Department of Electrical Engineering
Final term exam
Date: 23/09/2020

Course Details

Course Title: Signals & Systems **Module:** 04

Instructor: ________ **Total Marks:** 50

Student Details

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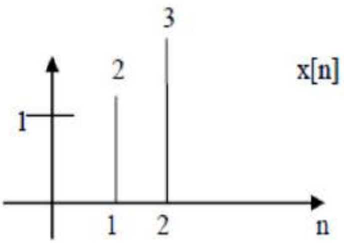
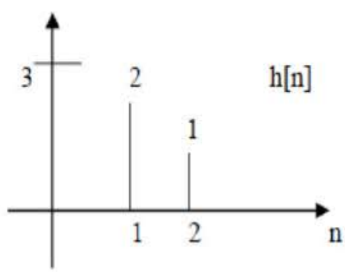
Q1.		**Identify** the basic difference between a periodic and an aperiodic signal using examples.	Marks 06 CLO 1
Q2.		$f(x) = \begin{cases} 0 & -\pi \le x \le 0 \\ \pi & 0 \le x \le \pi \end{cases}$ **Retrieve** the Fourier series for the given function.	Marks 12 CLO 3
Q3.		If $X(z) = 2z^2 + 2z \big/ (z^2 + 2z - 3)$ **Retrieve** x[n] using inverse Z-transform method.	Marks 10 CLO 3
Q4.		If $x[n] = 4\delta[n] - 3\delta[n-1] + 4\delta[n-2]$ $h[n] = 2\delta[n-1] - 3\delta[n-2] + 2\delta[n-3]$ **Produce** Y(z) and y[n]	Marks 10 CLO 3
Q5.		**Evaluate** y[n] using convolution summation. 	Marks 12 CLO 2

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Q(1)

Ans Periodic Signal:-

A signal is considered periodic if it repeats itself after a specific intervel of time.

* Definition:- Periodic signal is a signal which repeats itself after specific interval of time.

- Representation:-
Periodic can be represented by a mathematical equation.

- Determination of value:-
The value of periodic signal can be determined at any point in time.

- Type of Signal:-
periodic signal are deterministic signals.

- Example:-
Sinusoidal wave, cosine wave, triangle wave and square wave are example of periodic signal.

- **A Periodic Signal:-**

A signal is considered aperiodic signal when it does not repeat its pattern over a period or interval of time.

- **Definition:-** Aperiodic signal is a signal which does not repeat itself after a specific interval of time.

- **Representation:-** Aperiodic signal cannot be represented by any mathematical equation.

- Determination of value:- The value of aperiodic signal cannot be determined with certainty at any given point of time.

- Type of Signal:- Aperiodic signal are random signals.

- Example:- Aperiodic signal is signal created by microphone or telephone when one or two words are pronounced. Also, signal propa-gated by AM radio station or FM radio stations are all aperiodic signal.

Q(2) $f(x) \begin{cases} 0 & -\pi \leq x \leq 0 \\ \pi & 0 \leq x \leq \pi \end{cases}$

Sol :-

$$a_0 = \frac{1}{2\pi} \int_{-\pi}^{\pi} f(x)\, dx$$

$$= \frac{1}{2\pi} \left[\int_{\pi}^{0} f(x)\, dx + \int_{0}^{\pi} f(x)\, dx \right]$$

$$= \frac{1}{2\pi} \left[\int_{\pi}^{0} 0\, dx + \int_{0}^{\pi} \pi\, dx \right]$$

$$= \frac{1}{2\pi} \left[0 + \pi x \Big|_0^{\pi} \right]$$

$$= \frac{1}{2\pi} \left[\pi(\pi - 0) \right]$$

$$a_0 = \frac{1}{2\cancel{\pi}} \times \pi^{\cancel{2}}$$

$$a_0 = \pi/2 .$$

$$a_n = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)\cos nx\,dx$$

$$= \frac{1}{\pi}\left[\int_{-\pi}^{0} f(x)\cos nx\,dx + \int_{0}^{\pi} f(x)\cos nx\,dx\right]$$

$$= \frac{1}{\pi}\left[\int_{\pi}^{0} (0)\cos nx\,dx + \int_{0}^{\pi} \pi\cos nx\,dx\right]$$

$$= \frac{1}{\pi}\left[0 + \int_{0}^{\pi} \pi\cos nx\,dx\right.$$

$$= \frac{1}{\pi}\left[\pi\int_{0}^{\pi} \cos nx\,dx\right]$$

$$= \frac{1}{n}\left[\sin n(\pi) - \sin n(0)\right]$$

$$= \frac{1}{n}[0-0]$$

$$a_n = 0.$$

$$b_n = \frac{1}{\pi} \int_{-\pi}^{\pi} f(x) \sin nx \, dx$$

$$= \frac{1}{\pi} \left[\int_{-\pi}^{0} f(x) \sin nx \, dx \int_{0}^{\pi} f(x) \sin nx \, dx \right]$$

$$= \frac{1}{\pi} \left[\int_{-\pi}^{0} f(x) \sin nx \, dx \int_{0}^{\pi} f(x) \sin nx \, dx \right]$$

$$= \frac{1}{\pi} \left[0 + \pi \int_{0}^{\pi} \sin nx \, dx \right]$$

$$= \frac{1}{\pi} \left[\pi \left(-\frac{\cos nx}{n} \right) \Big|_{0}^{\pi} \right]$$

$$= \frac{-\cancel{\pi}}{n\cancel{\pi}} \left[\cos nx \Big|_{0}^{\pi} \right]$$

$$= -\frac{1}{n} \left[\cos n(\pi) - \cos n(0) \right]$$

$$b_n = \begin{cases} 0 & \text{if } n \text{ even} \\ 2/n & \text{if } n \text{ odd} \end{cases}$$

$$f(x) = a_0 + a_1 \cos x + a_2 \cos 2x + a_3 \cos 3x + \dots$$

$$b_1 \sin x + b_2 \sin 2x + b_3 \sin 3x + \dots$$

$$f(x) = \pi/2 + 2 \sin x + 2/3 \sin 3x.$$

Q (3)

Ans:- Given:-

$$X(z) = \frac{2z^2+2z}{(z^2+2z-3)}$$

$$X(z) = \frac{2z(z+1)}{z^2+3z-z-3}$$ Taking "2z" common

Simplify

$$X(z) = \frac{2z(z+1)}{z(z+3)-1(z+3)}$$

$$\frac{X(z)}{z} = \frac{2(z+1)}{(z+3)(z-1)}$$

or we can write

$$\frac{2(z+1)}{z^2+2z-3} = \frac{A}{(z+3)} + \frac{B}{(z-1)}$$

Putting

$2(z+1) = A(z-1) + B(z+3) \Rightarrow eq\ 1$

Now putting $z=1$ in eq 1

$2(1+1) = B(1+3)$

$4 = 4B$

$\cancel{4}/\cancel{4} = \cancel{4}/\cancel{4}\, B$

$1 = B$

$B = 1$

Now putting $z=-3$ in eq 1

$2(-3+1) = A(-3-1)$

$-4 = -4A$

$A = 1$

Now we will put A and B in eq (1)

$$\frac{2(z+1)}{(z+3)(z-1)} = \frac{1}{z+3} + \frac{1}{(z-1)}$$

$$x(z) = \frac{z}{z+3} + \frac{z}{(z-1)}$$

inverse z-transform

$$x(z) = u[3] + 1(-1)^k$$

Q(4)

Ans:- If $x[n] = 4\delta[n] - 3\delta[n-1]$
$+ 4\delta[n-2]$

$h[n] = 2\delta[n-1] - 3\delta[n-2] + 2\delta[n-3]$

$y(z)$ $y[n] = ?$

$x(z) = 4 - 3z^{-1} + 4z^{-2}$

$h(z) = 2z^{-1} - 3z^{-2} + 2z^{-3}$

Now $H(z) \cdot x(z)$

$y(z) = ((\cancel{2z^{-1}}) - \cancel{3}$

$y(z) = (2z^{-1} - 3z^{-2} + 2z^{-3}).(4 - 3z^{1}$
$+ 4z^{-2})$

$y(z) = 8z^{-1} - 6z^{-2} + 8z^{-3} - 12z^{-2} + 9z^{-3}$
$-12z^{-4} + 8z^{-3} - 6z^{-4} + 8z^{-3}$

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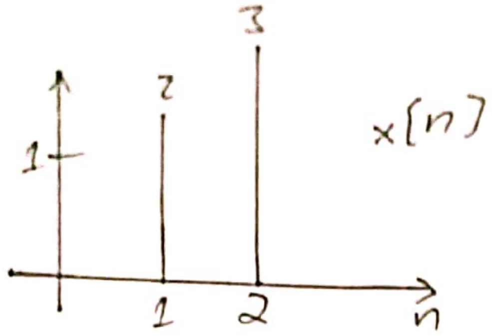
$$y(z) = 8z^{-1} - 6z^{-2} - 12z^{-2} + 8z^{-3} + 9z^{-3} + 8z^{-3} - 12z^{-4} - 6z^{-4} + 8z^{-5}$$

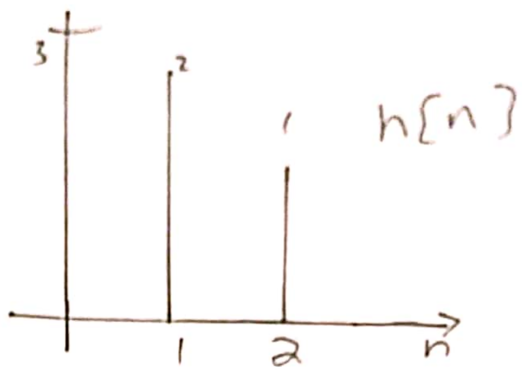
$$= 8z^{-1} - 18z^{-2} + 25z^{-3} - 18z^{-4} + 8z^{-5}$$

So

$$y[n] = 8\,\delta[n-1] - 18\,\delta[n-2] + 25\,\delta[n-3] - 18\,\delta[n-4] + 8\,\delta[n-5]$$

Q(5) Evaluate $y[n]$ using convolution summation.





Sol:-

$$y[n] = x[n] * h[n]$$

As we know

$$x[n] = x[n] + 2\{x-1] + 3x[1-2]$$

and

$$y[n] = 3x[n] + 2x[n-1] + x(n-2)$$

$$x[n] = x[0]\,\delta[n] + x[1]\,\delta[n-1] + x[2]\,\delta[n-2]$$

$$y[n] = x[0]\,\delta[n] + x[1]\,\delta[n-1] + x[2]\,\delta[n-2]$$

$$x[n] = \sum_{k=0}^{2} x[m]\,\delta[n-k]$$

$$\text{for } y[n] = \sum_{k=0}^{2} x[m]\,\delta[n-k]$$