

Unit 7 - Week-4 Quadrature Carrier Multiplexing (QCM) and Demodulation of QCM signals, Single Sideband Modulation (SSB), Hilbert Transform

Course outline

How does an NPTEL online course work?

Week-0

Week 1-Basic tools for communication, Fourier Series/Transform, Properties, Parsevals 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

- Lec 18- Introduction to Quadrature Carrier Multiplexing (QCM).
- Lec 19- Introduction to Single Sideband (SSB) Modulation
- Lec 20 - Generation of (SSB) Modulated Signals
- Lec 21 - Frequency Domain of Hilbert Transform
- Lec 22 - Time Domain Description of Hilbert Transform

Quiz : Assignment-4

Feedback For Week 4

Solution - 4

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

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-4

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

Due on 2020-02-26, 23:59 IST.

1) Let P_m denote the power of the message signal $m(t)$. The total power of the AM signal $A_c(1 + k_a m(t)) \cos(2\pi f_c t)$ is **1 point**

- $k_a^2 A_c^2 P_m$
- $\frac{1}{2} k_a^2 A_c^2 P_m$
- $\frac{1}{2} k_a^2 A_c^2 P_m + \frac{1}{2} A_c^2$
- $k_a^2 A_c^2 P_m + A_c^2$

No, the answer is incorrect. Score: 0

Accepted Answers: $\frac{1}{2} k_a^2 A_c^2 P_m + \frac{1}{2} A_c^2$

2) Consider the message signal $m(t) = \cos(20\pi t)$. Let carrier frequency $f_c = 1 \text{ kHz}$ and carrier amplitude $A_c = 20$. With 25% modulation, what is the efficiency of the AM signal **1 point**

- 25%
- 3.03%
- 12.33%
- 5.88%

No, the answer is incorrect. Score: 0

Accepted Answers: 3.03%

3) Synchronization between phase of locally generated carrier and that of the incoming signal for DSB-SC modulation is achieved using **1 point**

- Superheterodyne Receiver
- Single Sideband Modulation
- Envelope Detection
- Costas Loop

No, the answer is incorrect. Score: 0

Accepted Answers: Costas Loop

4) The maximum efficiency of an amplitude modulated (AM) signal without envelope distortion is **1 point**

- 1
- $\frac{1}{2}$
- $\frac{1}{3}$
- $\frac{1}{4}$

No, the answer is incorrect. Score: 0

Accepted Answers: $\frac{1}{3}$

5) Consider the envelope detector with load resistance R_L and capacitance C , employed to detect an AM signal with carrier frequency f_c and message frequency f_m . It is desirable that **1 point**

- $R_L C \gg \frac{1}{f_m}$
- $R_L C \gg \frac{1}{f_c}$
- $R_L C \gg \frac{f_m}{f_c}$
- $R_L C \ll \frac{1}{f_c}$

No, the answer is incorrect. Score: 0

Accepted Answers: $R_L C \gg \frac{1}{f_c}$

6) The maximum power efficiency of a Double Sideband – Suppressed Carrier (DSB-SC) signal is **1 point**

- 1
- $\frac{1}{2}$
- $\frac{1}{3}$
- ∞

No, the answer is incorrect. Score: 0

Accepted Answers: 1

7) Consider the signal $x(t) = A_c \cos(2\pi f_c t) + K \sin(2\pi f_m t)$ passed through a square law device with output $y(t)$ corresponding to input $x(t)$ given as $y(t) = x^2(t)$. The output is passed through a bandpass filter with center frequency f_c . What is the DSB-SC signal generated? **1 point**

- $2A_c(1 + K \sin(2\pi f_m t)) \cos(2\pi f_c t)$
- $2A_c K \cos(2\pi f_c t) \sin(2\pi f_m t)$
- $2A_c \cos(2\pi f_c t) + K \sin(2\pi f_m t)$
- $2A_c K(1 + \cos(2\pi f_c t)) \sin(2\pi f_m t)$

No, the answer is incorrect. Score: 0

Accepted Answers: $2A_c K \cos(2\pi f_c t) \sin(2\pi f_m t)$

8) Consider the signal $A_c \cos(2\pi f_c t) + K \sin(2\pi f_m t)$ passed through a square law device with input-output relation $y(t) = x^2(t)$, where $y(t)$ is the output corresponding to an input $x(t)$. The output is passed through a bandpass filter with center frequency f_c . What is the condition on the carrier frequency such that a DSB-SC signal can be generated through filtering? **1 point**

- $f_c < 3f_m$
- $f_c > 2f_m$
- $f_c < 2f_m$
- $f_c > 3f_m$

No, the answer is incorrect. Score: 0

Accepted Answers: $f_c > 3f_m$

9) The output voltage $v_2(t)$ of the non-linear device can be expressed in terms of the input voltage $v_1(t)$ as $v_2(t) = a_1 v_1(t) + a_2 v_1^2(t)$, where a_1, a_2 are known constants. Consider an input voltage signal $v_1(t)$ defined as $v_1(t) = A_c \cos(2\pi f_c t) + m(t)$, where $m(t)$ is the message signal of bandwidth W and $A_c \cos(2\pi f_c t)$ is the carrier wave. The output $v_2(t)$ is fed as input to a filter tuned to f_c . What is the amplitude sensitivity k_a of the AM signal thus generated with carrier frequency f_c ? **1 point**

- $\frac{a_2}{a_1}$
- $\frac{a_1}{a_2}$
- $\frac{2a_1}{a_2}$
- $\frac{2a_2}{a_1}$

No, the answer is incorrect. Score: 0

Accepted Answers: $\frac{2a_2}{a_1}$

10) The frequency response of the Hilbert transformer $H_{HT}(f)$ equals **1 point**

- $j \operatorname{sgn}(f)$
- $\operatorname{sgn}(f)$
- $-\operatorname{sgn}(f)$
- $-j \operatorname{sgn}(f)$

No, the answer is incorrect. Score: 0

Accepted Answers: $-j \operatorname{sgn}(f)$