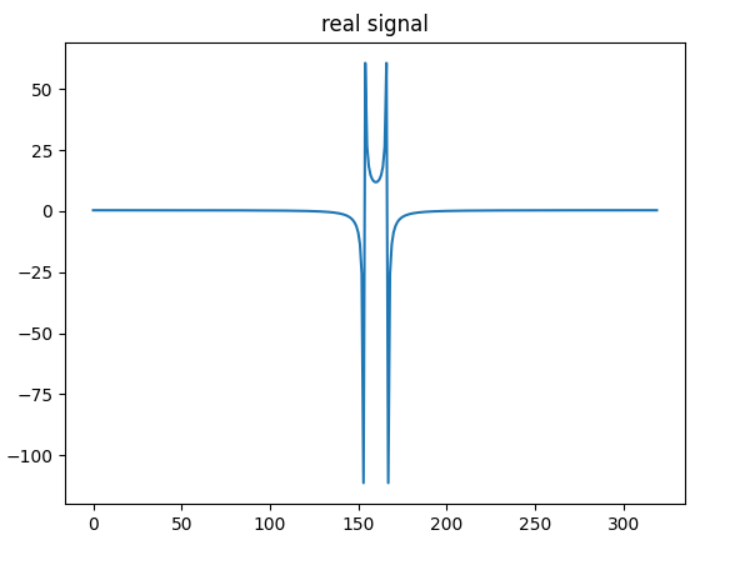
-The Fourier transform takes us from the time to the frequency domain, and this turns out to have a massive number of applications. The fast Fourier transform (FFT) is an algorithm for computing the DFT. FFT depend on the fact that

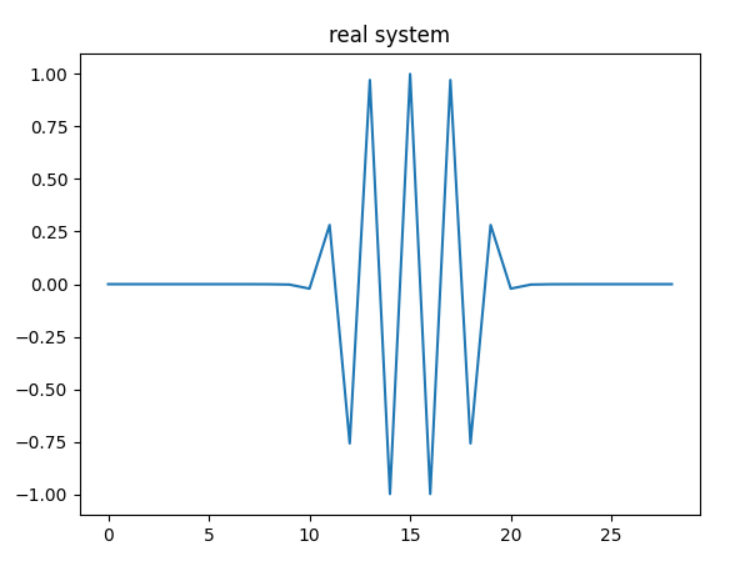


-The DTFT of an impulse response with LTI system



**c) Real**

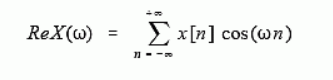
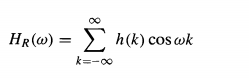




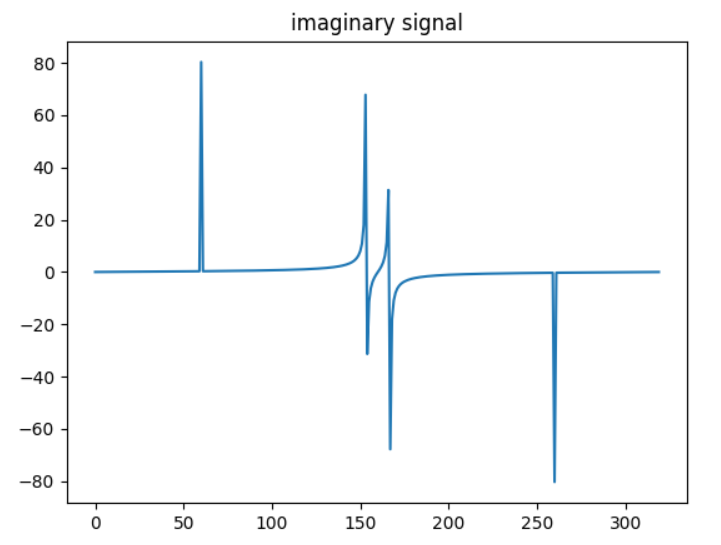
- The real DTFT and DFT transforms an N point time domain signal into two (N/2 + 1) point frequency domain signals/system. Points 0 through N/2 in the complex DTFT and DFT are the same as in the real DTFT and DFT . Even though the real DTFT and DFT uses only real numbers.

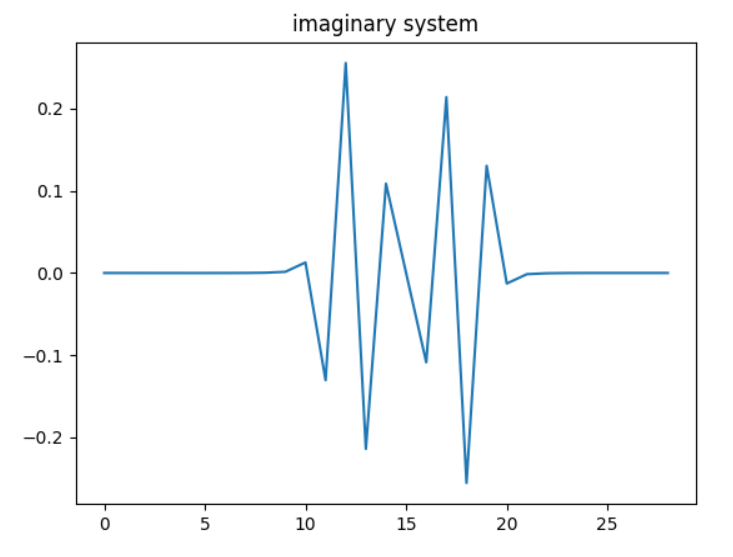
- The x axis is transferred to the domain from 0 to 2pi

**=**

**e) imaginary**

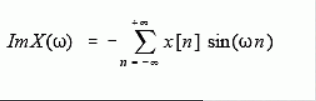
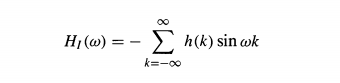
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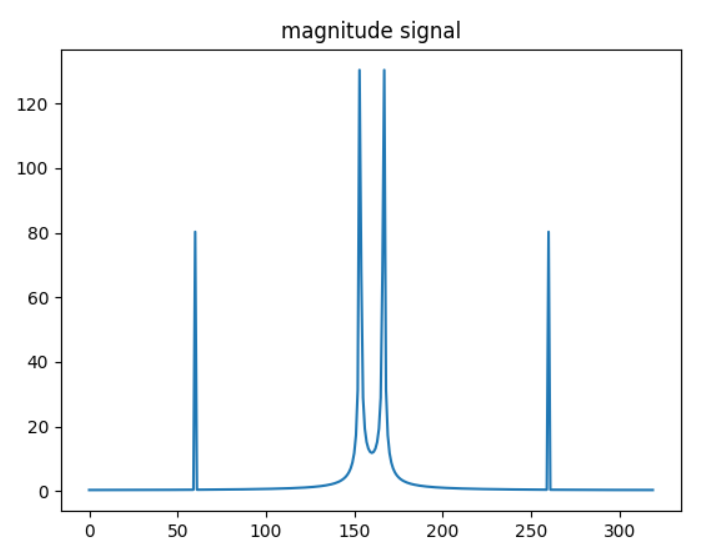
-The imaginaryDTFT and DFT transforms an N point time domain signal into two (N/2 + 1) point frequency domain signals.

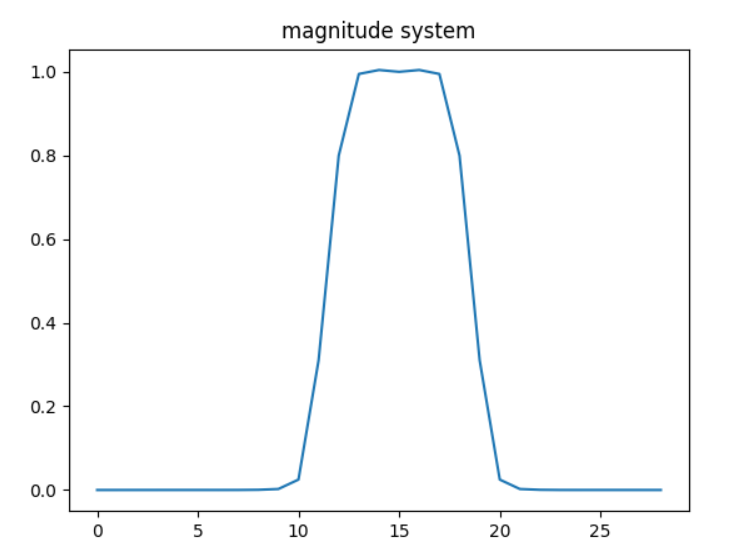
- Points N/2 through N-1 in the complex DTFT and DFT are the same as in the imaginary DTFT and DFT

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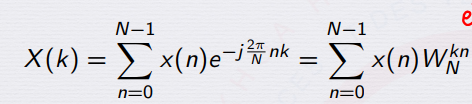
 

**e) Magnitude**





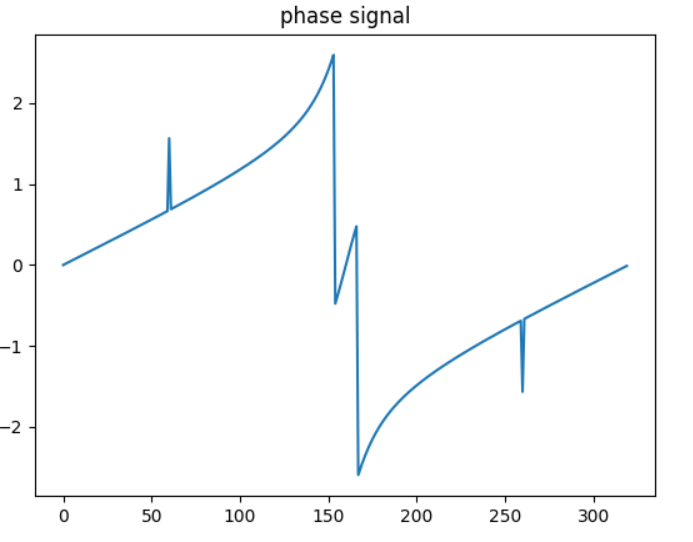
-With DFT as Linear Transformation

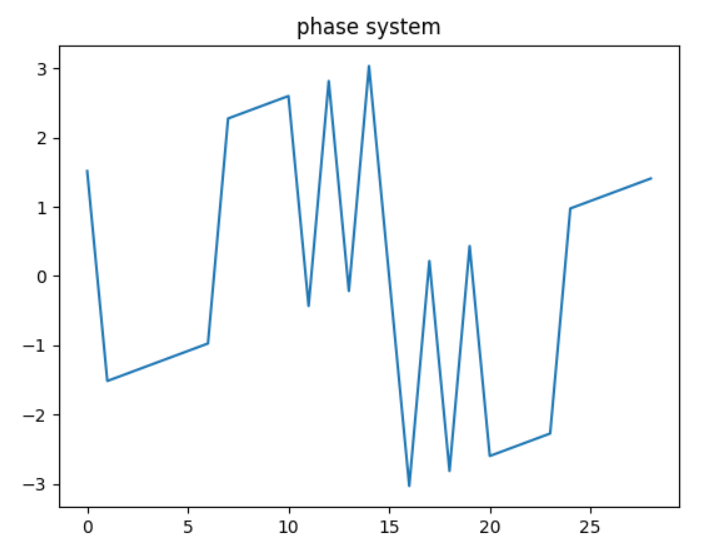


we defined WN = .

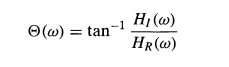
-Its magnitude is always maintained at uniform frequency domain.

**f) Phase**

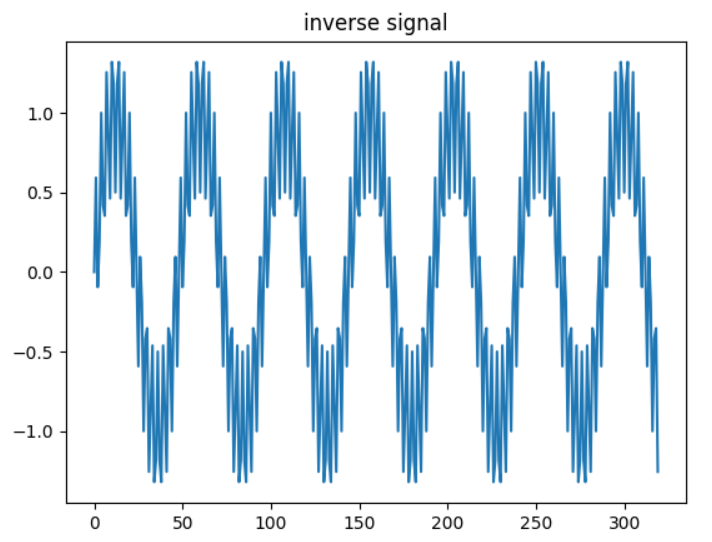




- Phase is an angle-like quantity representing the number of periods spanned by that variable.



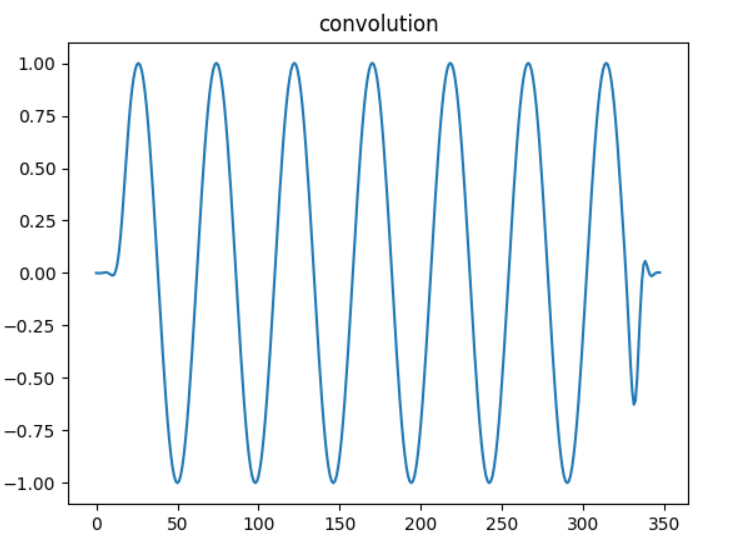
**g) Inverse-FFT**

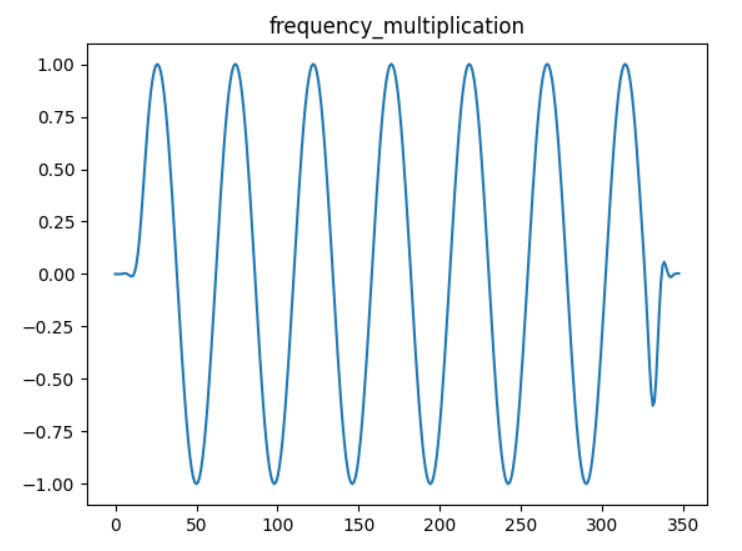


-The inverse transform is the same as the forward transform with the real and imaginary parts swapped for both input and output, up to a normalization

=> Inverse same input time domain

**h) Convolution and Multiplicaition Frequency**





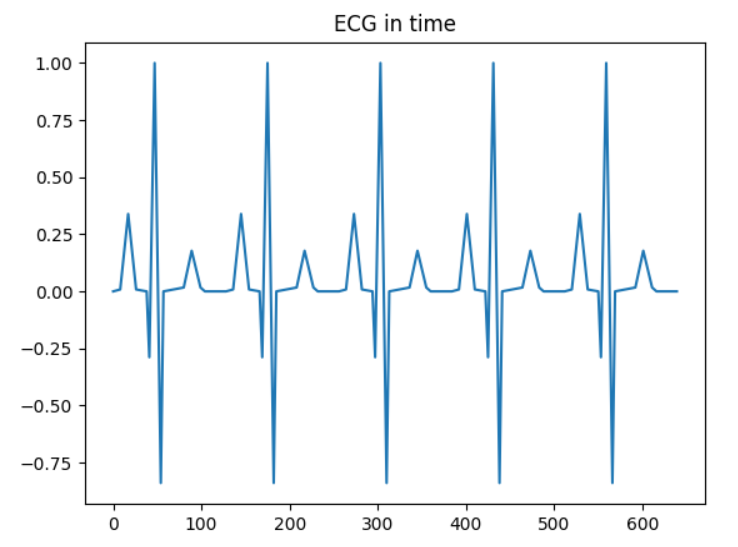
- Convolution in time domain equals multiplication in frequency domain

**F{x(t)\*y(t)}(f)=F{x(t)}(f) . F{y(t)}(f)**

where F{x(t)}(f)F{x(t)}(f) denotes the Fourier transform of x(t)x(t), evaluated at the frequency

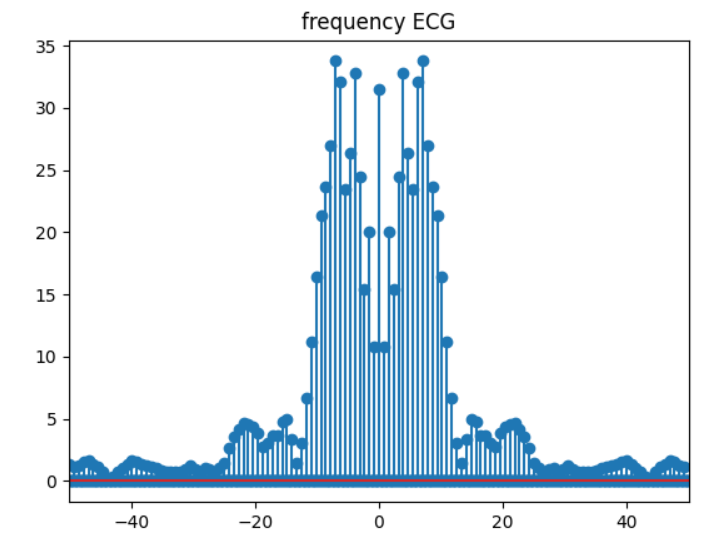
- The convolution theorem can be used to perform convolution via multiplication in the time domain.

**2.ECG**

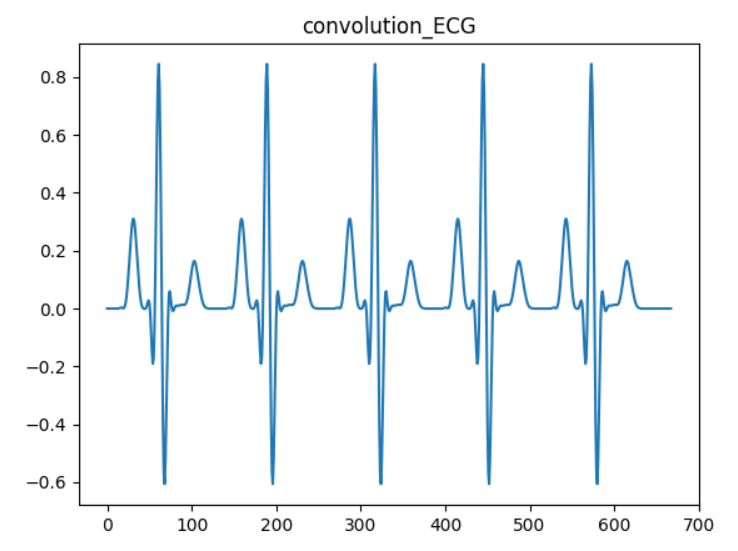
**+ ECG in time **

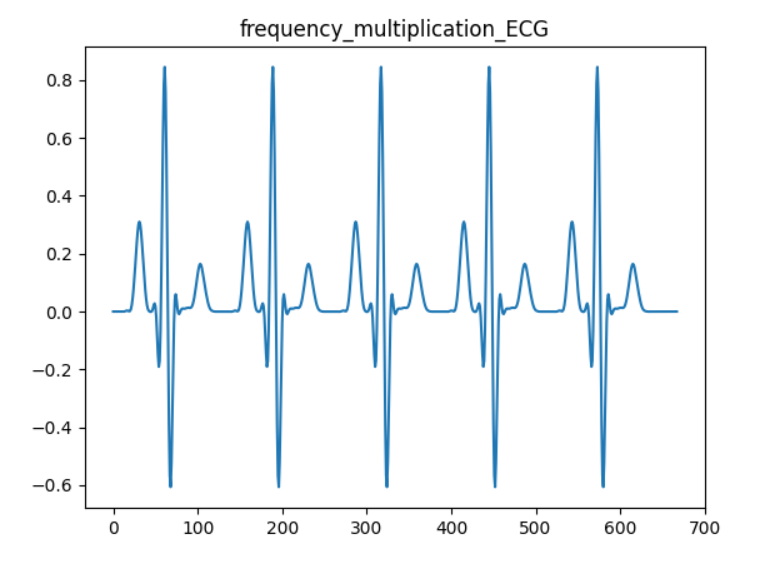
**-**x(n)=ECG ,n=640

**+ Frequency domain**

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**+ Concolution and Multipication frequency**

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* Convolution in time domain equals multiplication in frequency domain

- The convolution theorem can be used to perform convolution via multiplication in the time domain.