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EE27355

Communication Principles

Quiz #8

Tuesday 12/5/2026

Name:.....



Section 1

Q.1) A signal  $g(t) = \text{sinc}^2(5\pi t)$  (as shown in Figure Q.1(a) with its spectrum  $G(\omega) = 0.2\Delta(\omega/20\pi)$  in Figure Q.1(b)) is sampled (using uniformly spaced impulses) at a rate of: 10 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.

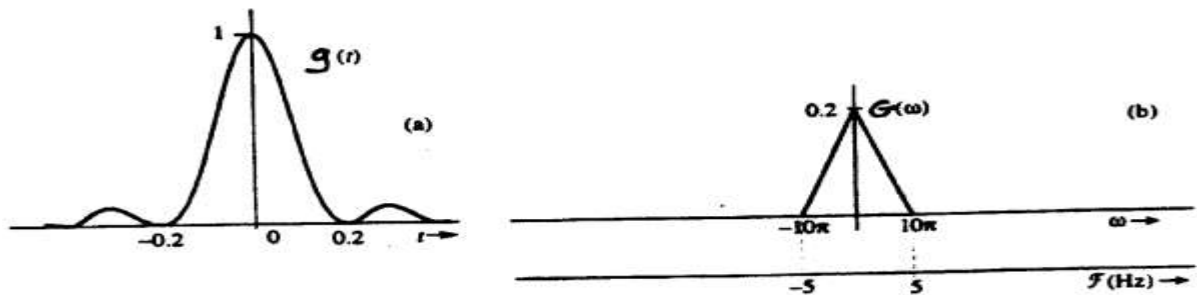
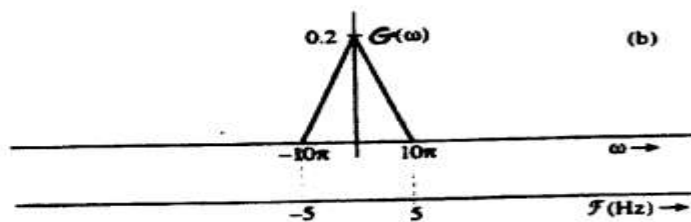
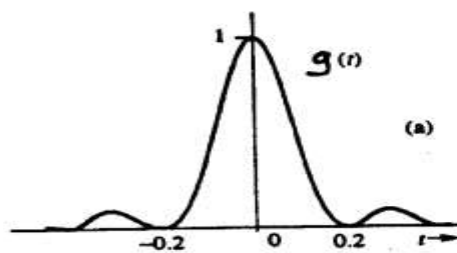


Figure Q.1

Solution: [14-Points]



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

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

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

$$W = 10\pi$$

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

From  $-10\pi$  to  $10\pi$   
or  $-5$  to  $5$  Frequency

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

$$\text{Nyquist Rate} = 2(5) = 10$$

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

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

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

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

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

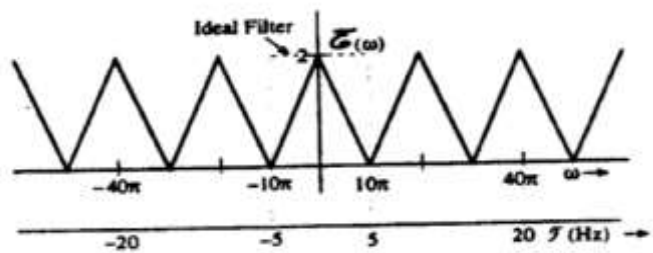
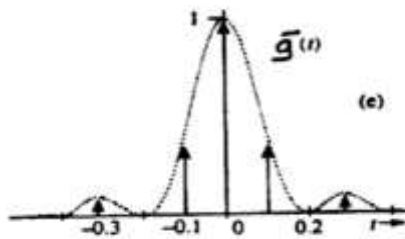
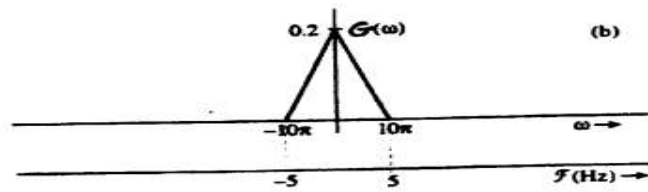
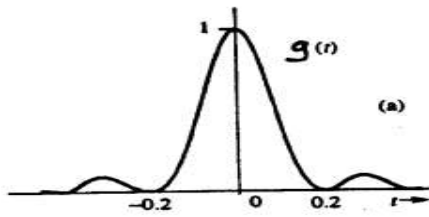
From  $-10\pi$  to  $10\pi$   
or  $-5$  to  $5$  Frequency

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

$$\text{Nyquist Rate} = 2(5) = 10$$

From Table, only select the 10 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  $y_3(t)$ .

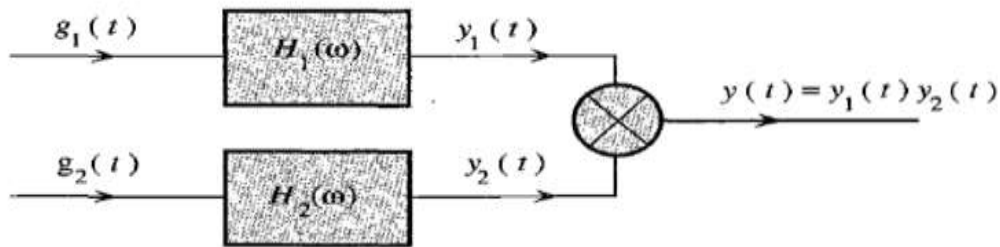


Figure Q.2

$$g_1(t) = 10^4 \text{rect}(10^4 t) \rightarrow G_1(\omega) = \text{sinc}\left(\frac{\omega}{20000}\right)$$

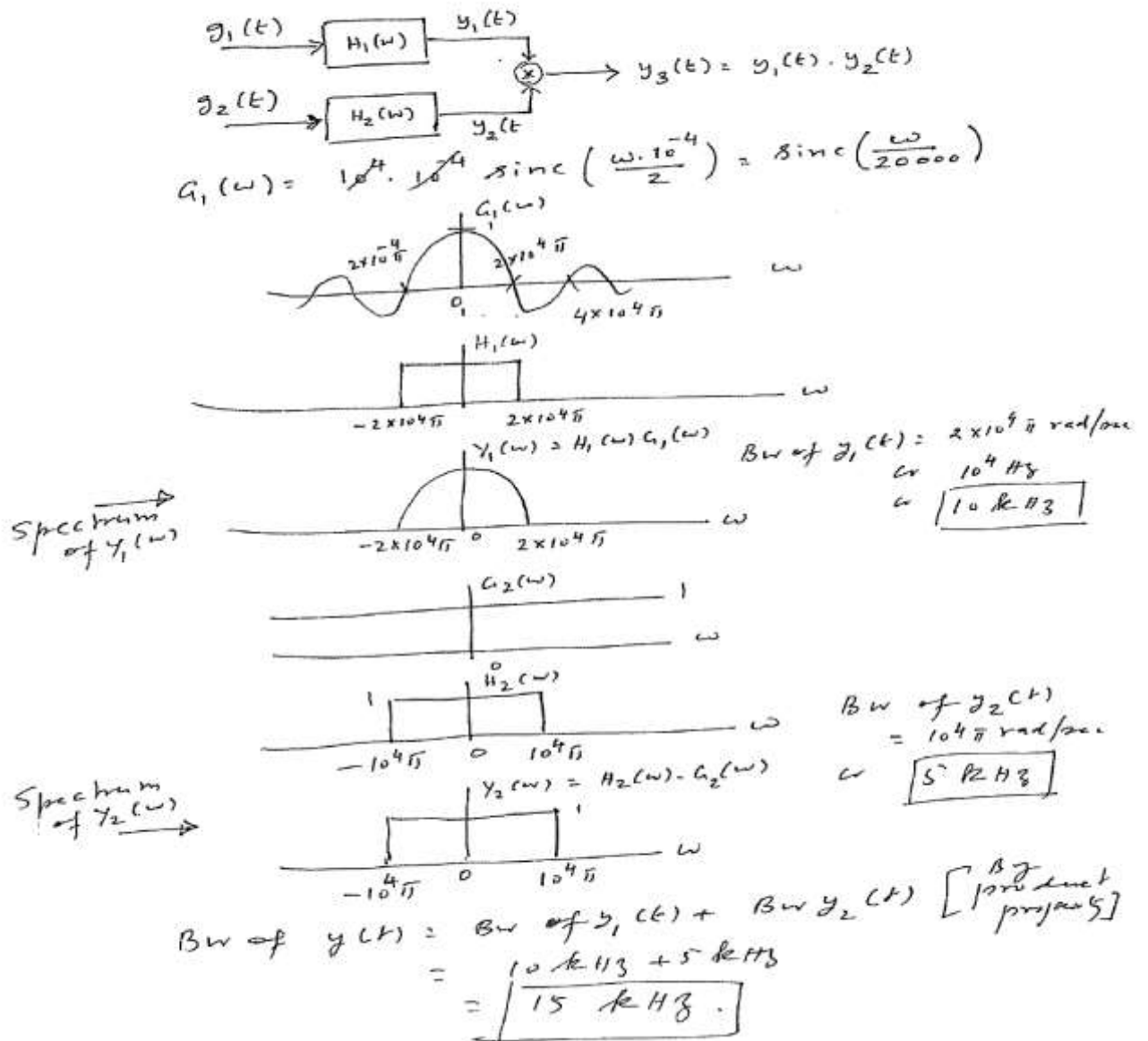
$$g_2(t) = \delta(t) \rightarrow G_2(\omega) = 1$$

$$H_1(\omega) = \text{rect}\left(\frac{\omega}{40000\pi}\right)$$

$$H_2(\omega) = \text{rect}\left(\frac{\omega}{20000\pi}\right)$$

**Solution:** [6-Points]

3. Signals  $g_1(t) = 10^4 \text{rect}(10^4 t)$  and  $g_2(t) = 5(t)$  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)



$10 \times 2 = 20$

$5 \times 2 = 10$

$15 \times 2 = 30$

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:

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

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	

**Solution:** [10-Points]

$$8 - (-8) = 16$$

# of levels 16 and  $n=4$

$$16/16 = 1 \text{ each step}$$

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