Analog Communication [18EC45]

Module: 2

Theory:

1. Define angle modulation, describe with the help of block diagrams, schemes for generating i) FM using PM wave ii) PM using FM wave
2. Derive an expression for the spectrum of FM wave with sinusoidal modulation
3. Explain the FM generation using Indirect method
4. Explain the FM generation using Direct method
5. Explain clearly how balanced slope detector is used for FM demodulation
6. Explain FM demodulation using Zero crossing detector
7. With the relevant analysis, explain FM demodulation using PLL
8. Explain Non-linear effect in FM system
9. Explain FM stereo multiplexing
10. Explain FM super heterodyne receiver

Problems:

1. An angle modulated signal is $s(t)= 10\sin[2\pi x\mathbf{10^6}t+0.2\sin(2000\pi)t]$ Find i. power in the modulated signal ii. Frequency deviation iii. Phase deviation iv. Bandwidth
2. An angle modulated signal is described by $s(t)= 10\cos[2\pi x\mathbf{10^6}t+0.1\sin\mathbf{10^3}\pi t]$, find the message signal m(t) considering i. s(t) is PM with Kp=10 ii. S(t) is FM with Kf=5
3. A Modulated signal $5\cos[2\pi 15x10^3t]$, angle modulates a carrier A $\cos w_c t$. find the modulation index & Bandwidth for the FM system. Determine the change in the bandwidth & modulation index if FM is reduced to 5Khz. What is the conclusion of the two results? Assume Kp=Kf=15Khz/volt.

4. An angle modulated signal is represented by $S(t)=10\cos[2\pi x10^6t+5\sin2000\pi t+10\sin3000\pi t]$. Find i. Power ii. Frequency deviation iii. Deviation ratio iv. Phase deviation v. bandwidth
5. A carrier is frequency modulated by a sinusoidal modulating signal of frequency 2Khz, resulting in a frequency deviation of 5Khz. i. What is the bandwidth occupied by the modulated waveform ii. If the amplitude of the modulating signal is increased by a factor of 2 & its frequency lowered to 1 KHz, What is the new bandwidth?
6. In FM system, when the audio frequency is 500Hz & modulating voltage 2.5V, the deviation produced is 5 KHz. If the modulating voltage is now increased to 7.5V, calculate the new value of frequency deviation produced, if the AF voltage is raised to 10V, while the modulating frequency dropped to 250Hz.

<u>MCQ:</u>

1. The FM modulation index:

a. increases with both deviation and modulation frequency

b. increases with deviation and decreases with modulation frequency

c. decreases with deviation and increases with modulation frequency

d. is equal to twice the deviation

Answer: b. increases with deviation and decreases with modulation frequency

2. One way to derive FM from PM is:

a. integrate the modulating signal before applying to the PM oscillator

b. integrate the signal out of the PM oscillator

c. differentiate the modulating signal before applying to the PM oscillator

d. differentiate the signal out of the PM oscillator

Answer: a. integrate the modulating signal before applying to the PM oscillator

3. FM bandwidth can be approximated by:

a. Armstrong's Rule

b. Bessel's Rule

c. Carson's Rule

d. none of the above

Answer: c. Carson's Rule

4. NBFM stands for:

a. National Broadcast FM

b. Non-Broadcast FM

c. Near Band FM

d. Narrowband FM

Answer: d. Narrowband FM

5. FM stereo

a. uses DSBSC AM modulation

b. is implemented using an SCA signal

c. has a higher S/N than mono FM

d. is not compatible with mono FM

Answer: a. uses DSBSC AM modulation

6. The ability of the receiver to select the wanted signals among the various incoming signals is termed as

a. Sensitivity

b. Selectivity

c. Stability

d. None of the above

ANSWER: (b) Selectivity

7. Super heterodyne receivers

a. Have better sensitivity

b. Have high selectivity

c. Need extra circuitry for frequency conversion

d. All of the above

ANSWER: (d) All of the above

8. The standard value for Intermediate frequency (IF) in AM receivers is

a. 455 KHz

b. 580 KHz

c. 10.7 MHz

d. 50 MHz

ANSWER: (a) 455 KHz

9. **FM signal is better than AM signal because**

a. Less immune to noise

b. Less adjacent channel interference

c. Amplitude limiters are used to avoid amplitude variations

d. All of the above

ANSWER: d. All of the above

10. A 100MHz carrier is frequency modulated by 10 KHz wave. For a frequency deviation of 50 KHz, calculate the modulation index of the FM signal.

a. 100

b. 50

c. 70

d. 90

ANSWER:b. 50

11.FM is disadvantageous over AM signal because

a. much wider channel bandwidth is required

b. FM systems are more complex and costlier

c. Adjacent channel interference is more

d. Both a and b

ANSWER: d. Both a and b

12.Determine the Bandwidth of a FM wave when the maximum deviation allowed is 75KHz and the modulating signal has a frequency of 10KHz.

a. 170 KHz

b. 200 KHz

c. 100 KHz

d. 1000 KHz

ANSWER: a. 170 KHz

13. A 100MHz carrier is frequency modulated by 5 KHz wave. For a frequency deviation of 100 KHz, calculate the carrier swing of the FM signal.

a. 2000 KHz

b. 100 KHz

c. 105 KHz

d. 200 KHz

ANSWER: a. 200 KHz

14. The increase or decrease in the frequency around the carrier frequency is termed as

a. Figure factor

b. Frequency deviation

c. Modulation index

d. Frequency spectrum

ANSWER: b. Frequency deviation

15. Phase-locked loop can be used as

a. FM demodulator

b. AM demodulator

c. FM receiver

d. AM receiver

ANSWER: a. FM demodulator

16. Change in instantaneous phase of the carrier with change in amplitude of the modulating signal generates

a. Direct FM

b. Indirect FM

c. SSB-SC

d. DSB-SC

ANSWER: b. Indirect FM

17. VCO is used to generate

a. Direct FM

b. Indirect FM

c. SSB-SC

d. DSB-SC

ANSWER: a. Direct FM

18. **Armstrong method is used for the generation of**

a. Direct FM

b. Indirect FM

c. SSB-SC

d. DSB-SC

ANSWER: b. Indirect FM

19. What are the disadvantages of using balanced slope detector for demodulation of FM signal?

a. The detector operates only for small deviation in frequency

b. Low pass filter of the detector produces distortion in the detection

c. Both a and b

d. None of the above

ANSWER: c. Both a and b

20. The amount of frequency deviation in FM signal depends on

a. Amplitude of the modulating signal

b. Carrier frequency

c. Modulating frequency

d. Transmitter amplifier

ANSWER: a. Amplitude of the modulating signal

Analog Communication [18EC45]

Module: 1

Theory:

1. Explain the generation of AM wave using Switching Modulator with relevant diagram & equations.
2. Explain the Generation & demodulation of VSB modulated wave
3. Discuss Ring Modulator with necessary equations & waveform to generate DSB-SC wave.
4. With a neat block diagram, explain FDM
5. With a neat block diagram, explain SSB modulated wave using phase discrimination method.
6. How a modulating signal can be detected using AM detector use an envelope detector & explain
7. Write a note on how coherent detection used in DSB-SC receiver
8. With a neat block diagram of DSB-SC, the detection using Costas receiver
9. With neat block diagram, explain frequency translation
10. With a neat block diagram, explain the operation of quadrature carrier multiplexing

Problems:

1. An audio frequency signal $5\sin 2\pi(1000)t$ is used to amplitude a carrier of $100\sin 2\pi(\mathbf{10^6})t$. assume modulation index of 0.4. Find i. Amplitude of each side band ii. Side band frequencies iii. Bandwidth iv. Total power delivered to a load of 100Ω.

2. Consider the message signal $m(t) = 20\cos(2\pi t)$v & the carrier $c(t) = 50\cos(100\pi t)$v. Find i. Write an expression for resulting AM wave for 75% modulation in time domain ii. Draw the spectrum of AM wave iii.

Sketch the resulting wave for 75% modulation.

3. A carrier wave with amplitude 12v & frequency of 10Mhz, is frequency modulated to 50% level with a modulated frequency of 1Khz. Write down the equation for the above wave & sketch the modulated signal in frequency domain.

4. The carrier wave with $4\sin(2\pi x500x10^3t)$ is amplitude modulated by an audio wave $[0.2\sin3(2\pi x500t)+0.1\sin5(2\pi x500t)$volt. Determine the upper and lower sideband & sketch the complete spectrum of the modulated wave. Estimate the total power in the sideband.

<u>MCQ:</u>

1) Amplitude modulation is

a. Change in amplitude of the carrier according to modulating signal

b. Change in frequency of the carrier according to modulating signal

c. Change in amplitude of the modulating signal according to carrier signal

d. Change in amplitude of the carrier according to modulating signal frequency

ANSWER: (a) Change in amplitude of the carrier according to modulating signal

2) The AM spectrum consists of

a. Carrier frequency

b. Upper side band frequency

c. Lower side band frequency

d. All of the above

ANSWER: (d) All of the above

3) The modulation technique that uses the minimum channel bandwidth and transmitted power is

a. FM

b. DSB-SC

c. VSB

d. SSB

ANSWER: (d) SSB

4) Calculate the bandwidth occupied by a DSB signal when the modulating frequency lies in the range from 100 Hz to 10KHz.

a. 28 KHz

b. 24.5 KHz

c. 38.6 KHz

d. 19.8 KHz

ANSWER: (d) 19.8 KHz

5) In Amplitude Demodulation, the condition which the load resistor R must satisfy to discharge capacitor C slowly between the positive peaks of the carrier wave so that the capacitor voltage will not discharge at the maximum rate of change of the modulating wave (W is message bandwidth and ω is carrier frequency, in rad/sec) is

a. RC < 1/W

b. RC > 1/W

c. RC < 1/ω

d. RC > 1/ω

ANSWER: (a) RC < 1/W

6) 11) A modulation index of 0.5 would be same as

a. 0.5 of Modulation Depth

b. 1/2% of Modulation Depth

c. 5% of Modulation Depth

d. 50% of Modulation Depth

ANSWER: (d) 50% of Modulation Depth

7) The function of multiplexing is

a. To reduce the bandwidth of the signal to be transmitted

b. To combine multiple data streams over a single data channel

c. To allow multiple data streams over multiple channels in a prescribed format

d. To match the frequencies of the signal at the transmitter as well as the receiver

ANSWER: (b) To combine multiple data streams over a single data channel

8) **The amount of data transmitted for a given amount of time is called**

a. Bandwidth

b. Frequency

c. Noise

d. Signal power

ANSWER: (a) Bandwidth

9) **Function of RF mixer is**

a. Addition of two signals

b. Multiplication of two signals

c. Rejection of noise

d. None of the above

ANSWER: (b) Multiplication of two signals

10) **Advantage of using a high frequency carrier wave is**

a. Signal can be transmitted over very long distances

b. Dissipates very small power

c. Antenna height of the transmitter is reduced

d. All of the above

ANSWER: (d) All of the above

11) **Advantage of using VSB transmission is**

a. Higher bandwidth than SSB

b. Less power required as compared to DSBSC

c. Both a and b

d. None of the above

ANSWER: (c) Both a and b

12) **Modulation is required for**

a. Reducing noise while transmission

b. Multiplexing the signals

c. Reduction of Antenna height

d. Reduction in the complexity of circuitry

e. All of the above

ANSWER: (e) All of the above

13) **Bandwidth required in SSB-SC signal is (f_m is modulating frequency):**

a. $2f_m$

b. $< 2f_m$

c. $> 2f_m$

d. f_m

ANSWER: (d) f_m

14) **Demodulation is:**

a. Detection

b. Recovering information from modulated signal

c. Both a and b

d. None of the above

ANSWER: (c)Both a and b

15) **Disadvantage of using a DSB or SSB signal modulation is**

a. Difficult to recover information at the receiver

b. Carrier has to be locally generated at receiver

c. Both a and b are correct

d. None of the above

ANSWER: (c) Both a and b are correct

16) Types of analog modulation are:

a. Phase modulation

b. Frequency modulation

c. Amplitude modulation

d. All of the above

ANSWER: (d) All of the above

17) Synchronous detection means

a. Extracting week signal from noise

b. Need a reference signal with predetermined frequency and phase

c. Both a and b

d. None of the above

ANSWER: (c) Both a and b

18) **The minimum antenna height required for transmission in reference to wavelength λ is**

a. λ

b. λ/4

c. λ/2

d. 4 λ

ANSWER:(b) λ/4

19) **Ring modulator is**

a. Is used for DSB SC generation

b. Consists of four diodes connected in the form of ring

c. Is a product modulator

d. All of the above

ANSWER: (d) All of the above

20) **Quadrature Amplitude Modulation (QAM) is**

a. Have same bandwidth used for two DSB-SC signals

b. Is also known as Bandwidth Conservation scheme

c. Is used in color television

d. All of the above

ANSWER: (d) All of the above

21) **Vestigial side band signals are detected by**

a. Filters

b. Synchronous detection

c. Balanced modulator

d. None of the above

ANSWER: (b) Synchronous detection

Analog Communication [18EC45]

Module:3

Theory:

1. Write a note on i. Shot Noise ii. Thermal Noise iii. White Noise
2. What is Noise equivalent Bandwidth? Derive an expression for noise equivalent bandwidth.
3. Define i. Signal to noise ratio ii. Noise factor iii. Noise figure
4. Mention the properties of i. auto correlation ii. Cross correlation
5. Describe mean & covariance function with respect to stationary random process
6. With an example, explain what is meant by statistical averages
7. Explain Conditional probability

Problems:

1. A 600Ω resistor is connected across the 600Ω antenna input of a radio receiver. The bandwidth of the radio receiver is 20 KHz & the resistor room temperature of 27^0C. Calculate the noise power & noise voltage applied at the input of the receiver.
2. The signal power & noise power measured at the input of an amplifier are 150 microwatt & 1.5 microwatt. If the signal power at the output is 1.5 watt & noise power is 40 mill watts, calculate the amplifier noise factor & noise figure.
3. Three 5kΩ resistors are connected in series. For room temperature $KT=4x10^{-21}$& an effective noise bandwidth of 1MHz, determine i. The noise voltage appearing across each resistor ii. The noise voltage appearing across series combination iii. What is the r.m.s noise voltage which appears across same three resistors connected in parallel under the same condition?

MCQ:

1. Shot noise is produced by
a) Electrons
b) Photons
c) Electrons & Photons
d) None of the mentioned

Answer: c

2. Shot noise is avoidable when current is
a) Zero
b) One
c) Infinity
d) None of the mentioned

Answer: a

3. Shot noise is
a) Stochastic process
b) Poisson process
c) Stochastic & Poisson process
d) None of the mentioned

Answer: b

4.Which has the same power spectral density?
a) White noise
b) Brown noise
c) White & Brown noise
d) None of the mentioned

Answer: a

5.Thermal noise is
a) Energy signal
b) Power signal
c) Energy & Power signal
d) None of the mentioned

Answer: b

6. Thermal Noise is ____.

a. Generated by resistors

b. Generated by semiconductor junctions

c. Dependent on current flow

d. Dominant at low frequencies

Answer: a

7. The value of a resistor creating thermal noise is doubled. The noise power generator is therefore

a. halved

b. quadrupled

c. doubled

d. unchanged

Answer: d

8. Indicate the false statement. The square of the thermal noise voltage generated by a resistor is proportional to

a. its resistance

b. its temperature

c. Boltzmann's constant

d. the bandwidth over which it is measured

Answer: C

9. Which of broad classifications of noise are most difficult to treat?

a. noise generated in the receiver

b. noise generated in the transmitter

c. externally generated noise

d. internally generated noise

Answer: a

10. Which of the following is the most reliable measurement for comparing amplifier noise characteristics?

a. signal-to-noise ratio

b. noise factor

c. shot noise

d. thermal noise agitation

Answer: b

11. What would be the joint probability of statistically independent events that occur simultaneously ?

a. Zero
b. Not equal to zero
c. Infinite
d. None of the above

ANSWER: b

12. What is the value of an area under the conditional PDF ?

a. Greater than '0' but less than '1'
b. Greater than '1'
c. Equal to '1'
d. Infinite

ANSWER: c

13. Autocorrelation is a function which matches
a) Two same signals
b) Two different signal

c) One signal with its delayed version
d) None of the mentioned

Answer: c

14. Autocorrelation is a function of
a) Time
b) Frequency
c) Time difference
d) Frequency difference

Answer: c

15.Autocorrelation is maximum at _____
a) Unity
b) Origin
c) Infinite point
d) None of the mentioned

Answer: b

16. The covariance is:

a) All of these.

b) A measure of the strength of relationship between two variables.

c) Dependent on the units of measurement of the variables.

d)An unstandardized version of the correlation coefficient.

Answer: a

17. The expected value of a random variable is its
a) Mean
b) Standard Deviation
c) Mean Deviation
d) Variance

Answer: a

18. Noise factor for a system is defined as the ratio of

a. Input noise power (Pni) to output noise power (Pno)

b. Output noise power (Pno) to input noise power (Pni)

c. Output noise power (Pno) to input signal power (Psi)

d. Output signal power (Pso) to input noise power (Pni)

Answer: b

19. Noise Factor(F) and Noise Figure(NF) are related as

a. NF = 10 log10(F)

b. F = 10 log10(NF)

c. NF = 10 (F)

d. F = 10 (NF)

Answer: a

Analog Communication [18EC45]

Module:4

Theory:

1. With relevant the equations, explain how noise is produced in a receiver model
2. Show that figure of merit for DSB-SC system is unity
3. Derive the expression for figure of merit of an AM receiver
4. Explain pre-emphasis & De-emphasis in frequency modulation
5. Explain about the FM Threshold effect & its reduction method
6. Derive the expression for figure of merit of an FM receiver

Problems:

1. In an AM receiver, find the figure of merit when the depth of modulation is i. 100% ii. 50% iii. 30%
2. An AM receiver operating with a sinusoidal wave of 80% modulation has an output signal to noise ratio of 30db. Calculate the corresponding channel signal to noise ratio
3. An FM signal with a maximum frequency deviation of 75KHz is applied to an FM demodulator. When input [channel] SNR is 15db &modulating frequency is 10KHz. Estimate FOM & SNR at demodulator output.

MCQ:

1. Figure of merit is

a) Ratio of output signal to noise ratio to input signal to noise ratio

b) Ratio of input signal to noise ratio to output signal to noise ratio

c) Ratio of output signal to input signal to a system

d) Ratio of input signal to output signal to a system

Answer: a

2. Threshold effect is:

a. Reduction in output signal to noise ratio

b. Large noise as compared to input signal to envelope detector

c. Detection of message signal is difficult

d. All of the above

ANSWER: d

3. De emphasis is

a. is restoring of original signal power

b. is done at the detector output of the receiver

c. is the inverse process of Pre emphasis

d. All of the above

ANSWER: d

4. Pre emphasis is done

a. For boosting of modulating signal voltage

b. For modulating signals at higher frequencies

c. In FM before modulation

d. All of the above

ANSWER: d

5. FOM for DSB-SC receiver

a.1/2

b. 0.5

c. 1

d. 0

ANSWER: c

6. FOM for AM receiver

a. $\mu^2/(2+\mu^2)$

b. $\mu^2/(\mu^2+2)$

c. $\mu^2/(4+\mu^2)$

d. $\mu^2/(\mu^2+4)$

ANSWER: a

7. FOM for FM receiver

a. $\mu^2/(2+\mu^2)$

b. 1

c. $3K_fP/w^2$

d. $3K_fP^2/w^3$

ANSWER: c

8. SNR due to pre-emphasis & de-emphasis in decibels

a. 6.7db

b. 6.3db

c. 7.3db

d. 3.6db

ANSWER: b

9. Calculate the FOM when the depth of modulation is 100%

a. 1/5

b.3/5

c. 2/5

d. 1/3

ANSWER: d

10. An FM receiver receives an FM signal s(t)= 10cos[(2πx10^8t)+6sin(2πx10^3t)]. Calculate the FOM for this receiver

a. 54

b. 64

c. 34

d. 74

ANSWER: a

Analog Communication [18EC45]

Module:5

Theory:

1. State and prove sampling theorem & reconstruction of low pass signal using Nyquist criterion
2. With a neat block diagram, explain the generation of pulse position modulation waves
3. With a relevant diagram, explain generation and reconstruction of pulse code modulation
4. With a neat diagram, explain the concept of time division multiplexing
5. What is quantization noise? Derive the output signal to noise ratio of a uniform quantizer
6. With a neat block diagram, explain pulse amplitude modulation
7. Mention the advantages of digital signals over analog signals
8. With neat diagram, explain the application of vocoders

Problems:

1. An analog signal is expressed by the equation $x(t)= 3\cos 50\pi t+10\sin 300\pi t+\cos 100\pi t$. Calculate the Nyquist rate & Nyquist interval
2. A Signal $g(t)= 2\cos(400\pi t)+6\cos(640\pi t)$ is ideally sampled at 500Hz. If the sampled signal is passed through an ideally LPF with a cut of frequency at 400Hz, what components will appear in the filter output
3. A signal $m_1(t)$ is band limited to 3KHz & other 3 signals $m_2(t)$, $m_3(t)$ & $m_4(t)$ are band limited to 1.5KHz each. These are transmitted by means of TDM. i. Set up a commutator schemeto realize the multiplexing with each signal sampled at Nyquist rate ii. Find the speed commutator in samples/sec & the minimum band width of the channel.

MCQ:

1. **In Pulse Position Modulation, the drawbacks are**

a. Synchronization is required between transmitter and receiver
b. Large bandwidth is required as compared to PAM
c. None of the above
d. Both a and b
ANSWER: Both a and b

2. In pulse amplitude modulation

a. Amplitude of the pulse train is varied
b. Width of the pulse train is varied
c. Frequency of the pulse train is varied
d. None of the above
ANSWER: a

3. Types of analog pulse modulation systems are

a. Pulse amplitude modulation
b. Pulse time modulation
c. Frequency modulation
d. Both a and b
ANSWER: Both a and b

4. The spectrum of the sampled signal may be obtained without overlapping only if

a. $f_s \geq 2f_m$
b. $f_s < 2f_m$
c. $f_s > f_m$
d. $f_s < f_m$
ANSWER: a

5. TDM is used to
a) Increase the information transmission rate
b) Use only one carrier frequency to handle different signals
c) To use different frequency bands for different signals
d) To protect all small signals in PCM from quantizing noise

Answer: b

6. Which maintains better fidelity?
a) Analog communication
b) Digital communication
c) Analog & Digital communication
d) None of the mentioned

Answer: b

7. When aliasing will take place?
a) Sampling signals less than Nyquist Rate
b) Sampling signals more than Nyquist Rate
c) Sampling signals equal to Nyquist Rate
d) Sampling signals at a rate which is twice of Nyquist Rate

Answer: a

8. A PAM signal can be detected using
a) Low pass filter
b) High pass filter
c) Band pass filter
d) All pass filter

Answer: a

9. **A PWM signal can be generated by**
a) Anastable multi vibrator
b) A monostable multi vibrator
c) Integrating a PPM signal
d) Differentiating a PPM signal

Answer: b

10. **TDM requires**
a) Constant data transmission
b) Transmission of data samples
c) Transmission of data at random
d) Transmission of data of only one measured

Answer: b

11. PCM includes the process of
a) Amplitude discretization

b) Time discretization
c) Amplitude & Time discretization
d) None of the mentioned

Answer: c

12. For which quantization process is used?
a) Amplitude discretization
b) Time discretization
c) Amplitude & Time discretization
d) None of the mentioned

Answer: a

13. The transition between continuous values of the image function and its digital equivalent is called
a) Quantisation
b) Sampling
c) Rasterisation
d) None of the Mentioned

Answer: a

14. The noise that affects PCM

a) Transmission noise
b) Quantizing noise
c) Transit noise
d) Both a) and b) are correct

ANSWER: d

15. Nyquist criterion helps in

a) Transmitting the signal without noise
b) Reduction in transmission bandwidth
c) Increase in transmission bandwidth
d) Both a) and b)

ANSWER: d

16. The use of non uniform quantization leads to
a) Reduction in transmission bandwidth
b) Increase in maximum SNR
c) Increase in SNR for low level signals
d) Simplification of quantization process

Answer: c

17. Time division multiplexing uses
a) High pass filter
b) Commutator
c) High pass filter &Commutator
d) None of the mentioned

Answer: b

18. Nyquist rate

a) =2WHz

b) >2WHz

c)<2WHz

d)=1/2WHz

Answer: a

19. Nyquist Interval

a) =2WHz

b) >2WHz

c)< 2WHz

d)=1/2WHz

Answer: d

20. Quantization SNR in decibels

a) [4.78+7V]dB

b)[4.78+6V]dB

c) [6V+4.78]dB

d) [6V+5.78]dB

Answer: b