Between

PDPM–INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, DESIGN & MANUFACTURING JABALPUR

Principle of Analog Communications (EC203a)

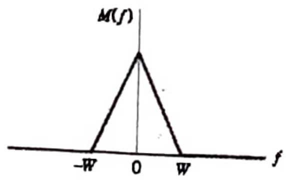
Mid-Semester Examination

Max. Marks: 30

Time: 2 Hour

Instructions: 1) Attempt all questions. 2) Answer all parts of a question at one place.

1. Consider a message signal $m(t)$ with the spectrum shown in figure. The message bandwidth $W = 1$ KHz. This signal is applied to a product modulator, together with a carrier $A_c \cos 2\pi f_c t$, producing the DSB-SC modulated signal $u(t)$. Let the carrier frequency is $f_c = 0.75$ KHz.

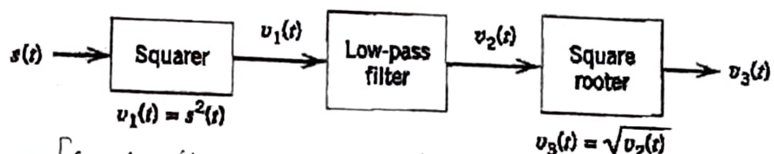


(a) Sketch the spectrum of $u(t)$.
(b) The modulated signal $u(t)$ is next applied to a coherent detector. Assuming a perfect phase synchronous carrier at the receiver, sketch the spectrum of the detector output.

(2+3)

2. The conventional AM signal $s(t) = A_c[1 + m(t)] \cos 2\pi f_c t$ is applied to the system shown in figure.

$m(t) = \cos 2\pi f_m t$



$A_c[\cos(2\pi(f_m+f_c)t) + \cos(2\pi(f_m-f_c)t)]$

Assuming $|m(t)| < 1$ for all t and the message signal $m(t)$ is limited to the interval $-W \leq f \leq W$ and the carrier frequency $f_c > 2W$, evaluate $v_3(t)$.

(5)

3. A SSB-SC AM signal is generated by modulating an 800 KHz carrier by the signal $m(t) = \cos 2000\pi t + 2 \sin 2000\pi t$. The amplitude of the carrier is $A_c = 100$.
(a) Determine the signal $\hat{m}(t)$.
(b) Determine the lower sideband SSB-SC AM signal.
(c) Determine the spectrum of the lower sideband SSB-SC AM signal. Where,

$$\left[\mathrm{FT}\{\sin 2\pi f_c t\} = \frac{1}{2j}\delta(f - f_c) - \frac{1}{2j}\delta(f + f_c)\right]$$

(2+3+3)

4. The modulating signal $m(t) = 2\cos 4000\pi t + 5\cos 6000\pi t$ modulates the carrier $c(t) = 100\cos 2\pi f_c t$ where $f_c = 50$ KHz. Determine and sketch the frequency spectrum of DSB-SC AM signal.

(4)

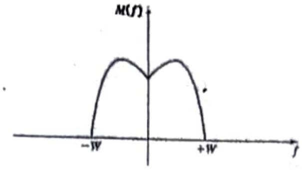
50k - 2k

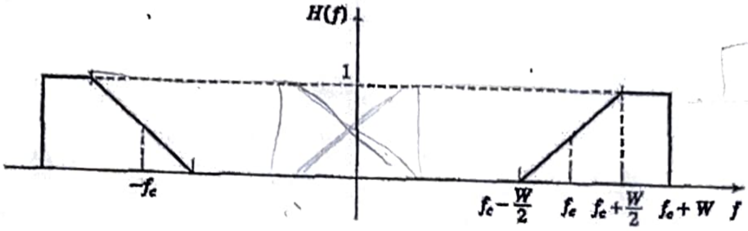
$100[\cos(2\pi\, 52\,kHz\, t) + \cos(2\pi(48\,kHz)t)] + 250[\cos(2\pi(53\,kHz)t) + \cos(2\pi(47\,kHz)t)]$

5. A message signal $m(t)$ modulates the carrier $A_c \cos 2\pi f_c t$ to produce the VSB AM signal. The frequency spectrum of $m(t)$ and VSB filter is shown in figure given below.

(a) Sketch the spectrum of VSB AM signal.

(b) The VSB AM modulated signal is applied to a perfect synchronised coherent detector. Sketch the spectrum of the output of demodulator.





(3+5)

$\theta : 45$

$\frac{\cos 2\theta}{2} = 2\cos^2\theta - 1$

$\frac{\cos 2\theta + 1}{2} = \cos^2\theta$

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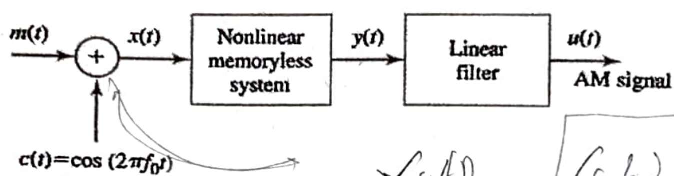
Principle of Analog Communications (EC203a)

End-Semester Examination

Max. Marks: 40 **Time: 3 Hour**

Instructions: 1) Attempt all questions. 2) Answer all parts of a question at one place.

1. (A) The system shown below in figure is used to generate a conventional AM signal. The modulating signal $m(t)$ has zero mean and its maximum (absolute) value is $A_m = \max|m(t)|$. The nonlinear device has a input–output characteristic $y(t) = ax(t) + bx^2(t)$.



$x(t) = \boxed{c(t) + m(t)}$

(a) Express $y(t)$ in terms of the modulating signal $m(t)$ and the carrier $c(t) = \cos 2\pi f_c t$.
(b) What is the modulation index?
(c) Specify the filter characteristics that yield a conventional AM signal at its output.

(B) The message signal $m(t) = 10\,\text{sinc}(400t)$ frequency modulates the carrier $c(t) = 100\cos 2\pi f_c t$. The modulation index is 6.
(a) Write an expression for the modulated signal $u(t)$.
(b) What is the maximum frequency deviation of the modulated signal?
(c) Find the bandwidth of the modulated signal.

$100\cos(2\pi f_c t + \phi(t))$

(6+6)

AM, fc

2. An angle-modulated signal has the form $u(t) = 100\cos[2\pi f_c t + 4\sin 2\pi f_m t]$ where $f_c = 10$ MHz and $f_m = 1$ KHz.
(a) If this is an FM signal, determine the modulation index and the transmitted signal bandwidth.
(b) If this is a PM signal, determine the modulation index and the transmitted signal bandwidth.

(3+3)

3. A message signal $m(t)$ be transmitted using single-sideband modulation. The power spectral density of $m(t)$ is

$$S_M(f) = \begin{cases} a\frac{|f|}{W}, & |f| \le W \\ 0, & otherwise \end{cases}$$

where a is a constant. Find the output signal-to-noise ratio if the noise is added at the receiver with power spectral density of $\frac{N_0}{2}$.

(5)

0.01

$\log \log \left(\frac{10}{1}\right)$

4. A normalized message signal $m_n(t)$ has bandwidth of 5000 Hz and power of 0.1 Watt, and the channel has a bandwidth of 100 KHz and attenuation of 80 dB. The noise power spectral density is 0.5×10^{-12} W/Hz, and the transmitter power is 10 KW.

   (a) What is $\left(\frac{S}{N}\right)_o$, if DSB-SC modulation is employed?

   (b) What is $\left(\frac{S}{N}\right)_o$, if conventional AM with $a = 0.8$ is employed?

   (c) What is $\left(\frac{S}{N}\right)_o$, if FM is employed?

Attenuation $= 10 \log_{10} \left(\frac{P_T}{P_R}\right)$ $P_r =$

$\left(\frac{S}{N_o}\right) = \frac{P_r}{N_o W}$

$\left(\frac{N_o}{2}\right) =$ Power Spectrum $\Rightarrow N_o = $

$W = 5000$ Hz

(2+2+2)

5. (A) A normalized message signal has a bandwidth of $W = 8$ kHz and a power of $P_{M_n} = \frac{1}{2}$. This signal is transmitted via a channel with an available bandwidth of 60 kHz and attenuation of 40 dB. The channel noise is additive and white with a power spectral density of $\frac{N_0}{2} = 10^{-12}$ W/Hz. A frequency modulation scheme has been proposed for this purpose.
   (a) If an SNR of at least 40 dB is required at the receiver output, what are the minimum required transmitter power and the corresponding modulation index?
   (b) If the minimum required SNR is increased to 60 dB, how would the answer changes?

   (B) If a FM system and a PM system are employed and these systems have the same output signal-to-noise ratio (SNR), show that

$$\frac{\mathrm{BW_{PM}}}{\mathrm{BW_{FM}}} = \frac{\sqrt{3}\beta_f + 1}{\beta_f + 1}$$

(6+5)

$\rightarrow b \sin^2(2\pi f_m t) + a \sin(2\pi f_m t) + \cos(2\pi f_c t)[a + 2b \sin(2\pi f_m t) + b \cos^2(2\pi f_c t)$

$\rightarrow a m(t) + A_c \cos(2\pi f_c t)[a + 2b m(t)] + 0$

$\rightarrow a m(t) + a A_c \cos(2\pi f_c t) + A_c \cdot 2b \cos(2\pi f_c t) \cdot m(t)$

$\rightarrow 0$

$\left(\frac{S}{N_o}\right) = \frac{0.5 \times A^2 a^2 P_m}{\cancel{1 + a^2 P_m}}$

$u(t) = 100 \cos(2\pi f_c t + \phi(t))$

$\phi(t) = 2\pi k_f \int m(t)\, dt$

$Q = 0.1$

$a =$