

# Unit 8 - Week-5 Generation of SSB , Complex pre-envelope of QCM, VSB , Introduction to AM

## Course outline

How does an NPTEL online course work?

### Week-0

Week 1-Basic tools for communication, Fourier Series/Transform, Properties, Parseval's Relation, Properties of Fourier Transform, LTI Systems

Week 2- Cross- and Auto-correlation, (ESD), Introduction to Amplitude Modulation (AM), Spectrum of AM, Envelope Detection, Power Efficiency, (DSB-SC) Modulation and Demodulation

Week-3- Power Efficiency, (DSB-SC) Modulation and Demodulation, Carrier Phase Offset Example for (DSB-SC), Costas Receiver

Week-4 Quadrature Carrier Multiplexing (QCM) and Demodulation of QCM signals, Single Sideband Modulation (SSB), Hilbert Transform

Week-5 Generation of SSB , Complex pre-envelope of QCM, VSB , Introduction to AM

Lec 23 Phase Shifting Method for Generation of SSB

Lec 24 -Complex Pre-Envelope of Passband Signals

Lec 25 - Complex Pre-Envelope of QCM Signals

Lec 26 - Introduction to VSB Modulation

Lec 27 -Vestigial Side Band Filter

Lec 28 - Introduction to Angle Modulation

Lec-29 FM with Sinusoidal Modulation Signal

Quiz : Assignment-5

Feedback For Week 5

Solution - 5

Week-6 Narrowband FM Generation, Spectrum of FM Signals, Carson's Rule for FM Bandwidth, Narrowband FM Generation, FM Demodulation, Introduction to Sampling, Spectrum of Sampled Signal, Aliasing, Nyquist Criterion

Week 7- Signal Reconstruction from Sampled Signal ,Introduction to Pulse Amplitude Modulation, Spectrum of PAM Signal and Reconstruction, Quantization, Uniform Quantizers – Midrise and Midtread, Quantization noise, Lloyd Max Quantization Algorithm, Non-uniform Quantizers

Week 8- Delta Modulation, Differential Pulse Code Modulation, Frequency Mixing and Translation in Communication Systems, Heterodyne and Super Heterodyne Receivers, Frequency Division Multiplexing, Time Division Multiplexing, T1 TDM System: Case Study

Week 9 - Basics of Probability, Conditional Probability, Independent Events - Mary-PAM Example, Independent Events-Block Transmission, Independent Events-Multiantenna Fading

Text Transcripts

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Week 10- Bayes Theorem, Maximum A posteriori Probability (MAP) Receiver, Random Variables and PDF, Power of Fading Wireless Channel, Mean & Variance of Random Variables and Application: Average & RMS Delay Spread

Week 11 - Transformation of Random Variables, Gaussian Random Variable ,Special Case: IID Gaussian Random Variables, Application: Uniform Linear Arrays, Random Processes and (WSS) and WSS Example

Week 12- Power Spectral Density(PSD) for WSS Random Process, PSD Application in Wireless, WSS Random Process Through LTI System, Special Random Processes and Gaussian Process Through LTI System

## Assignment-5

The due date for submitting this assignment has passed.  
As per our records you have not submitted this assignment.

**Due on 2020-03-04, 23:59 IST.**

1) The bandwidth of vestigial side band (VSB) modulation is

1 point

- Larger than that of both DSB-SC and SSB modulation  
 Smaller than that of both DSB-SC and SSB modulation  
 Larger than that DSB-SC but smaller than that of SSB modulation  
 Smaller than that DSB-SC but larger than that of SSB modulation

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
Smaller than that DSB-SC but larger than that of SSB modulation

2) Consider the SSB

1 point

$x(t) = m(t) \cos(2\pi f_c t) - \hat{m}(t) \sin(2\pi f_c t)$ . Its Fourier transform can be expressed as

- $\frac{1}{2}M(f - f_c)(1 + \text{sgn}(f - f_c)) + \frac{1}{2}M(f + f_c)(1 - \text{sgn}(f + f_c))$   
  $\frac{1}{2}M(f - f_c) + \frac{1}{2}M(f + f_c)$   
  $\frac{1}{2}M(f - f_c)(1 - \text{sgn}(f - f_c)) + \frac{1}{2}M(f + f_c)(1 + \text{sgn}(f + f_c))$   
  $\frac{1}{2}M(f - f_c)(1 + \text{sgn}(f - f_c)) + \frac{1}{2}M(f + f_c)(1 - \text{sgn}(f - f_c))$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $\frac{1}{2}M(f - f_c)(1 + \text{sgn}(f - f_c)) + \frac{1}{2}M(f + f_c)(1 - \text{sgn}(f + f_c))$

3) Consider the message signal  $\cos(60\pi t)$ . The SSB modulated signal with USB corresponding to carrier frequency  $f_c = 1000$  Hz is

1 point

- $\cos(2060\pi t)$   
  $\cos(60\pi t) \sin(2000\pi t)$   
  $\cos(60\pi t) \cos(2000\pi t)$   
  $\cos(1060\pi t)$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $\cos(2060\pi t)$

4) The impulse response of the Hilbert transformer is

1 point

- $\frac{1}{\pi j t}$   
  $-j \text{sgn}(t)$   
  $\text{sgn}(t)$   
  $\frac{1}{\pi t}$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $\frac{1}{\pi t}$

5) For carrier frequency  $f_c$  and message frequency  $f_m$ , the spectrum of the Lower Sideband (LSB) signal comprises of frequency band(s)

1 point

- $-f_c - f_m$  to  $-f_c$  and  $f_c - f_m$  to  $f_c$   
  $-f_c$  to  $-f_c + f_m$  and  $f_c - f_m$  to  $f_c$   
  $-f_c$  to  $-f_c + f_m$  and  $f_c$  to  $f_c + f_m$   
  $-f_c - f_m$  to  $-f_c + f_m$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $-f_c$  to  $-f_c + f_m$  and  $f_c - f_m$  to  $f_c$

6) Consider message signal  $m(t) = \sin(2\pi f_m t)$  modulated using DSB-SC with carrier frequency  $f_c$  and carrier amplitude  $A_c = 1$ . This is demodulated at the receiver with a carrier having a phase offset of  $\phi$  followed by low pass filtering. The resulting output signal is

1 point

- $\frac{1}{2} \cos(\phi) \sin(2\pi f_m t)$   
  $(2\pi f_m t)$   
  $\sin(\phi) \sin(2\pi f_m t)$   
  $\frac{1}{2} \cos(\phi) \cos(2\pi f_m t)$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $\frac{1}{2} \cos(\phi) \sin(2\pi f_m t)$

7) Consider the message signal  $\sin(100\pi t)$ . The Single Sideband (SSB) modulated signal with Lower Sideband (LSB) corresponding to carrier frequency  $f_c = 1500$  Hz is

1 point

- $\sin(100\pi t) \sin(3000\pi t)$   
  $-\sin(2900\pi t)$   
  $\sin(100\pi t) \cos(1500\pi t)$   
  $\sin(3100\pi t)$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $-\sin(2900\pi t)$

8) Consider the signal  $x(t)$  with Hilbert transform  $\hat{x}(t)$ . The complex pre-envelope of this signal is

1 point

- $x(t) - j\hat{x}(t)$   
  $x(t) + j\hat{x}(t)$   
  $x(t) + \hat{x}(t)$   
  $x(t) - \hat{x}(t)$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $x(t) + j\hat{x}(t)$

9) Given the message signal  $m_I(t), m_Q(t)$  and carrier frequency  $f_c$ , the modulation

1 point

$$x(t) = A_c m_I(t) \cos(2\pi f_c t) - A_c m_Q(t) \sin(2\pi f_c t)$$

is termed as

- Double Sideband suppressed carrier (DSB-SC)  
 Single Side Band (SSB)  
 Vestigial Side Band (VSB)  
 Quadrature Carrier Multiplexing (QCM)

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
Quadrature Carrier Multiplexing (QCM)

10) In vestigial Sideband Modulation (VSB), the filter  $H(f)$  must satisfy the constraint

1 point

- $H(f - f_c) - H(f + f_c) = 1$   
  $H(f - f_c) + H(f + f_c) = 0$   
  $H(f - f_c) + H(f + f_c) = 1$   
  $H(f - f_c) - H(f + f_c) = 0$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $H(f - f_c) + H(f + f_c) = 1$