Final Examination

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. A mid-rise uniform quantizer has a sinusoidal input signal th amplitude of 5 Volts. If the number of representation els is sufficiently large ($L = 256$), then the mean square ue of the quantization noise will be

- [✓ a)] $1.27\times10^{-4}\,V^2$
- b) $3.18\times10^{-5}\,V^2$
- c) $2.35\times10^{-4}\,V^2$
- d) $3.25\times10^{-3}\,V^2$

. A message signal is given by $m(t) = 2\mathrm{sinc}^2(2000t)$. en, the Nyquist rate will be

equal = twice of B.w of sinc(2000

??

- a) 2000 Hz
- b) 1000 Hz
- [✓ c)] 4000 Hz
- d) 8000 Hz

. The un-modulated pulse train in a PPM system is shown Figure P3.

$g(t) = A\,\mathrm{tri}\left(\frac{t}{2T}\right)$

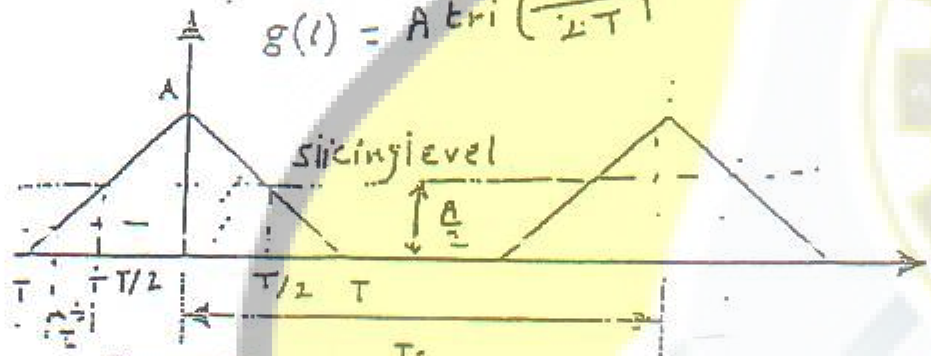


Figure P3.

ne slicing level in the receiver is set at A/2 and assuming a -load sinusoidal modulating wave and front end receiver se of zero mean and power spectral density $N_0/2$. The rage noise power at the output of the receiver will be

$E[v_n^2] = N_0 B_T$

- a) $\frac{K^2T^2}{2A^2}B_TN_0$, B_T is the transmission bandwidth
- b) $\frac{K^2T^2}{A^2}B_TN_0$
- [✓ c)] $\frac{K^2T^2}{A^2}4B_TN_0$
- d) $K^2B_TN_0$

$\frac{v_n}{\tau} = \frac{d}{dt}g(t)\Big|_{t=\frac{T}{2}} = \frac{A}{2}\mathrm{rect}\left(\frac{t}{T}\right) = \begin{cases}\frac{A}{2}, & -\frac{T}{2}\le t\le\frac{T}{2}\\ 0, & \text{otherwise}\end{cases}$

$\Rightarrow \frac{v_n}{\tau} = \frac{A}{2} \Rightarrow \tau = \frac{2v_n}{A}$

Avg. noise power at output : $K^2E[\tau^2]$

$= \frac{4K^2}{A^2}E[v_n^2]$

$= \frac{K^2}{A^2}4B_TN_0$

If the message signal in P3 has a bandwidth of W Hz, then ~~channel signal to noise ratio~~ is given by

- a) $\frac{A^2T/3T_s}{WN_0}$
- [✓ b)] $\frac{2A^2T/3T_s}{WN_0}$
- c) $\frac{2A^2T^2/3T_s}{WN_0}$
- d) $\frac{A^2T/T_s}{WN_0}$

$P_{modulation} = \frac{1}{T_s}\int_{-\frac{T}{2}}^{\frac{T}{2}} g^2(t)\,dt$

$= \frac{2A^2}{T_s}\left(t - \frac{t^2}{T} + \frac{t^3}{3T^2}\right)\Big]_{-\frac{T}{2}}^{\frac{T}{2}}$

$= \frac{2A^2}{T_s}\left[T - \frac{T^2}{T} + \frac{T^3}{3T^2}\right]$

$= \frac{2A^2}{T_s}\left[\cancel{T} - \cancel{T} + \frac{T}{3}\right]$

$= \frac{2A^2T}{3T_s}$

[illegible] message signal bandwidth $= N_0W$

$R)_C = \frac{2A^2T/3T_s}{N_0W}$

From right g(t) eq:

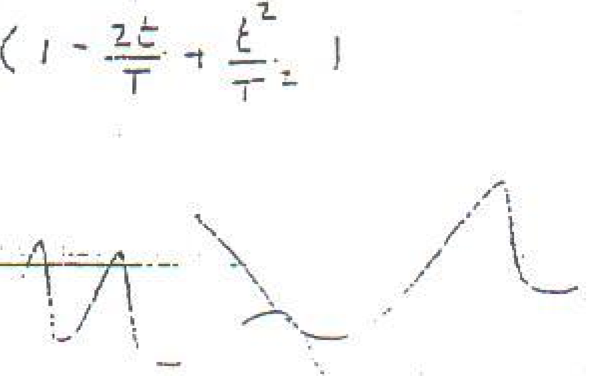
$(0, A)$, $(T, 0)$

$\text{slope} = \frac{0-T}{A-0} = -\frac{T}{A}$

$t - T = -\frac{T}{A}(g(t) - 0)$

$g(t) = A\left(1 - \frac{t}{T}\right)$

$g^2(t) = A^2\left(1 - \frac{2t}{T} + \frac{t^2}{T^2}\right)$



P5. The signal $s(t) = A_c\cos(2\pi f_ct) + w(t)$ is applied to the low-pass RC filter shown in Figure P5. The amplitude A_c and the frequency f_c are constants. $w(t)$ is a white Gaussian noise of zero mean and power spectral density $N_0/2$.

Figure P5

If the sinusoidal component of $s(t)$ is regarded as the signal of interest, then the power in the signal of interest at the output of the filter will be

- a) $A_c^2/2[1+(2\pi f\,RC)]$
- b) $A_c^2/2[1+(2\pi f_cRC)]^2$
- c) $A_c/2[1+(2\pi f_cRC)^2]^{0.5}$
- [✓ d)] $A_c^2/2[1+(2\pi f_cRC)^2]$

P6. Consider the information given in P5. The output noise power is given by: (Hint: $e^{(-a|t|)} \Leftrightarrow \frac{2a}{a^2+(2\pi f)^2}$)

- a) $\frac{N_0}{2RC}$
- [✓ b)] $\frac{N_0}{4RC}$!
- c) $\frac{N_0}{RC}$
- d) $\frac{RC}{N_0}$

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" [illegible] "

P7. A ve[illegible] sideband signal is given as ٤

$$s(t) = \frac{1}{2}A_c m(t)\cos(2\pi f_c t) - \frac{1}{2}m_s(t)\sin(2\pi f_c t)$$ where

he upper sideband completely and a vestige of bandwidth f_v of the lower sideband are transmitted. The signal $s(t)$ is ransmitted over an AWGCH (noise power spectral density $N_0/2$) and then is put through a BPF and finally through a oherent detector. The noise at the output of the BPF will have power of

a) $N_0W + f_v$. W is the bandwidth of $m(t)$

b) $N_0(2W + f_v)/2$

c) $N_0(W + f_v)/2$

[✓ d) $N_0(W + f_v)$]

8. The filtered noise at the output of the BPF in P7 can be :pressed as

a) $n(t) = n_I(t)\cos[\pi(W - f_v)] - n_Q(t)\sin[\pi(W - f_v)]$

[✓ b) $n(t) = n_I(t)\cos[2\pi f_c t + \pi(W - f_v)] - n_Q(t)\sin[2\pi f_c t + \pi(W - f_v)]$]

c) $n(t) = n_I(t)\cos[2\pi f_c t + 2\pi(W + f_v)] - n_Q(t)\sin[2\pi f_c t + 2\pi(W + f_v)]$

d) $n(t) = n_I(t)\cos[2\pi f_c t - \pi(W - f_v)] - n_Q(t)\sin[2\pi f_c t - \pi(W - f_v)]$

$B = 0.2$
$= K_f A_m$

If the oscillator at the receiver in P7 is synchronized in h frequency and phase and has unity amplitude, then the nal power at the output of the receiver will be

a) $A_c^2P/8$, P is the power in $m(t)$

b) $A_c^2P_s/8$, P_s is the power in $m_s(t)$

[✓ c) $A_c^2P/16$]

d) $A_c^2(P_s^2 + P^2)/8$

1. An DSB-SC signal is given by

) $= CA_c\cos(2\pi f_c t)m(t)$. The signal $s(t)$ is transmitted r an AWGCH (noise power spectral density $N_0/2$) and i is put through a BPF and finally through a coherent ctor. If $m(t)$ has a bandwidth W and a power of P. Then input signal to noise ratio will be:

a) $C^2A_c^2P^2/2N_0W$

b) $C^2A_c^2P/2N_0W$

[✓ c) $C^2A_c^2P/4N_0W$]

d) CA_cP/N_0W

P11. If the modulation in P10 is changed to SSB, that is

$$s(t) = \frac{1}{2}CA_c\cos(2\pi f_c t)m(t) - \frac{1}{2}CA_c\sin(2\pi f_c t)\hat{m}(t).$$

Then the input signal to noise ratio will be:

a) $C^2A_c^2P/8N_0W$

b) $C^2A_c^2P/16N_0W$

[✓ c) $C^2A_c^2P/4N_0W$]

d) zero

P12. If the modulated signal is SSB as that in P11, then the average noise power at the output of the receiver will be:

a) $N_0W/8$

[✓ b) $N_0W/4$]

c) $N_0W/2$

d) N_0W

$B_T = \frac{}{1000}$

$B = \frac{\Delta f}{F_m}$

P13. An FM modulated signal is given by

$$s(t) = 2[2\pi f_c t + 0.2\sin(2000\pi t)]$$

An estimation of the bandwidth for this signal will be:

a) 4400 Hz

[✓ b) 2400 Hz]

c) 1200 Hz

d) 800 Hz

$B = 0.2$
$f_m = 1\,\text{kHz}$

$B_T = 2\Delta f\left(1 + \frac{1}{B}\right)$

$= 2 * 200\left[1 + \frac{1}{0.2}\right.$

P14. If $s(t)$ in P13 is applied to a frequency multiplier with $n = 10$, then the output signal will be

$f_c = 10$
$B = 2$

a) $20[2\pi f_c t + 0.2\sin(2000\pi t)]$

b) $2[20\pi f_c t + 0.2\sin(2000\pi t)]$

[✓ c) $2[20\pi f_c t + 2\sin(2000\pi t)]$]

d) $20[20\pi f_c t + 2\sin(2000\pi t)]$

P15. Consider the following linear modulated signal

$$s(t) = 10\sin(1000\pi t)\cos(2\times10^5\pi t)$$

No Carrier

Then the power in the lower sideband will be

$\frac{\left(\frac{10}{2}\right)^2}{2} = \frac{100}{8} =$

a) 100 W

b) 25 W

[✓ c) 12.5 W]

d) 0 W

P16. For the linear modulated signal in P15, the carrier has an average power of

[✓ a) 0 W]

b) 100 W

c) 50 W

d) 25 W

(13)

The Hilbert transform of $\delta(t)$ is

a) $\delta(t)$
b) $\delta(t-\pi/2)$
c) $\delta(t+\pi/2)$
[✓ d) $1/\pi t$]

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6. An AM signal is given as

$(t) = 5[1+1.2\cos(2000\pi t)]\cos(2\times10^5\pi t)$. The
nimum value of the envelope of this signal will be

a) -1 V
b) -5 V
c) -11 V
[✓ d) 0 V]

7. The AM signal given in P16 can be demodulated using

a) Envelope Detector
[✓ b) Costas Receiver]
c) PLL
[✓ d) a and b]

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. In FM stereo multiplexing, the left-hand microphone
ed up the signal $m_l(t) = \cos(2000\pi t)$, while the right-
 microphone was turned off. If the pilot signal has a
uency of 19KHz, then the spectra of the multiplexed
al $m(t)$ will have deltas at

a) 1KHz, 19KHz, 37KHz, 38KHz
b) 19KHz, 37KHz, 38KHz, 39KHz
c) 1KHz, 19KHz, 37KHz, 39KHz
d) 1KHz, 37KHz, 38KHz, 39KHz

lem	Answer	Problem	Answer
		11	
		12	
		13	
		14	
		15	
		16	
		17	
		18	
		19	
		20	