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* Assignment No: 01 *

* Digital Signal processing *

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Section: B

Submitted to:

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M T W T F S H/W C/W Dated: / /20

Question No: 1

$$x_a(t) = 3\sin(40\pi t)$$

a) Sketch $x_a(t)$ $0 \le t \le 75$ ms

at $t = 0s$

$$x_a(0) = 3\sin(40\pi 0)$$

$$x_a(0) = 0$$

at $t = 0.01s$

$$x_a(0.01) = 3\sin(40\pi(0.01))$$

$$x_a(0.01) = 2.8$$

at $t = 0.012s$

$$x_a(0.012) = 3 \rightarrow \text{max Amplitude.}$$

at $t = 0.02$

$$x_a(0.02) = 3\sin(40\pi(0.02))$$

$$x_a(0.02) = 1.8$$

at $t = 0.03$

$$x_a(0.03) = 3\sin(40\pi(0.03))$$

$$x_a(0.03) = -1.8$$

at $t = 0.038$

$$x_a(0.038) = 3\sin(40\pi(0.038))$$

$$x_a(0.038) = -3$$

P ↓ T↓ 0

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at $t = 0.05$

$x_a(0.05) = 3 \times \sin(40 \times \pi \times 0.05)$

$x_a(0.05) = 0$

at $t = 0.06$

$x_a(0.064) = 3 \times \sin(40 \times \pi \times 0.064)$

$= 3$

at $t = 0.07$

$x_a(0.07) = 3 \times \sin(40 \times \pi \times 0.07)$

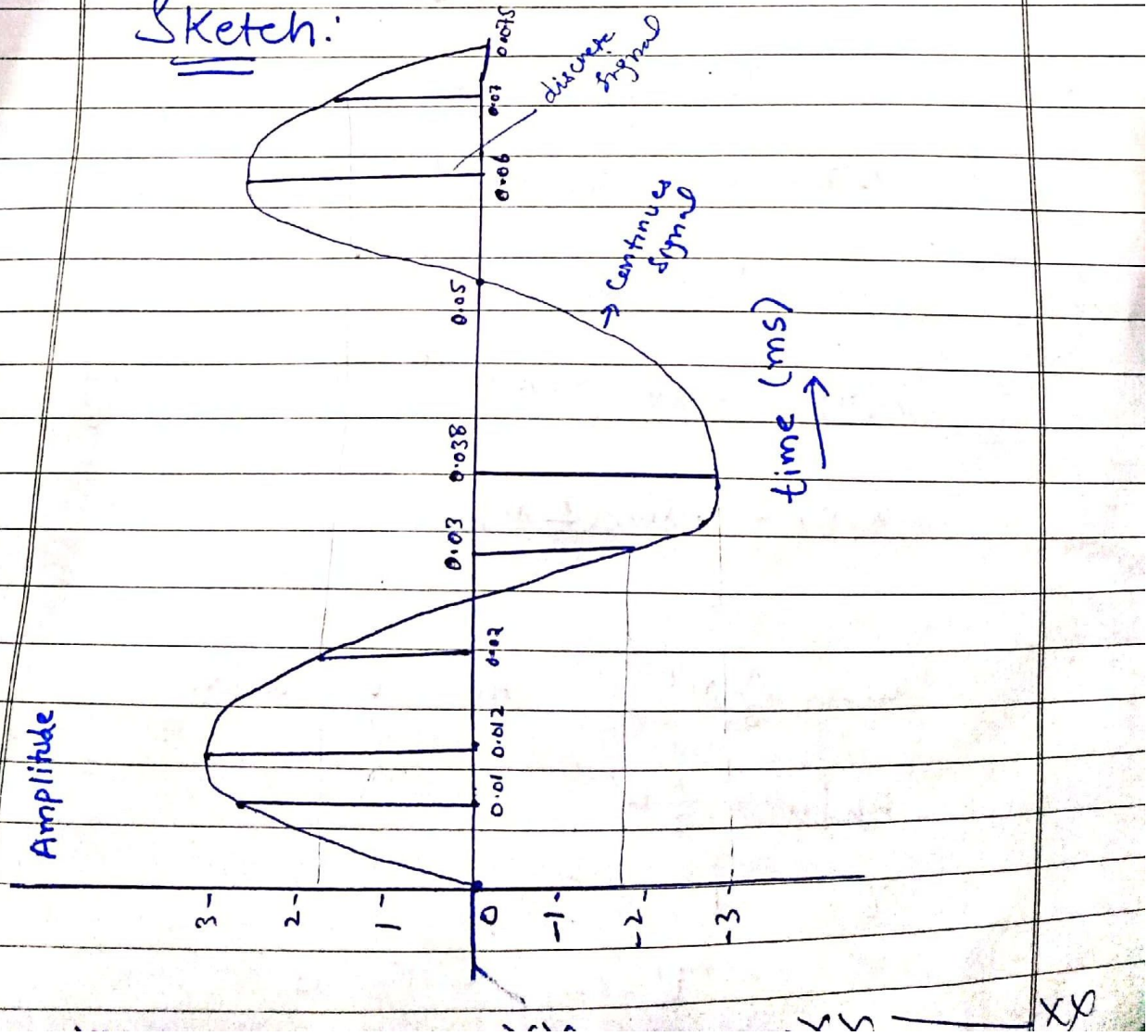
$= 1.8$

at $t = 0.075$

$x_a(0.075) = 3 \times \sin(40 \times \pi \times 0.075)$

$x_a(0.075) = 0$

Sketch:



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Part - (b)

Given:

$F_s = 120$ Hrtz

$x[n] = x_a(nT_s)$ $T_s = \frac{1}{F_s}$

frequency of discrete signal = $f = ?$

Sol

As

$$x_a(t) = 3\sin(40\pi t)$$

$$\Rightarrow x_a(nT_s) = 3\sin(40\pi n T_s)$$

So

$$x[n] = 3\sin(40\pi n T_s)$$

As $T_s = \frac{1}{F_s}$ So

$$x[n] = 3\sin\left(40\pi n \frac{1}{F_s}\right)$$

As $F_s = 120$ So

$$x[n] = 3\sin\left(40\pi n \left(\frac{1}{120}\right)\right)$$

$$x[n] = 3\sin\left(\underbrace{\frac{\pi}{3}}_{\omega} n\right)$$

$\omega = \frac{\pi}{3} n$ As $\omega = 2\pi f n$

$2\pi f n = \frac{\pi}{3} n$

$6f = 1$

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$6f = 1$

$$\boxed{f = 1/6}$$

As we know that discrete-time Sinusoidal Signal is periodic only if and only if the frequency is Rational. So 1/6 is Rational no thus Signal is periodic.

Part – c

→ The Sketch is drawn on Page 2.

→ Now period of $x(n)$ is

$$T = \frac{1}{F} = \frac{1}{1/6}$$

$T = 6$ sec

Now In milli-sec

~~$T = 6000$ ms~~

$$\boxed{T = 6000 ms}$$

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Question NO : 2 :

Given:

$$x_a(t) = \sin(480\pi t) + 3\sin(720\pi t)$$

Sampling Rate $= f_s = 600/\text{sec}$

(a) NYQUIST Sampling Rate for $x_a(t) = ?$

There are two frequencies in $x_a(t)$.

$2\pi f_1 t = 480\pi t$ & $2\pi f_2 t = 720\pi t$

$f_1 = 240$ Hz $\qquad f_2 = 360$ Hz

According to NYQUIST S.R.

The minimum Sampling Rate $\omega_s = 2\omega_{max}$ or $F_s = 2F_{max}$ Required to Recover the analog signal again is called NYQUIST theorem.

NYQUIST $f_s = 2 \times F_2$

NYQUIST $f_s = 2(360)$

NYQUIST $f_s = 720$ Hrtz.

→ minimum Sampling Rate Required for above signal to Re-shape again.

(b) folding frequency = ?

half of NYQUIST Sampling Rate is called folding frequency.

$$f_f = \frac{F_s}{2} = \frac{600}{2}$$

$f_f = 300\ Hz$

(C) frequencies in radian in resulting discrete time signal.

first we convert above continues-time signal to discrete time

$$x[n] = x_a\left[\frac{n}{F_s}\right] = x_a[nT_s]$$

$$x[n] = \sin\left(\frac{480\pi n}{600}\right) + 3\sin\left(\frac{720\pi n}{600}\right)$$

$$x[n] = \sin\left(\frac{8}{10}\pi n\right) + 3\sin\left(\frac{6}{5}\pi n\right)$$

Now frequencies in radian are

$$\frac{8}{10}\pi \quad \& \quad \frac{6}{5}\pi$$

(D) if $x[n] \rightarrow$ [D/A] $\rightarrow y_a(t) = ?$

Sol

As in analog to digital or discrete signal we take $t = nT_s$

So in Digital to discrete or digital (D/A) we take $n = t/T_s = F_s t$

So

$$y_a(t) = x_a(F_s t) \qquad x = \text{discrete time}$$

$$= \sin\left(\frac{8}{10}\pi(600)t\right) + 3\sin\left(\frac{6}{5}(600\pi t)\right)$$

$$F_s = \frac{8}{10}\pi,\ \frac{6}{5}\pi$$

$$y_a(t) = \sin(480\pi t) + 3\sin(720\pi t)$$

→ which if this signal was to pass through an Ideal D/A Converter it would

Complet Recover.

Question NO # 3

Given:

$$x[n] = 7.5 \sin\left[\frac{\pi}{5} n + \pi/6\right]$$

Required:

no of bits Required in A/D Conversion.

a) $\Delta = 0.10$

Since Sin function oscillate b/w +7.5 (max) & −7.5 (min) then

$$\Delta = \frac{max - min}{L - 1}$$

$$\Delta = \frac{7.5 + 7.5}{L-1} = \frac{15}{L-1}$$

$$L = \frac{15}{\Delta} + 1$$

when $\Delta = 0.1$ then L= the no of bits b is the Smallest Integer greater than or equal to $\log_2(L)$

for $\Delta = 0.1$ $L = 15$ and

$\log_2(15) = 7.29$

So $\boxed{b = 8}$

b) When $\Delta = 0.05$

$$L = 1 + \frac{15}{0.05}$$

P + T P a

$\log_2(301) = 8.22$

so

$\boxed{b = 9}$

2) $\Delta = 0.01$

so

$$L = 1 + \frac{15}{0.01}$$

$$L = 1501$$

$\log_2(1501) = 10.55$

so $\boxed{b = 11}$

— xx — xx — xx — xy

the END