Princess Sumaya University for Technology
King Abdullah II School of Engineering

EE27355
Communication Principles

Quiz #8
Wednesday 13/5/2026

Name:…………………………………………………………………. **Section 2**

Q.1) A signal g(t)=sinc^2(5πt) (as shown in Figure Q.1(a) with its spectrum G(ω)=0.2Δ(ω/20π) in Figure Q.1(b)] is sampled (using uniformly spaced impulses) at a rate of: 5 Hz. Explain whether the signal g(t) can be recovered from the sampled signal by sketching the sampled signal in both time and frequency domains.

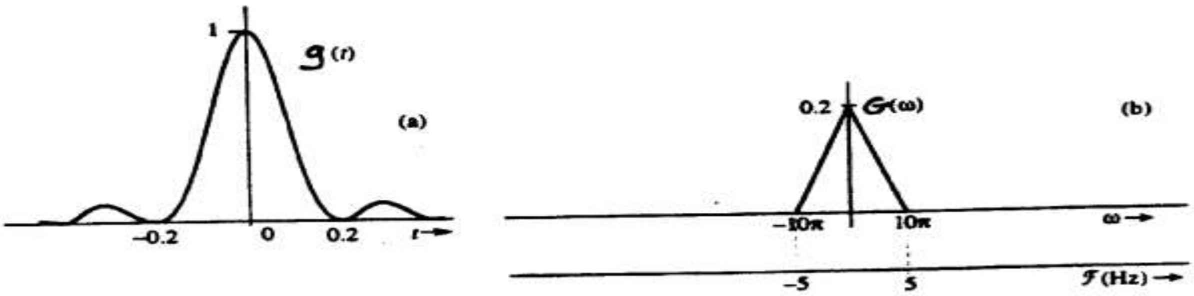
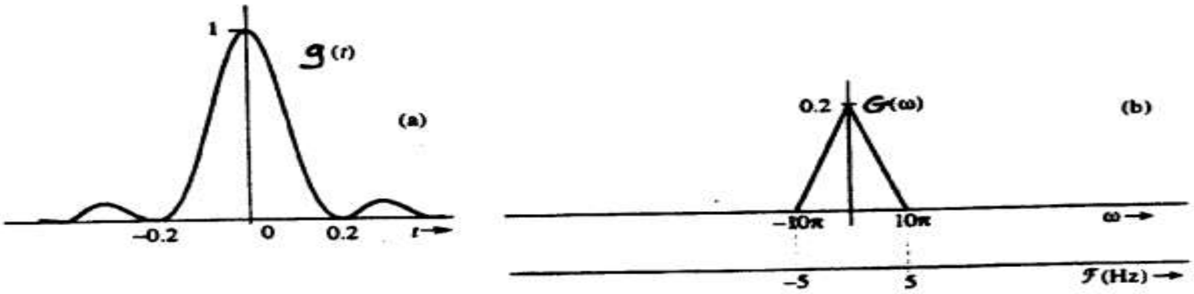


Figure Q.1

<u>Solution:</u> [14-Points]



$$g(t) = \text{sinc}^2(5\pi t) \xrightarrow{F}$$

$$\frac{W}{2\pi}\,\text{sinc}^2\left(\frac{Wt}{2}\right) \longrightarrow \Delta\left(\frac{\omega}{2W}\right)$$

$$\frac{Wt}{2} = 5\pi t$$

$$\boxed{W = 10\pi}$$

$$\left[\frac{1}{5}\right] \frac{10\pi}{2\pi}\,\text{sinc}^2(5\pi t) \xrightarrow{F} \left[\frac{1}{5}\right] \Delta\left(\frac{\omega}{20\pi}\right)$$

↑ From -10π to $(+10)$
or -5 to 5 Frequency

$$BW = \frac{10\pi}{2\pi} = 5$$

Nyquist Rate $= 2(5) = 10$

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↑

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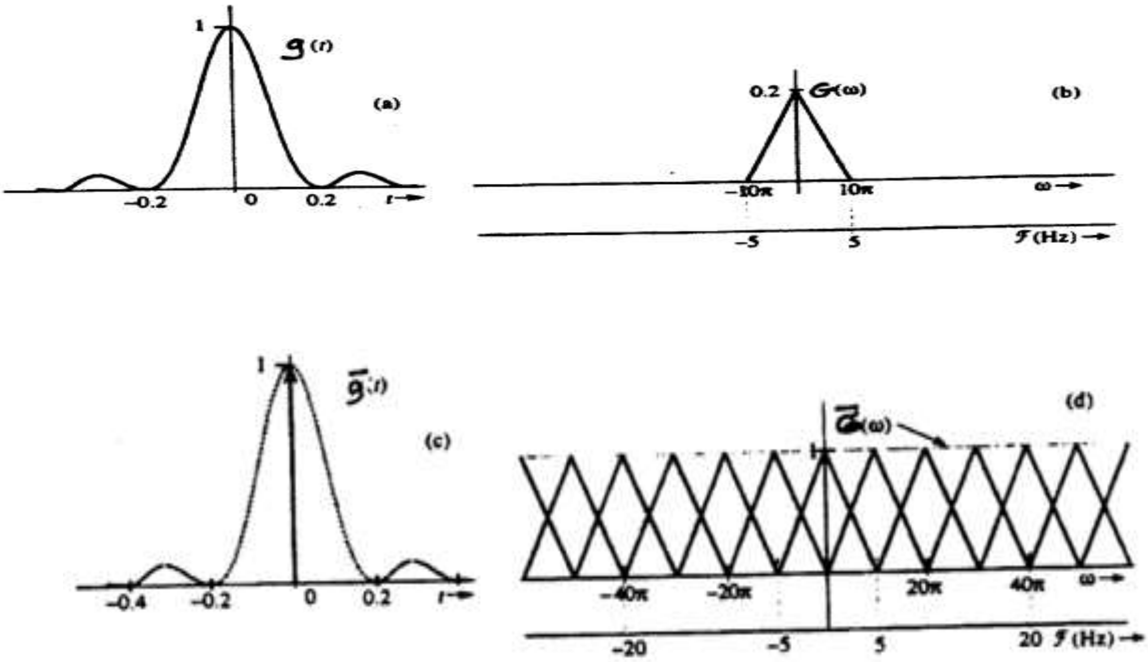
From Table, only select the 5 Hz

sampling frequency f_s	sampling interval T	$\frac{1}{T}G(\omega)$	comments
5 Hz	0.2	$\Delta\left(\frac{\omega}{20\pi}\right)$	Undersampling
10 Hz	0.1	$2\Delta\left(\frac{\omega}{20\pi}\right)$	Nyquist Rate
20 Hz	0.05	$4\Delta\left(\frac{\omega}{20\pi}\right)$	Oversampling



Q.2) Two signals $g_1(t)$ and $g_2(t)$ are applied at the inputs of the ideal low pass filters $H_1(\omega)$ and $H_2(\omega)$ (as shown in Figure Q.2). Find the Nyquist rate of $y_1(t)$, $y_2(t)$ and $y_3(t)$.

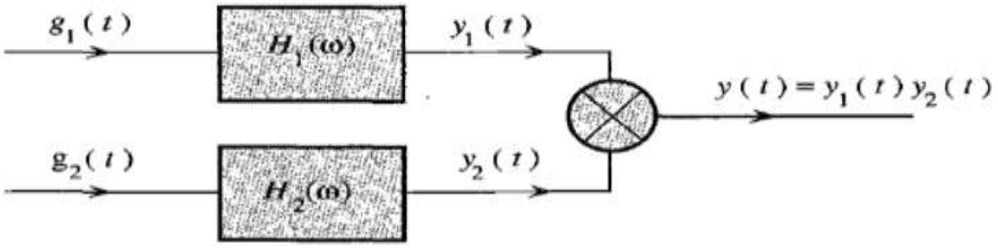


Figure Q.2

$$g_1(t) = 10^4 rect(10^4 t) \rightarrow G_1(\omega) = \sin c(\frac{\omega}{20000})$$

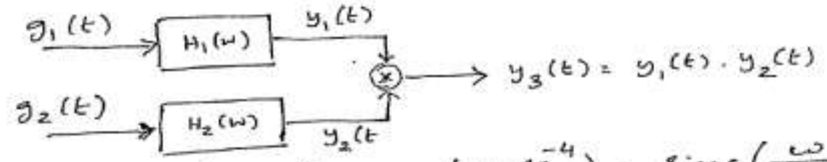
$$g_2(t) = \delta(t) \rightarrow G_2(\omega) = 1$$

$$H_1(\omega) = rect(\frac{\omega}{40000\,\pi})$$

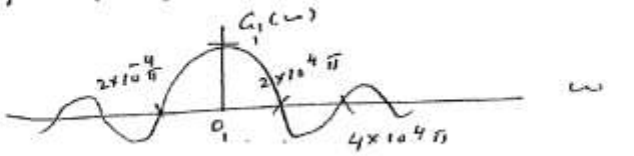
$$H_2(\omega) = rect(\frac{\omega}{20000\,\pi})$$

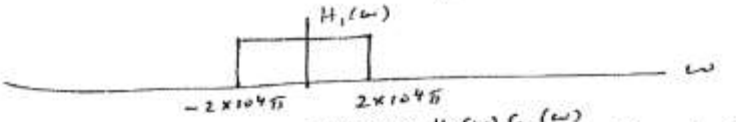
<u>**Solution:**</u> **[6-Points]**

3. Signals $g_1(t) = 10^4 \text{rect}(10^4 t)$ and $g_2(t) = \delta(t)$ are applied at the inputs of the ideal low pass filters $H_1(\omega) = \text{rect}(\omega/40{,}000\pi)$ and $H_2(\omega) = \text{rect}(\omega/20{,}000\pi)$. (a) Sketch $Y_1(\omega)$ and $Y_2(\omega)$, (10 points)and (b) find the bandwidths of $y_1(t)$, $y_2(t)$, and $y_3(t)$ (10 points)



$G_1(\omega) = 10^4 \cdot 10^{-4}\, \text{sinc}\left(\frac{\omega \cdot 10^{-4}}{2}\right) = \text{sinc}\left(\frac{\omega}{20000}\right)$



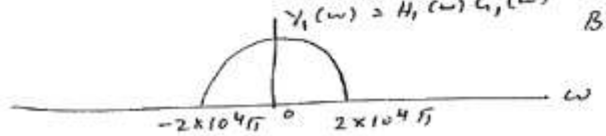


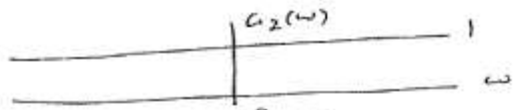
Bw of $y_1(t)$: $2\times10^4\pi$ rad/sec

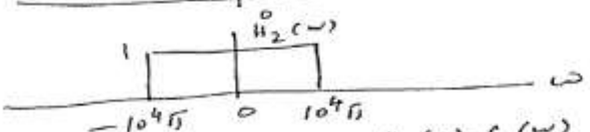
or 10^4 Hz

or **10 kHz**

Spectrum of $Y_1(\omega)$ →





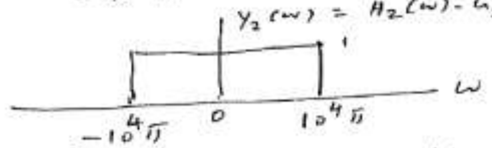


Bw of $y_2(t)$

$= 10^4\pi$ rad/sec

or **5 kHz**

Spectrum of $Y_2(\omega)$ →



Bw of $y(t)$ = Bw of $y_1(t)$ + Bw $y_2(t)$ [By product property]

= 10 kHz + 5 kHz

= **15 kHz.**

10x2=20

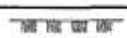
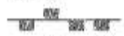
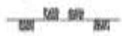
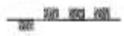
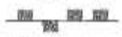
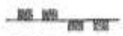
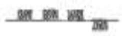
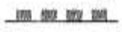
5x2=10

15x2=30

Q.3) For the following sequence {-1.2,1.2,0.2,-0.2,0.5,0.4,-0.89,-1.3,-7.2,7.2}, Quantize it using a uniform quantizer in the range of (-8,8) with 16 levels, and write the quantized sequence and the corresponding binary stream.

Hint:

$$L = 2^n \qquad \text{or} \qquad n = \log_2 L$$

Digit	Binary equivalent	Pulse code waveform
0	0000	
1	0001	
2	0010	
3	0011	
4	0100	
5	0101	
6	0110	
7	0111	
8	1000	
9	1001	
10	1010	
11	1011	
12	1100	
13	1101	
14	1110	
15	1111	

<u>Solution:</u> [10-Points]

8-(-8)=16

# of levels 16 and n=4

16/16 = 1 each step

6, 9, 7, 8, 8, 8, 7, 6, 0, 15

Bit stream

0110, 1001, 0111, 1000, 1000, 1000, 0111, 0110, 0000, 1111

Quantized levels:

-1.5, 1.5, -0.5, 0.5, 0.5, 0.5, -0.5, -1.5, -7.5, 7.5