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SUBJECT: EC6651 COMMUNICATION ENGINEERING

(FOR VI SEMESTER EEE)

COURSE OUTCOMES:

CO1	Acquire information on the various types of communication systems and the possibilities of Amplitude Modulation and Angle Modulation systems
CO2	Introducing modulation schemes relating to Digital Communication systems and assessing its performance through bit error rate.
CO3	Providing Information about source coding, line coding and channel coding schemes
CO4	Gain knowledge on multiple access schemes used in wired and wireless communication systems.
CO5	Introducing about satellite communication and optical communication systems
CO6	Providing an overview of different applications of communications systems.

UNIT I-ANALOG COMMUNICATION

AM – Frequency spectrum – vector representation – power relations – generation of AM – DSB, DSB/SC, SSB, VSB AM Transmitter & Receiver; FM and PM – frequency spectrum – power relations : NBFM & WBFM, Generation of FM and DM, Amstrong method & Reactance modulations : FM & PM frequency.

PART-A

Remember:

1. Define modulation?

Modulation is a process by which some characteristics of high frequency carrier signal is varied in accordance with the instantaneous value of the modulating signal.

2. What are the types of analog modulation?

Modulation is of two types:
Amplitude modulation & Angle Modulation

3. Define depth of modulation or Modulation index of AM.

(or)

State the significance of modulation index (MAY/JUNE 2014)

It is defined as the ratio between message amplitude to that of carrier amplitude. m=Em/Ec. It is also known as co efficient of modulation

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4. What are the degrees of modulation?

Under modulation. m<1
Critical modulation m=1
Over modulation m>1

5. What is the need for modulation?

Needs for modulation is as follows:

Ease of transmission Multiplexing
Reduced noise
Narrow bandwidth
Frequency assignment
Reduce the equipment limitations.
Reduce antenna height.

6. What are the types of AM modulators?

There are two types of AM modulators. They are

Linear modulators
Non-linear modulators

Linear modulators are classified as Transistor modulator and Switching modulators.
There are three types of transistor modulator.

a) Collector modulator b) Emitter modulator c) Base modulator

Non-linear modulators are classified as Square law modulator Product modulator and Balanced modulator

7. Give the classification of modulation.

There are two types of modulation. They are Analog modulation Digital modulation
Analog modulation is classified into Continuous wave modulation and Pulse modulation

Continuous wave modulation is classified as follows
Amplitude modulation and Phase modulation

There are 3 types of amplitude modulation:

1. Double side band suppressed carrier 2. Single side band suppressed carrier 3. Vestigial side band suppressed carrier

Angle modulation is further classified as

1. Frequency modulation 2. Phase modulation

Pulse modulation is classified as follows

1. Pulse amplitude modulation 2. Pulse position modulation 3. Pulse duration modulation 4. Pulse code modulation

Digital modulation is classified as follows
Amplitude shift keying
Phase shift keying
Frequency shift keying

8. What is single tone and multi tone modulation?

If modulation is performed for a message signal with more than one frequency component then the modulation is called multi tone modulation.

If modulation is performed for a message signal with one frequency component then the modulation is called single tone modulation.

9. What are the advantages of VSB-AM?

1. It has bandwidth greater than SSB but less than DSB system. 2. Power transmission greater than DSB but less than SSB system. 3. No low frequency component lost. Hence it avoids phase distortion.

10. Define demodulation.

Demodulation or detection is the process by which modulating voltage is recovered from the modulated signal. It is the reverse process of modulation.

11. Define multiplexing.

Multiplexing is defined as the process of transmitting several message signals simultaneously over a single channel.

12. What is meant by frequency translation?

The process of translating incoming carrier frequency into upward and down ward frequency is called as frequency translation. It can be either up conversion or down conversion.

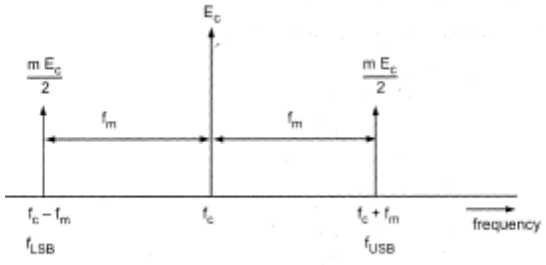


Fig 2 Frequency domain representation of AM wave

13. What are advantages and disadvantages of SSB?

Advantages: Saving power, Reduce BW by 50%, Increase efficiency & increased SNR

Disadvantages: Complex circuits for frequency stability

14. What are the applications of SSB-SC-AM?

- SSB telegraph system
- Aircraft
- Radio telephone
- VHF and UHF communication system.

15. What is the difference between high level modulation and lowlevel modulation?

Low level AM modulator	High level AM modulator
1. Modulation takes place prior to the final stage of the transmitter	1.Modulation takes place in the final element of final stage.
2. Less modulating signal power is required	2.More modulating signal power is required.

16. What is diagonal clipping and how can we eliminate it and peak negative clipping?

This type ofdistortion occurs when the constant of the RC load is too large. At high modulation depths, the current changes so fast the time constant of the load does not follow the Changes. As a result the current will decay exponentially instead of following the wave form.Diagonal clipping can be eliminated by choosing a proper value of time constant

Choose $RC \leq \sqrt{\frac{1-m^2}{w_m R_a}}$

Peak negative clipping can be eliminated by keeping AC and DC load resistance equal and the modulation index of modulated signal and detector should be same.

17. Define Amplitude modulation.

The amplitude of the high frequency carrier signal is varied in accordance with the instantaneous value of the message signal.

18. What is over modulation and Envelope distortion?

If modulation index of an AM is greater than 1, the envelope does not preserve the side bands rather the base band signal recovered from the envelope is distorted.

19. Define frequency modulation. (MAY/JUNE 2014)

Frequency modulation is defined as the process by which the frequency of the carrier wave is varied in accordance with the **instantaneous amplitude of the modulating or message signal.**

20. Define modulation index of frequency modulation. (MAY/JUNE 2015)

It is defined as the ratio of maximum frequency deviation to the modulating frequency. $\beta = \delta f/fm$

21. Define phase modulation. (MAY/JUNE 2014)

Phase modulation is defined as the process of changing the phase of the carrier signal in accordance with the instantaneous amplitude of the message signal.

22. What is meant by detection? Name the methods for detecting FM?

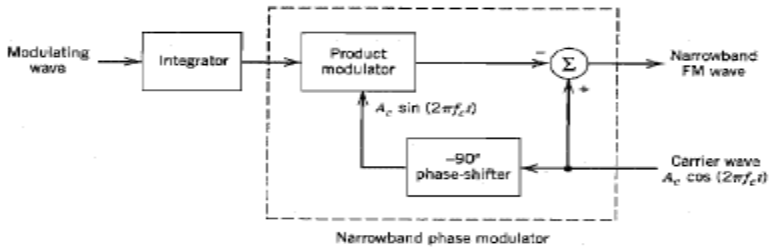
Detection is the process of getting back the original message signal from the received modulated signal. The various methods for detecting FM are as follows

1.Round travis detector or Balanced discriminator.
2.Fosterseeley discriminator or Phase discriminator
3. Ratio detector
4. PLL demodulator

23.What are the advantages of Ratio detector?

The main advantage of using Ratio detector is that there is no need for separate amplitude limiting circuitry.

24.Draw the block diagram of a method for generating a narrow band FM.



Block diagram of a method for generating a narrowband FM signal.

25. What are the types of Frequency Modulation? (MAY/JUNE 2015)

Based on the modulation index FM can be divided into types. They are Narrow band FM and Wide band FM. If the modulation index is greater than one then it is wide band FM and if the modulation index is less than one then it is Narrow band FM.

26. What is the basic difference between an AM signal and a narrowband FM signal?

In The case of sinusoidal modulation, the basic difference between an AM signal and a narrowband FM signal is that the algebraic sign of the lower side frequency in the narrow band FM is reversed.

27. What are the two methods of producing an FM wave?

Basically there are two methods of producing an FM wave. They are,

i) Direct method

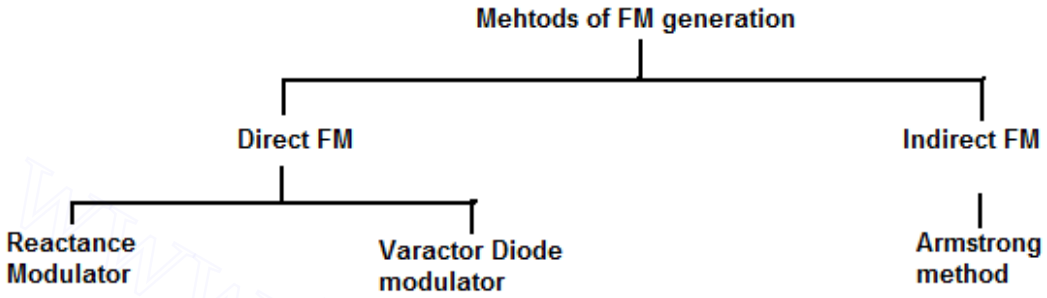
In this method the transmitter originates a wave whose frequency varies as function of the modulating source. It is used for the generation of NBFM

ii) Indirect method

In this method the transmitter originates a wave whose phase is a function of the modulation. Normally it is used for the generation of WBFM where WBFM is generated from NBFM

FM Modulators: There are 2 types of FM modulators.

1. Direct Method
2. Indirect Method



28. List the properties of the Bessel function. (MAY/JUNE 2015)

The properties of the Bessel function is given by,

i) $J_n(\beta)=(-1)^n J_{-n}(\beta)$ for all n, both positive and negative.

ii) For small values of the modulation index β ,we have $J_0(\beta)=1$

$J_1(\beta)=\beta/2$

$J_n(\beta)=0, n>2.$

iii) $\sum_{n=-\infty}^{\infty} J^2_n(\beta)=1$

29. Give the average power of an FM signal.

The amplitude of the frequency modulated signal is constant .The power of the FM signal is same as that of the carrier power. $P=1/2\ E_c^2$.

30. State the Carson's rule. (Nov/DEC 2015)

An approximate rule for the transmission bandwidth of an FM Signal generated by a single tone-modulating signal of frequency f_m is defined as

$$BW = 2(\Delta f + f_m)$$

Where Δf is the frequency deviation.

31. Define the deviation ratio D for non-sinusoidal modulation.

The deviation ratio D is defined as the ratio of the frequency deviation f, which corresponds to the maximum possible amplitude of the modulation signal m(t),to the highest modulation frequency .

$D = f / f_m$

32. What are the disadvantages of FM system?

1. A much wider channel is required by FM.
2. FM transmitting and receiving equipments tend to be more complex and hence it is expensive .

33. What are the types of FM detectors?

Slope detector and phase discriminator**.**

34. What are the types of phase discriminator? (Nov/DEC 2015)

Foster-seely discriminator and ratio detector.

35. What are the disadvantages of balanced slope detector?

1. Amplitude limiting cannot be provided
2. Linearity is not sufficient
3. It is difficult to align because of three different frequency to which various tuned circuits to be tuned.
4. The tuned circuit is not purely band limited.

36. Define frequency Deviation.

The maximum change in instantaneous frequency from the average is known as frequency deviation

$$\Delta f = \frac{KE_m}{2\pi}$$

37. Define Phase deviation.

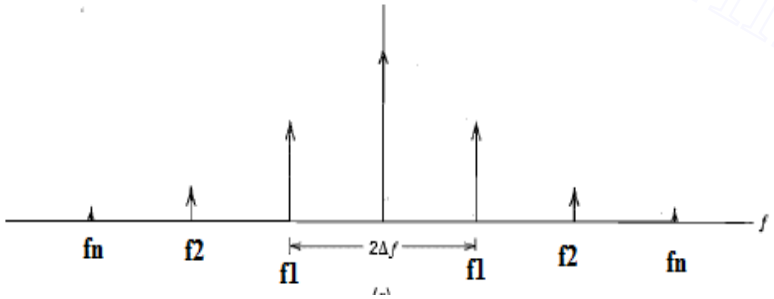
The maximum phase deviation of the total angle from the carrier angle is called phase deviation

$$\Delta\theta = K_f E_m$$

38. Give the merits of ratio detector.

It gives excellent noise free output
It does not require limiter
Relatively fewer components are required.

39. Draw the frequency spectrum of FM.



40. Define sensitivity of a receiver.

It is defined as a measure of its ability to receive weak signals.

41. Define selectivity of a receiver.

Selectivity of a receiver is defined as its ability to select the desired signals among the various signals.

42. Define stability.

It is the ability of the receiver to deliver a constant amount of output for a given a given period of time.

43. Define super heterodyne principle.

It can be defined as the process of operation of modulated waves to obtain similarly modulated waves of different frequency. This process uses a locally generated carrier wave, which determines the change of frequency.

44. What is TRF receiver?

Tuned Radio Frequency is also called straight receiver. Here the receiver operates in straight forward manner without frequency conversion.

45. What are the advantages of super heterodyne receiver over TRF? (Nov/DEC 2015)

The advantages of super heterodyne receiver over TRF are high selectivity, improved sensitivity throughout the carrier frequency band. It eliminates image frequency.

46. What is the figure of merit of DSBSC system ?

The figure of merit of DSBSC signal is unity

47. What is Capture effect? (MAY/JUNE 2015)

When the interference signal and FM input are of equal strength, the receiver fluctuates back and froth between them .This phenomenon is known as the capture effect.

48. What is threshold effect?

As the input noise power is increased the carrier to noise ratio is decreased the receiver breaks and as the carrier to noise ratio is reduced further crackling sound is heard and the output SNR cannot be predicted by the equation. This phenomenon is known as threshold effect.

49. What is Pre-emphasis?

The premodulation filtering in the transistor, to raise the power spectral density of the base band signal in its upper-frequency range is called pre emphasis (or pre distortion**)**

Pre emphasis is particularly effective in FM systems which are used for transmission of audio signals.

50. Define de-emphasis.

The filtering at the receiver to undo the signal pre-emphasis and to suppress noise is called de-emphasis.

51. What do you infer from the receiver output of a coherent detector?

The output equation $y(t)=1/2Cacm(t) +1/2n_I(t)$ indicates that the message signal and in-phase noise component of the filtered noise appear additively at the receiver output. The quadrature component of the narrow band noise is completely rejected by the coherent detector.

52. What is the figure of merit of a AM system with 100 percent modulation?

The figure of merit of a AM system with 100 percent modulation is 1/3.This means that other factors being equal an AM system must transmit three times as much average power as a suppressed system in order to achieve the same quality of noise performance**.**

53. What is called image frequency?

Image frequency is defined as the signal frequency plus twice the intermediate frequency. This has the effect of two stations being received simultaneously and hence it is undesirable.

$$f_{si} = f_s + 2 f_i$$

f_{si} - image frequency

It can be eliminated by providing adequate image signal selectivity between antenna and mixer input.

54. What is intermediate frequency?

Intermediate frequency (IF) is defined as the difference between the signal frequency and the oscillator frequency**.**

$$IF = f_S - f_O \qquad \text{when } f_S > f_O$$

$$IF = f_O - f_S \qquad \text{when } f_O > f_S$$

55. What are the characteristics of a receiver?

The characteristics of a receiver are sensitivity, selectivity, fidelity, and signal to noise ratio.

56. What is the function of amplitude limiter in FM system?

The function of amplitude limiter in FM system is used to remove the amplitude variations by clipping the modulated wave at the filter output almost to the zero axis .The resultant wave is rounded off by another BPF that is an integral part of the limiter thereby suppressing the harmonics of the carrier frequency.

57. What are the advantages of Super heterodyne receiver? (MAY/JUNE 2015)

- Improved selectivity and sensitivity.
- High stability.
- Uniform BW.
- No tuning noise problems

Understand:

58.Compare AM DSBFC with DSB-SC and SSB-SC.

AM DSBFC	DSB-SC	SSB-SC
Bandwidth=$2f_m$	Bandwidth=$2f_m$	Bandwidth=f_m
Contains USB, LSB, carrier	Contains USB,LSB	Contains LSB or USB
More power is required for transmission	Power required is less than that of AM	Power required is less than AM & DSB-SC

59. Compare linear and non-linear modulators.

Linear modulators	Non-linear modulators
1.Heavy filtering is not required	1.Heavy filtering is required
2.These modulators are used in high level modulation	2.These modulators are used in low level modulation

60. How will you generating DSBSC-AM?

There are two ways of generating DSBSC-AM such as

1. balanced modulator 2.ring modulators

61. Why VSB is preferred for TV transmission? (NOV/DEC 2014)

VSB is preferred for TV transmission because of reduced BW of modulation system

62. Draw the frequency spectrum of AM wave.

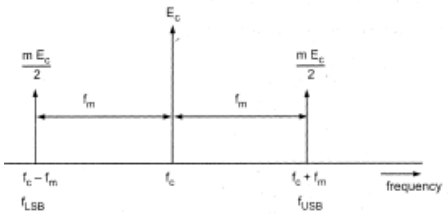
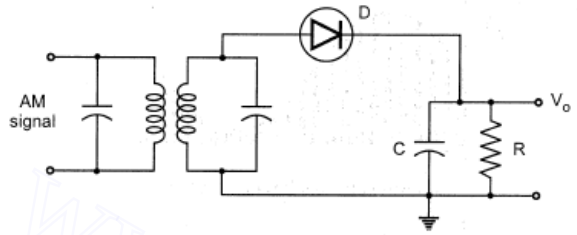


Fig 2 Frequency domain representation of AM wave

63. Sketch the basic envelope detector.

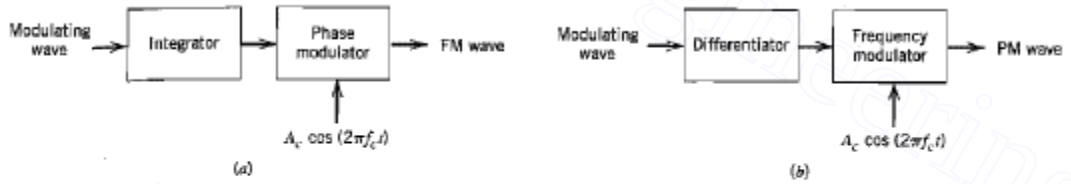


64. Compute the BW of AM signal given by

$$BW = 2f_m$$

$$2\pi f_m = 310 \qquad \textbf{Hence } BW = \frac{310}{\pi}$$

65. Illustrate the relationship between FM and PM with block diagrams. 0r How PM wave can be converted to FM wave?



Ilustration of the relationship between FM and PM
Fig (a) Generation of FM using PM
Fig (b) Generation of PM from FM

66 .How is the narrow band FM converted to Wide band FM?

Wide band Fm can be generated from Narrow band FM by passing the out put of Narrow band FM through stages of multipliers.

67.Distinguish between Narrow band FM and Wide Band FM.

S.No	Narrow band FM	Wide band FM
1	Modulation index is < 1	Modulation index > 10
2	$s(t) = A_c \cos(2\pi f_c t) - mA_c \sin(2\pi f_c t)\sin(2\pi f_m t)$	$s(t) = A_c \sum_{n=-\infty}^{\infty} J_n(m)\cos[2\pi(f_c + nf_m)t]$
3	Spectrum contains 2 sidebands and carrier	Spectrum cont6ains infinite number of sidebands and carrier

4	BW=2fm	$BW = 2(\delta + f_m(\max))$
5	It is used for mobile communication	It is used for broadcasting and entertainment
6	Maximum deviation =75Hz	Maximum deviation = 5 Hz
7	Range of modulating frequency 30Hz to 15 Kz	Range of modulating frequency 30Hz to 3 Kz

68. How will you generate message from frequency-modulated signals?

First the frequency-modulated signals are converted into corresponding amplitude-modulated signal using frequency dependent circuits. Then the original signal is recovered from this AM signal

69.Compare the noise performance of an AM and FM system?

The figure of merit of AM system is 1/3 when the modulation is 100 percent and that of FM is$(3/2)mf^2$.

The use of FM offers improved noise performance over AM when $(3/2)mf^2 > 1/3.mf$ –modulation index in FM.

70. How is threshold reduction is achieved in FM system? (Nov/DEC 2015)

Threshold reduction is achieved in FM system by using an FM demodulator with negative feedback or by using a phase locked loop demodulator.

71. Compare the noise performance of AM receiver with that of DSB-SC receiver.

The figure of merit of DSB-SC or SSB-SC receiver using coherent detection is always unity, The figure of merit of AM receiver using envelope detection is always less than unity. Therefore noise performance of AM receiver is always inferior to that of DSB-SC due to the wastage of power for transmitting the carrier.

APPLY:

72. **.The antenna current of an AM transmitter is 8A when only carrier is sent. It increases to 8.93A when the carrier is modulated by a single sine wave. Find the percentage modulation.**

Solution: Given Ic=8A , It-8.93A and m=0.8

$I_t=I_C\ (1+m^2/2)^{½}$

$8.93=8(1+m^2/2)^{½}$

m=0.701

$8.93=8(1+m^2/2)^{½}$

It=9.1A

73. How many AM broadcast station can be accommodated in a 100KHz bandwidth if the highest frequency modulating a carrier is 5KHz?

Total BW given is 100 KHz: fm=5KHZ

BW of AM is equal to 2fm=10 KHz

Number of stations accommodated = Total BW/ BW per station = 10 stations.

74. A transmitter supplies 8 Kw to the antenna when modulated. Determine the total power radiated when modulated to 30%.

m=0.3;Pc=8kw

$Pt=Pc(1+m^2/2)=8.36$ kw

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PART – B

Remember

1. Explain in detail about the FM generation using Armstrong method **(NOV/DEC 2014)** (16)
2. i. Explain the demodulation of an AM wave using envelope detector (8)
   ii. Explain the envelop detector circuit used for AM demodulation
3. Explain the working of FM stereo transmitter with necessary circuitry.
4. a) Explain the working of a SSB transmitter and receiver. **(MAY/JUNE 2014)** **(8)**
   b) Explain the direct and indirect method generation of Fm signal. **(MAY/JUNE 2014)** (8)
5. a) Illustarte the operation of VSB transmission**(May/June 2015)** **(8)**
   b) Explain the operation or Armstrong Frequency modulation system**(NOV/DEC 2015)**

Understand

6. i. Compare AM with FM with special reference to spectrum, power requirements, sidebands and bandwidth required **(NOV/DEC 2014)** (8)
   ii. Explain any two methods used for generating SSB/SC. (8)
   iii. With neat block diagram, explain the Tuned Radio Frequency (TRF) receivers.
7. With the help of neat block diagram, explain the functioning of a heterodyne radio receiver. List out the significance of it over the TRF receivers (16)
8. Draw the block diagram of single sideband AM transmitter and explain function of each block. (16)
9. With the help of a neat block diagram, explain FM receiver (16)
10. i. Compare wide band and narrow band Fm system (6)
    ii. How does the phase-shift method efficiently suppress the unwanted side band? Explain with diagram (10)

11. i. With a neat block diagram, explain the operation of Armstrong frequency modulation system.
    ii. Illustrate the operation of VSB transmission (4)

12.Name the methods used for the suppression of unwanted side band in AM transmission?Discuss the working of any ome of them? **(NOV/DEC 2014)** **(16)**

13.Explain the principle of indirect method of frequency modulation with diadram **(NOV/DEC 2015)** **(8)**

14. a) Describe the relationship between PM and FM**(NOV/DEC 2015)** **(8)**
    b) Explain the generation of FM signsl using reactance modulation scheme **(8)**

15. Explaain the working of SSB transmitter and receiver**(NOV/DEC 2015) (May/June 2016)** **(8)**

16 .Name the method used for the suppression of unwanted bands in Am transmission?Discuss the working of any one of them **(May/June 2016)** **(8)**

20. Describe the working of direct and indirect method of transmitting FM signals **(May/June 2016)** **(8)**

21.Solve the expression for Am wave and its power relation and give the time and frequency domain representation of AM wave **(May/June 2016)** **(8)**

22. Derive an expression for the amplitude modulated wave and its power relations. Also give its time and frequency domain representation (16)

23. Derive an expression for the amplitude modulated wave and its power relations. (10)

24. Deduce an analytical expression for the frequency modulated wave. (8)

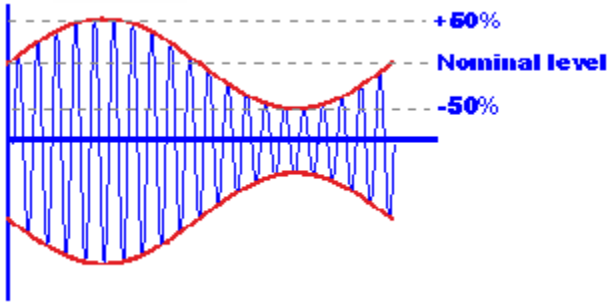
25. Discuss any one method of generating the frequency modulated signals with the relevant sketch. (8)

APPLY:

26) A carrier wave of 10MHZ is amplitude modulated to 50% level with tone of 5000Hz.Sketch the waveform and amplitude modulation in time and frequency domain.Assume carrier amplitude as 10V **(NOV/DEC 2015) (8)**

Assignment:

1. From the diagram say whether what type of modulation has undergone. .[Understand]



2. Draw the SSB-SC spectrum and explain the significance [Understand]
3. A 5000 KHz carrier is simultaneously AM modulated with 200 Hz, 600Hz and 2.5KHz audio sine .What will be the frequencies present in the output? [Apply]
4. A Carrier wave is represented by e(t)=24 sin 2πfct . What happens to the wave form representations under the following depth of modulation scenarios? [Analyze]
   a. i) m=1 ii)m=0.5 iii) m=1.75

5. A Commercial AM station is broadcasting with an unmodulated carrier power of 20KW.the modulation index is set at 0.5 for a sinusoidal message signal. Find total transmitted power and efficiency. [Apply]
6. Design a AM modulator using FET. [Create]
7. Design a envelope detector for the input E(t)= E(1+ m sinωt) sinωt and time constant 1/fc<1/Rc<1/fm. .[Create]
8. A carrier wave of 20MHZ is amplitude modulated to 40% level with tone of 6000Hz.Sketch the waveform and amplitude modulation in time and frequency domain.Assume carrier amplitude as 5V. [Apply]
9. The antenna current of an AM transmitter is 16A when only carrier is sent. It increases to 8.9.52A when the carrier is modulated by a single sine wave. Find the percentage modulation. [Apply]
10. A transmitter supplies 9 Kw to the antenna when modulated. Determine the total power radiated when modulated to 50%. [Apply]
11. Compare AM with FM with special reference to spectrum, power requirements, Sidebands and bandwidth required. [Understand]
12. Solve the expression for Am wave and its power relation and give the time and frequency domain representation of AM wave. [Understand]
13. Compare wide band and narrow band Fm system How does the phase-shift method efficiently suppress the unwanted side band? Explain with diagram. [Understand]

UNIT II - DIGITAL COMMUNICATION

Pulse modulations – concepts of sampling and sampling theormes, PAM, PWM,PPM,PTM,quantization and coding : DCM, DM, slope overload error. ADM, DPCM, OOK systems – ASK, FSK, PSK, BSK, QPSK, QAM, MSK, GMSK, applications of Data communication.

PART –A
REMEMBER

1. What are the advantages of digital transmission?

- The advantage of digital transmission over analog transmission is noise immunity.
- Digital pulses are less susceptible than analog signals to variations caused by noise.
- Digital signals are better suited to processing and multiplexing than analog signals.
- Digital transmission systems are more noise resistant than the analog transmission systems.
- Digital systems are better suited to evaluate error performance.

2. What are the disadvantages of digital transmission?

- The transmission of digitally encoded analog signals requires significantly more bandwidth than simply transmitting the original analog signal.
- Analog signal must be converted to digital codes prior to transmission and converted back to analog form at the receiver, thus necessitating additional encoding and decoding circuitry.

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3. Define pulse code modulation.

In pulse code modulation, analog signal is sampled and converted to fixed length, serial binary number for transmission. The binary number varies according to the amplitude of the analog signal.

4. What is the purpose of the sample and hold circuit?

The sample and hold circuit periodically samples the analog input signal and converts those samples to a multilevel PAM signal.

5. What is the Nyquist sampling rate?

Nyquist sampling rate states that, the minimum sampling rate is equal to twice the highest audio input frequency.

6. Define and state the causes of fold over distortion.

The minimum sampling rate(fs) is equal to twice the highest audio input frequency(fa).If fs is less than two times fa ,distortion will result. The distortion is Called aliasing or fold over distortion. The side frequencies from one harmonic fold over into the sideband of another harmonic. The frequency that folds over is an alias of the input signal hence, the names "aliasing" or "fold over distortion".

7. Define overload distortion.

If the magnitude of sample exceeds the highest quantization interval, overload distortion occurs.

8. Define quantization. (Nov/DEC 2015)

Quantization is a process of approximation or rounding off. Assigning PCM codes to absolute magnitudes is called quantizing.

9. Define dynamic range.

Dynamic range is the ratio of the largest possible magnitude to the smallest possible magnitude. Mathematically, dynamic range is DR= (Vmax) /(Vmin)

10. Define coding efficiency. (May/June 2015)

Coding efficiency is the ratio of the minimum number of bits required to achieve a certain dynamic range to the actual number of PCM bits used. Mathematically, coding efficiency is

Coding efficiency= Minimum number of bits (including sign bit) X 100 Actual number of bits (including sign bit)

11. Define Companding.

Companding is the process of compressing, then expanding. With companded systems, the higher amplitude analog signals are compressed prior to transmission, then expanded at the receiver.

12. Define slope overload. How it is reduced. (May/June 2015)

The slope of the analog signal is greater than the delta modulator can maintain, and is called slope overload. Slope overload is reduced by increasing the clock frequency and by increasing the magnitude of the minimum step size.

13. Define granular noise. How it is reduced? (Nov/DEC 2015)

When the original input signal has relatively constant amplitude, the reconstructed signal has variations that were not present in the original signal. This is called granular noise. Granular noise can be reduced by decreasing the step size.

14. Define adaptive delta modulation.

Adaptive delta modulation is a delta modulation system where the step size of the AC is automatically varied depending on the amplitude characteristics of the analog input signal.

15. Define peak frequency deviation for FSK.

Peak frequency deviation (_f) is the difference between the carrier rest frequency and either the mark or space frequency and either the mark or space frequency. (Δf)=|fm-fs|/2

16. Define modulation index for FSK.

The modulation index in FSK is defined as h = (Δf)/ fa

Where h= FM modulation index called the h factor in FSK fa = fundamental frequency of the binary modulating signal (Δf) = Peak frequency deviation (hertz)

17. Define bit rate.

In digital modulation, the rate of change at the input to the modulator is called the bit rate (fb) and has the unit of bits per second (bps).

18. Define Baud rate.

The rate of change at the output of the modulator is called baud.

19. Define QAM.

Quadrature amplitude modulation is a form of digital modulation where the digital information is contained in both the amplitude and phase of the transmitted carrier.

20. Write the relationship between the minimum bandwidth required for an FSK system and the bit rate.

The minimum bandwidth can be approximated as B=2Δf +2fb

Where B=minimum bandwidth (hertz)

Δf=minimum peak frequency deviation (hertz)

fb=bitrate

21. What is meant by Digital Amplitude Modulation (DAM)?

The digital amplitude modulation is simply double sideband, full carrier amplitude modulation where the input-modulating signal is a binary waveform.

22. Define FSK bite rate & baud.

The rate of change at the input to the modulator is called the bit rate (¦b) and has the unit of bits per second. The rate of change at the output of the modulator is called baud.

23. What is meant by Frequency Shift Keying (FSK)?

Frequency Shift Keying is the relatively simple, low performance type of digital modulation. Binary FSK is a form of constant amplitude angle modulation similar to conventional frequency modulation except that the modulating signal is a binary signal that varies between two discrete voltage levels rather than a continuously changing analog waveform.

24. What do you meant by M-ary encoding?

M-ary is a term derived from the word binary. M is simply a digit that represents the number of conditions or combinations possible for a given number of binary variables.

25. What does QPSK mean? (NOV/DEC 2014)

Quaternary Phase Shift Keying (QPSK), or quadrature PSK as it is sometimes called, is another form of angle modulated, constant amplitude digital modulation. QPSK is an M-ary encoding technique where M=4.

27. What is meant by offset QPSK?

Offset QPSK is a modified form of QPSK where the bit waveforms on the I and Q channels are offset or shifted in phase from each other by one half a bit time.

28. What does QAM stands for?

Quadrature amplitude Modulation (QAM) is a form of digital modulation where the digital information is contained in both the amplitude and phase of the transmitted carrier.

29. Define Bandwidth efficiency.

It is defined as the ratio of the transmission bit rate to the minimum bandwidth required for a particular modulation scheme.

BW efficiency = transmission rate (bps) / minimum BW (Hz) bits/cycle

30. Define carrier recovery & what are all the methods used for this?

Carrier recovery is the process of extracting a phase coherent reference carrier from a receiver signal. This is sometimes called phase referencing. Methods are squaring loop, costas loop, or remodulator.

31. What is meant by DPSK?

Differential Phase Shift Keying (DPSK) is an alternative form of digital modulation where the binary input information is contained in the difference between two successive signaling elements rather than the absolute phase.

32. What is meant by Probability of error & Bit Error Rate?

Probability of error P (e) & Bit Error Rate (BER) are often used interchangeably, although in practice they do have slightly different meanings. P(e) is a theoretical expectation of the bit error rate for a given system. BER is an empirical record of a systems actual bit error performance.

33. What is meant by antipodal signaling?

The phase relationship between signaling elements for BPSK (i.e., 180 degree out of phase) is the optimum-signaling format, referred to as antipodal signaling, and occurs only when two binary signal levels are allowed and when one signal is the exact negative of the other.

34. Give the formula for the error distance of the PSK.

The error distance of the PSK is given by,

d = (2 sin 180/M)*D Where,

d – error distance M – number of phases

D – peak signal amplitude

35. What does 8-QAM & 16-QAM means?

Eight QAM is an M-ary encoding technique where M=8. The output signal from an 8-QAM is not constant amplitude. Sixteen QAM is also an M-ary system where M=16.

36. What are all the types of FSK systems & explain them?

There are two types of FSK system.

Non coherent FSK

Coherent FSK

With non-coherent FSK, the transmitter and receiver are not frequency or phase synchronized.

With coherent FSK, local receiver reference signals are in frequency and phase lock with the transmitted signals.

38. What is meant by peak frequency deviation?

Peak frequency deviation is the product of the binary input voltage and the deviation sensitivity of the VCO.

Δf = Vm (t)* kL Where,

Δf = Peak frequency deviation (Hz)

vm(t)= peak binary modulating signal voltage (volts)

kL = deviation sensitivity (Hz per volt)

39. What is meant by pulse modulation & name the methods of it?

Pulse modulation includes many different methods of converting information into pulse form for transferring pulses from a source to a destination.
Methods:
Pulse Width Modulation
Pulse Position Modulation
Pulse Amplitude Modulation
Pulse code Modulation

40. Define Pulse Width Modulation (PWM).

The pulse width (active portion of the duty cycle) is proportional to the amplitude of the analog signal. This method is sometimes called as pulse duration modulation (PDM) or pulse length modulation (PLM).

41. Define Pulse Position Modulation (PPM) & Pulse Amplitude Modulation (PAM).

The position of a constant width pulse within a prescribed time slot is varied according to the amplitude of the analog signal is called PPM. The amplitude of a constant width, constant position pulse is varied according to the amplitude of the analog signal.

42. What is meant by Codec? (May/June 2015)

An integrated circuit that performs the PCM encoding and decoding functions is called a codec (coder/decoder).

43. What are all the two basic techniques used to perform the sample and hold Function?

There are two basic techniques used to perform the sample and hold function and they are given by, Natural sampling & Flat top sampling.

45. Define the term synchronous transmission.

In the synchronous transmission, the transmitter and receiver both operate at common clock signal. The data is transmitted as a block. There are no start and stop bits. Timing errors are minimum in synchronous mode.

49. What is meant by Adaptive Delta Modulation in PCM?

Adaptive delta modulation is the delta modulation system where the step size of the Digital to Analog Converter (DAC) is automatically varied depending on the amplitude characteristics of the analog input signal.

50. Give the formula for percentage error of PCM.

The percentage error is given by,
%Error = |Transmit voltage – Receive voltage| / Receive voltage*100

51. What is meant by Inter Symbol Interference (ISI)?

At the sampling instants (i.e., the center of the pulses), the signal does not always attain the maximum value. The tails of several pulses have overlapped, thus interfering with the major pulse lobe. This interference is called inter symbol interference.

52. State Sampling theorem. (May-June 2014)

A bandlimited signal of finite energy, which has no frequency components higher than W Hz, may be completely recovered from the knowledge of its samples taken at the rate of 2W samples per second.

UNDERSTAND

53. Compare Amplitude Shift Keying (ASK) & Frequency Shift Keying (FSK)?
(MAY-JUNE 2014)

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ASK

1. Amplitude of the signal is modulated as per digital data
2. Minimum BW = 2fb
3. Transmitted power keeps on changing

FSK

1. Frequency of the signal is modulated as per digital data
2. Minimum BW = 4fb
3. Transmitted power remains constant

54. Compare the bandwidth efficiency of BPSK and QPSK modulated signals.

The bandwidth efficiency of BPSK is 1 bit per cycle, where as that of QPSK is 2 bits per cycle

The bandwidth efficiency of QPSK is more because it encodes the signal with 4 different phase shifts. Therefore it combines two successive bits.

55. Explain how eye pattern is used to measure ISI in pulse transmission.

From the interpretation of eye pattern the following measures can be obtained,

Best sampling time of the signal

Height of eye opening gives margin over noise

Slope of eye opening gives sensitivity to timing error.

56. What are the methods of pulse modulation (April/May 2015)

57.Differentiate Bit rate and Band rate of digital modulation (April/May 2015)

PART – B

REMEMBER:

1. For the binary data transmission obtain the expressions and waveforms for ASK, FSK and PSK schemes. (16)

2. Draw the block diagram of a TDM system and explain where is TDM applied? (16)

3. Describe pulse code modulation scheme and draw the waveforms. (16)

4. Explain the generation and noise performance of delta modulation. (16)

5. Explain quantization noise in PCM system. How can it be reduced? **(MAY/JUNE 2014)** (16)

6. Using block diagram, explain the functioning of each block present in a PCM transmitter and receiver setup (16)

7. Explain the functioning of FSK digital transmitter cum receiver operation in detail with the relevant diagrams. (16)

8. Explain the working of a FSK modulator and demodulator with the signal constellation diagram (16)

9. With a neat block diagram explain the principle of DPCM. How does it differ from DM? (16)

10.Explain the operation of QPSK receiver and derive the expression for its bit error probability **(NOV/DEC 2015) (APRIL/MAY 2015)**

12. Describe in detail about the operation of ASK and BSK with neat diagram**(APRIL/MAY 2016) (16)**

13. List the advantages of digital communication and Explain GMSK and QAM techniques with neat diagram **(APRIL/MAY 2016) (16)**

14 Explain about different types of delta modulation schemes. **(MAY/JUNE 2014)** (16)

UNDERSTAND

15. i) Compare performances of PSK and FSK. (8)
ii) Draw the block diagram of a PCM communication system. Explain the function of each block with neat sketch of input and output at each stage. (8)

16.Draw the block diagram of BPSK transmitter and receiver. Explain the same digital modulation scheme with appropriate constellation diagram. **(APRIL/MAY 2016)** (16)
17.How does ADM differ from DM? Support your answer with block diagram and waveforms. (16)

18.Draw the block diagram of QPSK transmitter and receiver. Explain the same digital modulation scheme with appropriate constellation diagram. **(MAY/JUNE 2014), (NOV/DEC 2014)** (16)
19**.** Explain QPSK with a block diagram an spectrum. Also discuss the phasor diagram for sinusoidals. **(NOV/DEC 2014)** (16)
20. How does ADM differ from DM? Support your answers with block diagram and waveforms **(NOV/DEC 2015)** (16)

21. With neat block diagram explain PAM modulation demodulation process and derive an expression for PAM wave and depth of modulation **(NOV/DEC 2015)** (16)

ANALYSE

22.For an AM DSBSC modulator with fc=100KHZ and fm(max)=10KHZ .Determine i) Frequency limits for upper side bands ii)Bandwidth iii) upper and lower side band frequencies produced modulating signal is a single frequency 3KHz tone iv) Draw the output frequency spectrum **(APRIL/MAY 2015) (16)**

ASSIGNMENT

REMEMBER

1. Define and state the causes of fold over distortion.
2. Explain quantization noise in PCM system.
3. Explain about different types of delta modulation schemes.

UNDERSTAND

1. Describe in detail about the operation of ASK and BSK with neat diagram
2. How does ADM differ from DM? Support your answers with block diagram and waveforms
3. Draw the block diagram of FPSK transmitter and receiver. Explain the same digital modulation scheme with appropriate constellation diagram.
4. Derive an expression for PAM wave and depth of modulation
5. How does ADM differ from DM? Support your answers with block diagram and waveforms

ANALYSE

1. For an AM DSBSC modulator with fc=50KHZ and fm(max)=1KHZ .Determine i) Frequency limits for upper side bands ii)Bandwidth iii) upper and lower side band frequencies produced modulating signal is a single frequency 4 KHz tone iv) Draw the output frequency spectrum
2. An FM modulator with fc=50KHZ and fm(max)=1KHZ .Determine i) Frequency limits for upper side bands ii)Bandwidth iii) upper and lower side band frequencies produced modulating signal is a single frequency 4 KHz tone iv) Draw the output frequency spectrum

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UNIT – III SOURCE CODES, LINE CODES AND ERROR CONTROL

Primary communication – entropy, properties, BSC, BEC, source coding : Shaum, Fao, Huffman coding : noiseless coding theorum, BW – SNR trade off codes: NRZ, RZ, AMI, HDBP, ABQ, MBnBcodes : Efficiency of transmissions, error control codes and applications: convolutions & block codes.

Part-A

REMEMBER:

1. Define lossless channel.

The channel described by a channel matrix with only one nonzero element in each column is called a lossless channel. In the lossless channel no sources information is lost in transmission**.**

2. Define Deterministic channel

A channel described by a channel matrix with only one nonzero element in each row is called a deterministic channel and this element must be unity.

3. Define noiseless channel.

A channel is called noiseless if it is both lossless and deterministic. The channel matrix has only one element in each row and in each column and this element is unity. The input and output alphabets are of the same size.

4. What are the types of Correlation?

The types of Correlation are Cross Correlation and Auto Correlation

5. What is the difference between Correlation and Convolution?

1. In Correlation physical time 't' is dummy variable and it disappears after solution of an integral. But in convolution 'ι' is a dummy variable.

2. Convolution is a function of delay parameter 't' but convolution is a function of' t'.

1. Convolution is commutative but correlation is noncom mutative**.**
2.

7. Define Signal.

A signal is defined as any physical quantity carrying information that varies with time. The value of signal may be real or complex. The types of signal are continuous signal and discrete time signal.

8. State Shannon's capacity theorem for a power and band limited channel.

The information capacity of a continuous channel of BW B Hz perturbed by a AWGN of PSD No/2 and limited to BW B is given by $C=\log_2[1+(P/NoB)]$ .where P is the average transmitted power

9. Define entropy. (May/June 2015)

Entropy is the measure of the average information content per second. It is given by the expression

$H(X)=\sum_I P(xi)\log_2 P(xi)$ bits/sample.

10 .Define mutual information.

Mutual information I(X,Y) of a channel is defined by I(X,Y)=H(X)-H(X/Y) bits/symbol

H(X)- entropy of the source H(X/Y)- conditional entropy of Y.

11. State the properties of mutual information.

1. I(X,Y)=I(Y,X)
2. I(X,Y)>=0
3. I(X,Y)=H(Y)-H(Y/X)
4. I(X,Y)=H(X)+H(Y)-H(X,Y).

12. Give the relation between the different entropies.

H(X,Y)=H(X)+H(Y/X)

=H(Y)+H(X/Y)

H(X)- entropy of the source(Y/X),H(X/Y)-conditional entropy H(Y)-entropy of destination

H(X,Y)- Joint entropy of the source and destination

13. Define information rate.

If the time rate at which source X emits symbols is r symbols per second. The information rate R of the source is given by

R=r H(X) bits/second H(X)- entropy of the source

14. What is data compaction?

For efficient signal transmission the redundant information must be removed from the signal prior to transmission .This information with no loss of information is ordinarily performed on a signal in digital form and is referred to as data compaction or lossless data compression.

15. State the property of entropy. (May/June 2015)

1. $\text{Log}M \geq H(x) \geq 0$
2. $H(X) = 0$ if all probabilities are zero
3. $H(X) = \log_2 M$ if all probabilities are equal

16. What is differential entropy?

The average amount of information per sample value of x(t) is measured by

$$H(X) = -\int_{-\infty}^{\infty} f_X(x) \log f_X(x) dx \text{ bit/sample}$$

H(X) –differential entropy of X.

17. What is the channel capacity of a discrete signal?

The channel capacity of a discrete signal C= max I(X,Y) P(xi)

I(X, Y)-mutual information.

18. What is source coding and entropy coding?

A conversion of the output of a DMS into a sequence of binary symbols is called source coding. The design of a variable length code such that its average cod word length approaches the entropy of the DMS is often referred to as entropy coding.

19. State Shannon Hartley theorem.

The capacity 'C' of a additive Gaussian noise channel is $C=B \log_2 (1+S/N)$ B= channel bandwidth, S/N=signal to noise ratio.

20. What is the entropy of a binary memory-less source?

The entropy of a binary memory-less source $H(X)=-p_0 \log_2 p_0-(1-p_0)\log_2(1-p_0)$ p_0 probability of symbol '0',$p1=(1- p_0)$ =probability of transmitting symbol '1'.

21. What happens when the number of coding alphabet increases?

When the number of coding alphabet increases the efficiency of the coding technique decreases.

22. What is information theory?

Information theory deals with the mathematical modeling and analysis of a communication system rather than with physical sources and physical channels

23. What is the channel capacity of a BSC and BEC?

For BSC the channel capacity $C=1+p\log_2 p +(1-p)\log_2(1-p)$. For BEC the channel capacity C=(1-p)

29. Why is huffman code is called as minimum redundancy coding? (May june 2014)

24. List the properties of Hamming distance. (NOV/DEC 2014)

The Hamming distance is a metric on the set of the words of length n (also known as a Hamming space), as it fulfills the conditions of non-negativity, identity of indiscernibles and symmetry, and it can be shown by complete induction that it satisfies the triangle inequality as well.

25.What are the popular coding sequences of CDMA system. (NOV/DEC 2014)

Popular code sequences used in spread-spectrum transmission are

- -Maximum Length sequences
- -Walsh Hadamard sequences
- -Gold codes, and
- -Kasami codes.

26.State and prove Shannon noiseless coding theorem.(MAY-JUNE014)(12)

27. Explain Shannon-Fano coding. (May/June 2015)

An efficient code can be obtained by the following simple procedure, known as Shannon- Fano algorthim.

1. List the source symbols in order of decreasing probability.

28. Partition the set into two sets that are as close to equiprobable as possible, and sign 0 to the upper set and 1 to the lower set.

29. Continue this process, each time partitioning the sets with as nearly equal probabilities as possible until further partitioning is not possible.

28. A source generates 3 messages with probability 0.5, 0.25 and 0.25. Calculate the entropy.

$$H(X) = \sum P_k \log \frac{1}{P_k}$$

29. What are the types of characters used in data communication codes (April/May 2015)

UNDERSTAND

1. Prove that I (x_i x_j) = I(x_i) + I(x_j) if x_i and x_j are independent.

If x_i and x_j are independent.

$P(x_i\ x_j) = P(x_i)\ P(x_j)$

$I(x_i\ x_j) = \log 1/P(x_i\ x_j)$

$= \log 1/ P(x_i)\ P(x_j)$

$= I(x_i) + I(x_j)$

2. Differentiate between lossless and lossy coding.

Lossless Coding	Lossy coding
Coding that reduces the number of bits required to represent the symbol without affecting the equality of information by removing the redundant information	Lossy coding involves the loss of information due to compression in controlled manner
Process is reversible	Process is not reversible
Eg: Data compaction	Eg: Lempel Ziv algorithm

3. How is the efficiency of the coding technique measured?

Efficiency of the code =H(X) /L

L=∑p(xi)li average code word length & li=length of the code word.

APPLY:

1. Calculate the Entropy of the source with symbol probabilities 0.6, 0.3, 0.1.

$$H(X) = \sum P_k \log \frac{1}{P_k} = 1.299 bits/msg$$

PART – B

ANALYSE:

1.i) In binary PCM if "0" occur with probability p and "1" occur with Probability , then calculate amount of information conveyed by each binit. (8)

ii) If there are M equally likely and independent messages, then prove that amount of information carried by each message will be, I = N bits. Where $M = 2^N$ and N is an integer (8)

UNDERSTAND:

2. i) Describe Bandwidth-SNR trade off problem of coding. (6)

ii) Discuss any one of the decoding methods of convolution coding precisely. (10)

3. Explain the coding and decoding process of block codes. (16)
4. Explain the convolution codes. Constraint length 6 and rate is 1/2. **(MAY-JUNE 2014)**
5. What do you mean by binary symmetric channel? Derive channel capacity formula for symmetric channel

6.Derive the channel capacity theorem and discuss the implications of the information capacity theorem.

7. Discuss the Viterbi algorithm by showing the possible paths through the trellis of a coder. Assume the state diagram of any coder (NOV/DEC 2014)
(16)

8.Briefly discuss on various error control codes and explain in detail with one example of convolution codes (NOV/DEC 2015) (8)

9. Draw in detail about the procedure for Shannon-Fano Coding Scheme (NOV/DEC 2015) (8)

10. Explain coding and decoding procedure for block codes (NOV/DEC 2015) (NOV/DEC 2016) (8)
11. Discuss the BW-SNR trade off of a communication systems (MAY/JUNE 2016) (8)

12.For a given 8 bit stream 11010100 plot NRZ, RZ ,AMI, and differential Manchester code(NOV/DEC 2016)
APPLY:

7.Apply the following coding and dram the waveform for bit stream 10011100 on NRZ,RZ,AMI,HDBP,ABQ and MBnB. (MAY-JUNE 2014) (NOV/DEC 2014) (12)

8. An analog signal is bandlimited to B Hz and sampled at Nyquist rate.The samples are quantized into 4 levels. Each level represents one message. Thus there are 4 messages. The probabilities of occurrence of these 4 levels (Messages) are p1 =0.1, p4 =0.2, p2 =0.45 & p3 =0.25. Find out information rate of the source. (16)

9. A black and white TV picture consists of about 2X106 picture elements with 1 different brightness levels, with equal probabilities. If pictures are repeated at the rate of 32 per second, calculate average rate of information conveyed by this TV picture Source. If SNR is 30 db, what is the maximum bandwidth required to support the transmission of the resultant video signal? (16)
10. A discrete memory less source has five symbols x1, x2, x3, x4 and x5 with probabilities 0.4, 0.19, 0.16, 0.15 and 0.15 respectively attached to every symbol.

1. Construct a Shannon-Fano code for the source and calculate code efficiency.
2. Repeat (i) for Huffman code compare the two techniques of source coding. (16)

11. The generator polynomial of a (7, 4) cyclic code is G (p) = p3+p+1 Find all the Code vectors for

the code in non systematic form.
(16)

12.Draw the polar, unipolar, bipolar, Manchester NRZ for the data(1 0 1 1 0 0) (NOV/DEC 2015) (8)

17. Apply the Shannon-Fano Coding Scheme for the source x1.x2,x3,x4 with the probabilities 1/8 1/2 ¼ 1/8 respectively and determine the code efficiency (MAY/JUNE 2016) (8)

ASSIGNMENTS

REMEMBER:

1. State the properties of mutual information.

APPLY:

1. Calculate the Entropy of the source with symbol probabilities 0.7, 0.6, 0.2.

ANALYSE

1. In binary PCM if "0" occur with probability p and "1" occur with Probability, then calculate amount of information conveyed by each binit.
2. If there are M equally likely and independent messages, then prove that amount of information carried by each message will be, I = N bits. Where $M = 2^N$ and N is an integer

UNDERSTAND:

3. Discuss the Viterbi algorithm by showing the possible paths through the trellis of a coder. Assume the state diagram of any coder

4. For a given 8 bit stream 11110000 plot NRZ, RZ ,AMI, and differential Manchester code

5. Apply the following coding and dram the waveform for bit stream 10011100 on NRZ,RZ,AMI,HDBP,ABQ and MBnB.

6. An analog signal is bandlimited to B Hz and sampled at Nyquist rate.The samples are quantized into 4 levels. Each level represents one message. Thus there are 4 messages. The probabilities of occurrence of these 4 levels (Messages) are p1 =0.1, p4 =0.2, p2 =0.45 & p3 =0.25. Find out information rate of the source.

7. The generator polynomial of a (5, 4) cyclic code is G (p) = p2+p Find all the Code vectors for the code in non systematic form.

8. Apply the Shannon-Fano Coding Scheme for the source x1.x2,x3,x4 with the probabilities 1/8 1/2 ¼ 1/8 respectively and determine the code efficiency.

UNIT-IV MULTIPLE ACCESS TECHNIQUES

SS&MA techniques : FDMA, TDMA, CDMA, SDMA application in wire and wireless communication : Advantages (merits) :

PART-A

REMEMBER:

1. What is the significance of spread spectrum?
The narrow bandwidth signal is spread over wide band with the help of special code. Hence the name spread spectrum is given.

2. What is the use of special code in spread spectrum?
The special code decides the way in which narrowband signal is spread over wide band.

3. What is key in spread spectrum?
The special code is a pseudo-noise sequence. It is also called key. Sometimes, the logic for generation of pseudo-noise sequence is called key.

4. What are averaging system and avoidance systems?
In averaging systems, the interference is reduced by averaging it over long period. In avoidance systems making the signal to avoid the interference a large fraction of time reduce the interference.

5. Where spread spectrum is used?
It is used in anti-jam capability; secure communication such as military and banking purposes.

6. What are the two types of spread spectrum?
Direct sequence spread spectrum
Frequency hop spread spectrum

7. What is the meaning of the word jamming and anti-jam?
In general, the word Jam means to block or resist the flow. A noise is transmitted within the bandwidth of the channel. This noise interferes with the signal, so that the receiver cannot interpret the signal. This is called Jamming. The capability created against jamming is called anti-jam.

8. What is jamming margin?

$$\text{Jamming Margin} = \frac{\text{Average interference power (J)}}{\text{Average signal power (Ps)}}$$

9. What is meant by PN sequence and what are the properties of PN sequence?
The PN sequence is coded sequence of ones and zeros with certain auto-correlation properties.

There are three properties
Balance Property
Run Property
Correlation property

10. Define chip duration and chip rate?

The bit period PN sequence is called chip duration (Tc). Chip rate is the rate at which bits of PN sequence are produced. Chip rate (Rc) =1 / Tc

11. What is the relationship between chip duration and bit duration?

Tb = N Tc
Where N is the period of PN sequence
Tb is the bit duration
Tc is chip duration

12. What is the shape of auto-correlation function of PN sequence?

The shape of auto-correlation function of PN sequence is the triangular shape with period NTc.

13. Define slow frequency hopping. (NOV/DEC 2015)

Several symbols of data are transmitted in one frequency hop. This means symbol rate is higher than hop-rate.

14. Define FDMA, TDMA and CDMA?

FDMA – Overall bandwidth is shared.
TDMA – Time of Channel is shared.
CDMA – Time as well as bandwidth is shared.

15. List the important features of TDMA. (NOV/DEC 2014)

- Shares single carrier frequency with multiple users
- Non-continuous transmission makes handoff simpler
- Slots can be assigned on demand in dynamic TDMA
- Less stringent power control than CDMA due to reduced intra cell interference
- Higher synchronization overhead than CDMA
- Advanced equalization may be necessary for high data rates if the channel is "frequency selective" and creates Intersymbol interference
- Cell breathing (borrowing resources from adjacent cells) is more complicated than in CDMA
- Frequency/slot allocation complexity
- Pulsating power envelop: Interference with other devices

16. What is an FDMA? Explain it.

FDMA is certainly the most conventional method of multiple access and was the first technique to be employed in modern wireless applications. In FDMA, the available bandwidth is split into a number of equal subbands, each of which constitutes a physical channel. The channel bandwidth is a function of the services to be provided and of the available technology and is identified by its center frequency, known as a carrier. In single channel per carrier FDMA technology, the channels, once assigned, are used on a non-time-sharing basis. Thus, a channel allocated to a given user

remains allocated until the end of task for which the specific assignment was made.

17. What is SDMA? What special features it has when compared to other multiple access techniques? (MAY-JUNE 2014)

SDMA is a nonconventional multiple-access technique that finds application in modern wireless systems mainly in combination with other multiple-access techniques. The spatial dimension has been extensively explored by wireless communications systems in the form of frequency reuse. The deployment of advanced techniques to take further advantage of the spatial dimension is embedded in the SDMA philosophy. In SDMA, the entire bandwidth is made available simultaneously to all signals. Signals are discriminated spatially using spot beam antemnnas, and the communication trajectory constitutes the physical channels. (Ex: Spot beam antennas used in IRIDIUM satellites.)

The implementation of SDMA architecture is based strongly on antennas technology coupled with advanced digital signal processing. As opposed to the conventional applications in which the locations are constantly illuminated by rigid-beam antennas, in SDMA the antennas should provide for the ability to illuminate the locations in a dynamic fashion. The antenna beams must be electronically and adaptively directed to the user so that, in an idealized situation, the location alone is enough to discriminate the user. FDMA and TDMA systems are usually considered to be narrowband, whereas CDMA systems are usually designed to be wideband. SDMA systems are deployed together with the other multiple-access technologies.

18. What are the pros and cons of CDMA technique?

Pros

Hard to spy, immune from narrowband noise, no need for all stations to synchronize, no hard limit on capacity of a cell &all cells can use all frequencies.

Cons

Implementation complexity, need for power control, to avoid capture need for a large contiguous frequency band (for direct sequence) &problems installing in the field.

19.What is near – far problem? (MAY-JUNE 2014)

The near-far problem is a condition in which a receiver captures a strong signal and thereby makes it impossible for the receiver to detect a weaker signal

20.What are the popular coding sequences of CDMA system. (NOV/DEC 2014)

Popular code sequences used in spread-spectrum transmission are

-Maximum Length sequences

-Walsh Hadamard sequences

-Gold codes, and

-Kasami codes.

21. Explain direct sequence spread spectrum.

In the first stage, incoming data sequence modulates wideband code. This transforms narrow-band incoming data sequence into wideband signal. The wideband signal digitally modulates carrier.

22. Explain frequency hop spread spectrum(NOV/DEC 2015)

In this technique, changing the carrier frequency in pseudo-random manner widens the spectrum of data modulated carrier.

23. Why pseudo-random code is used as special code for spreading the spectrum?

Unintended receiver should not receive the signal. If the spreading code is not random, then

unintended receiver can obtain the code by observing the signal over certain period of time. But if the code is random, then it is very difficult to identify it.

24. Is spread spectrum a modulation technique?

Sometimes people call spread spectrum modulation. But that does not carry conventional meaning of modulation. Rather it includes conventional digital modulation techniques to generate spread spectrum modulated signals.

25. How many stages of flip-flops are required to generate PN sequence of length 31?

N=2

$31 = 2^m - 1$

m = 5 stages

26. Any 4 Applications of FDM **(April/May 2015)**

PART – B

UNDERSTAND:

1. With neat block diagram, explain the operation of a typical TDMA system and Compare with FDMA. **(MAY-JUNE 2014)** (12)

2. Discuss the concept of CDMA techniques and mention its merits and demerits. **(MAY-JUNE 2014)** (12)

3.Explain the Different types of multiple access technique. (16)

4. With neat block diagram, explain the operation of a typical FDMA system. (16)

5. Explain the spread spectrum techniques. (16)

6. Discuss the concept of TDMA techniques and mention its merits and demerits. **(NOV/DEC 2014) (16)**

7. Explain about TDMA and FDMA system . **(NOV/DEC 2015) (8)**

8. Discuss the various multiple access techniques used in wireless communication with its merits and demerits . **(NOV/DEC 2015) (8)**

9. Describe CDMA techniques in detail **(May/June 2016) (8)**

10. Illustrate how interference is avoided by using Code division Multiplexing **(May/June 2016) (8)**

11. Discuss about wire and wireless communication system **(May/June 2016) (8)**

12. Discuss the BSC and BEC with their channel diagram and transmission matrix **(May/June 2016)**

APPLY:

9. Determine the BCS for the following data and CRC generating Polynomials

Data G(x) = $x^7 + x^5 + x^4 + x^2 + + x^1 + 1$ and CRC P(x) = $x^5 + x^4 + x^1 + + x^0$. **(May/June 2015) (16)**

10. 500 users employ FDMA to transmit 1000 packets of data. The Channel B>W is 100 MHz and QPSK is used of the 500 carrier frequencies employed. i) What is the max B,W allocated to each user? ii) What is the bit rate employed by each user? iii) How long does it take to transmit a packet? **(May/June 2015)** **(16)**

APPLY:

1. Determine the BCS for the following data and CRC generating Polynomials
2. Data G(x) = $x^7 + x^5 + x^4 + x^2 + + x^1 + 1$ and CRC P(x) = $x^5 + x^4 + x^1 + + x^0$.
3. 200 users employ FDMA to transmit 400 packets of data. The Channel B>W is 100 MHz and QPSK is used of the 1000 carrier frequencies employed. i) What is the max B, W allocated to each user? ii) What is the bit rate employed by each user? iii) How long does it take to transmit a packet?

UNDERSTAND:

1. Discuss the concept of CDMA techniques and mention its merits and demerits.
2. Discuss the various multiple access techniques used in wireless communication with its merits and demerits.Illustrate how interference is avoided by using Code division Multiplexing.
3. Discuss the BSC and BEC with their channel diagram and transmission matrix.
4. Discuss the BSC and BEC with their channel diagram and transmission matrix.
5. Compare CDMA,TDMA and FDMA system .

UNIT – V SATELLITE, OPTICAL FIBER – POWERLINE, SCADA

Orbits : types of satellites : frequency used link establishment, MA techniques used in satellite communication, earth station; aperture actuators used in satellite – Intelsat and Insat: fibers – types: sources, detectors used, digital filters, optical link: power line carrier communications: SCAD

PART –A

REMEMBER:

1. Define satellite.

Satellite is a celestial body that orbits around a planet.In aerospace terms, a satellite is a space vehicle launched by humans and orbits earth or another celestial body.

2. State Kepler's first law.

Kepler's first law states that a satellite will orbit a primary body following an elliptical path.

3. State Kepler's second law.

Kepler's second law states that for equal time intervals of time a satellite will sweep out equal areas in the orbital plane, focused at the bary center.

4. State Kepler's third law.

The third law states that the square of the periodic time of orbit is proportional to the cube of the mean distance between the primary and the satellite.

5. Define orbital satellite.

Orbital satellites are also called as nonsynchronous satellite.Nonsynchronous satellites rotate around earth in an elliptical or circular pattern. In a circular orbit, the speed or rotation is constant however in elliptical orbits the speed depends on the height the satellite is above the earth.

6. Define prograde orbit.

If the satellite is orbiting in the same direction as earth's rotation and at an angular velocity greater than that of earth, the orbit is called a prograde (or) posigrade orbit.

7. Define retrograde orbit.

If the satellite is orbiting in the opposite direction as the earth's rotation or in the same direction with an angular velocity less than that of earth, the orbit is called a retrograde orbit.

8. Define Geo synchronous satellite. (April/May 2016)

Geo synchronous or geo stationary satellites are those that orbit in a circular pattern with an angular velocity equal to that of Erath. Geosynchronous satellites have an orbital time of approximately 24 hours, the same as earth; thus geosynchronous satellites appear to be stationary as they remain in a fixed position in respect to a given point on earth.

9. Define apogee and perigee.

The point in an orbit which is located farthest from the earth is called apogee.

The point in an orbit which is located closest to earth is called perigee.

10. Define angle of inclination.

The angle of inclination is the angle between the earth's equatorial plane and the orbital plane of a satellite measured counterclockwise at the point in the orbit where it crosses the equatorial plane traveling from south to north

.11. Define Descending node.

The point where a polar or inclined orbit crosses the equatorial plane traveling from south to north. This point is called descending node.

12. Define ascending node.

The point where a polar or inclined orbit crosses the equatorial plane traveling from north to south is called ascending node.

13. Define line of nodes.

The line joining the ascending and descending nodes through the center of earth is called line of nodes.

14. Define angle of elevation.

Angle of elevation is the vertical angle formed between the direction of travel of an electromagnetic wave radiated from an earth station antenna pointing directly toward a satellite and the horizontal plane.

15. Define Azimuth angle.

Azimuth is the horizontal angular distance from a reference direction, either the southern or northern most point of the horizon.

16. What are the advantages of optical fiber or optical fiber communication? (MAY-JUNE 2014)

1. Greater information capacity
2. Immunity to crosstalk
3. Immunity to static interference
4. Environmental immunity
5. Safety
6. Security
7. Small Size and Weight
8. Ruggedness and flexibility of fiber
9. Potential low cost for long distance transmission
10. All three modes of communication possible (Underground, overhead and as a buried cable)
11. Abundance of raw material (silica from sand) for manufacturing optical fiber

17. Define a fiber optic system. (NOV/DEC 2015)

An optical communications system is an electronic communication system that uses light as the carrier of information. Optical fiber communication systems use glass or plastic fibers to contain light waves and guide them in a manner similar to the way electromagnetic waves are guided through a waveguide.

18. Define refractive index.

The refractive index is defined as the as the ratio of the velocity of propagation of light ray in free space to the velocity of propagation of a light ray in a given material.

Mathematically, the refractive index is

$n = c/v$

Where c = speed of light in free space

v = speed of light in a given material

19. Define critical angle.

Critical angle is defined as the minimum angle of incidence at which a light ray may strike the interface of two media and result in an angle of refraction of 90°or greater.

20. Define single mode and multi mode propagation.

If there is only one path for light to take down the cable, it is called single mode.

If there is more than one path, it is called multimode.

21. Define acceptance angle.

It defines the maximum angle in which external light rays may strike the air/fiber interface and still propagate down the fiber with a response that is no greater than 10 dB below the maximum value.

22. Define numerical aperture. (NOV/DEC 2015)

Numerical aperture is mathematically defined as the sine of the maximum angle a light ray entering the fiber can have in respect to the axis of the fiber and still propagate down the cable by internal reflection.

23. Define modal dispersion.

Modal dispersion or pulse spreading is caused by the difference in the propagation times of light rays that take different paths down a fiber. Modal dispersion can occur only in multimode fibers. It can be reduced by using single mode step index fibers and graded index fibers.

24. What are the advantages of heterojunction LEDs?

a. The increase in current density generates a more brilliant light spot.
b. The smaller emitting area makes it easier to couple its emitted light into fiber.
c. The small effective area has a smaller capacitance, which allows the planar heterojunction LED to be used at higher speeds.

25. What are the disadvantages of injection laser diode?

ILDs are typically on the order of 10 times more expensive than LEDs Because ILDs operate at higher powers, they typically have a much shorter life time than LEDs.
ILDs are more temperature dependent than LEDs.

26. List the characteristics of LEO orbit or LEO satellite.

LEO Orbit/ Satellite Characteristics:

1) Circular/ slightly elliptical orbit under 2000 Kms.
2) Orbital period ranges from 1.5 to 2 hours.
3) Diameter of coverage on the earth's surface is about 8000 Kms.
4) Round-trip Signal propagation delay (between earth station to satellite and satellite to earth station) is less than 20-ms.
5) Maximum Satellite visible time up to 20 min.
6) Satellite and earth station must cope up with Doppler Shift (i.e.) Change in frequency for a stationary satellite or Constant frequency for moving satellite.
7) Atmospheric drag results in orbital perturbations. And Tracking of satellite in this orbit is very difficult.

27. List the characteristics of MEO orbit or MEO satellites.

MEO Orbit/ Satellite Characteristics:

1) Circular orbit at an altitude in the range of 5000 to 12000 Kms.
2) Orbital period 6 hours.
3) Diameter of coverage is about 10000 to 15000Kms.
4) Round-trip Signal propagation delay less than 50-ms.
5) Maximum Satellite visible time is few hours.
6) Less Doppler Shift.
7) Tracking problem is better than LEO but not as good as GEO satellites.

29. List the characteristics of GEO satellite.

GEO Orbit/ Satellite Characteristics:

1) Negligible Doppler shift and the tracking of satellite are simplified.
2) Diameter of coverage is Very high and three satellites in geosynchronous orbit spaced at 120° from each other are enough to cover the entire globe.
3) Circular orbits slightly above the equator. So Polar Regions are poorly served.
4) Satellite angular separation of 2° gives a chance to accommodate 180 satellites in a single orbit looking like an ornamental chain.
5) Round trip propagation delay is 500 to 600 ms and it can be a maximum about 0.24 seconds.
6) Weak signal strength after traveling 25000 miles (36000Kms).
7) Launching of satellite is difficult and expensive.
8) Geosynchronous satellites are available to all earth stations within their *shadow*

100% of the time. The shadow of a satellite includes all the earth stations that have a line-of-sight path to it and lie within the radiation pattern of the satellite's antennas.

9) There is no need to switch from one geosynchronous satellite to another as they orbit overhead. Consequently, there are no transmission breaks due to switching times.
10) Geosynchronous satellites require sophisticated and heavy propulsion devices Onboard to keep them in a fixed orbit.
11) Geosynchronous satellites require higher transmit powers and more sensitive

Receivers because of the longer distances and greater path losses.

12) High-precision spacemanship is required to place a geosynchronous satellite into Orbit and to keep it there.

30. Show the frequency band designations used for satellites.

TABLE 1.1 Frequency Band Designations

Frequency range, GHz	Band designation
0.1–0.3	VHF
0.3–1.0	UHF
1.0–2.0	L
2.0–4.0	S
4.0–8.0	C
8.0–12.0	X
12.0–18.0	Ku
18.0–27.0	K
27.0–40.0	Ka
40.0–75	V
75–110	W
110–300	mm
300–3000	μm

L band	1 to 2 GHz
S band	2 to 4 GHz
C band	4 to 8 GHz
X band	8 to 12 GHz
Ku band	12 to 18 GHz
K band	18 to 26.5 GHz
Ka band	26.5 to 40 GHz
Q band	30 to 50 GHz
U band	40 to 60 GHz
V band	50 to 75 GHz
D band	110 to 170 GHz

31. What are the types of LASER source?

Basically, there are four types of lasers: gas, liquid, solid, and semiconductor.

1. *Gas lasers.* Gas lasers use a mixture of helium and neon enclosed in a glass tube. A flow of coherent (one frequency) light waves is emitted through the output coupler when an electric current is discharged into the gas. The continuous light-wave output is monochromatic (one color).
2. Liquid lasers. Liquid lasers use organic dyes enclosed in a glass tube for im active medium. Dye is circulated into the tube with a pump. A powerful pulse of light excites the organic dye.
3. Solid lasers. Solid lasers use a solid, cylindrical crystal, such as ruby, for the active medium. Each end of the ruby is polished and parallel. The ruby is excited by a tungsten lamp tied to an ac power supply. The output from the laser is a continuous wave.
4. *Semiconductor lasers.* Semiconductor lasers are made from semiconductor *p-n* junctions and are commonly called ILDs. The excitation mechanism is a dc power supply that controls the amount of current to the active medium. The output light from an ILD is easily modulated, making it very useful in many electronic communications applications.

32. What are the special characteristics of LASER?

All types of lasers have several common characteristics. They all use (l) an active material to convert energy into laser light, (2) a pumping source to provide power or energy, (3) optics to direct the beam through the active material to be amplified, (4) optics to direct the beam into a narrow powerful cone of divergence, (5) a feedback mechanism to provide continuous operation, and (6) an output coupler to transmit power out of the laser. The radiation of a laser is extremely intense and directional. When focused into a fine hair like beam, it can concentrate all its power into the narrow beam. If the beam of light were allowed to diverge, it would lose most of its power.

33. List and explain the characteristics of Light detectors.

The most important characteristics of light detectors are the following:

1. Responsivity. A measure of the conversion efficiency of a photo detector. It is the ratio of the output current of a photodiode to the input optical power and has the unit of amperes per watt. Responsivity is generally given for a particular wavelength or frequency.
2. Dark current. The leakage current that flows through a photodiode with no light input. Thermally generated carriers in the diode cause dark current.
3. Transit time. The time it takes a light-induced carrier to travel across the depletion region of a semiconductor. This parameter determines the maximum bit rate possible with a particular photodiode.
4. Spectral response. The range of wavelength values that a given photodiode will respond. Generally, relative spectral response is graphed as a function of wavelength or frequency, as shown in Figure 13-39.

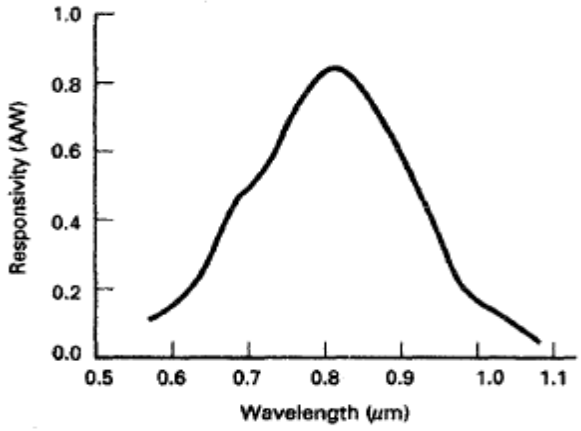

FIGURE 13-39 Spectral response curve

5. Light sensitivity. The minimum optical power a light detector can receive and still produce a usable electrical output signal. Light sensitivity is generally given for a particular wavelength in either dBm or dBμ.

34.Classify the communication satellites along with their band of frequency allocation?

(MAY-JUNE 2014)

There are two major classes of communications satellites, Passive and Active. Passive satellites only redirect (usually via reflection) the signal coming from the source, toward the direction of the receiver. With passive satellites, the reflected signal is not amplified before it returns to Earth, so it has the tendency to be very weak.

35. What is SCADA? **(MAY-JUNE 2014)**

SCADA is the acronym for Supervisory Control and Data Acquisition. SCADA is a computer-based system for gathering and analyzing real-time data to monitor and control equipment that deals with critical and time-sensitive materials or events.

36.What are the major advantages of optical fiber system (April/May 2015)

- Small size and weight
- High security
- Low transmission Noise
- System Reliability
- Immunity to interferece and Noise

37.Define Angle of elevation (April/May 2015)

APPLY:

38. Give the orbital velocity and round trip propagation delay of GEO satellite.

Geosynchronous Satellite Orbital Velocity

The circumference (C) of a geosynchronous orbit is

$$C = 2\pi(42{,}164 \text{ km})$$
$$= 264{,}790 \text{ km}$$

Therefore, the velocity (v) of a geosynchronous satellite is

$$v = \frac{264{,}790 \text{ km}}{24 \text{ hr}}$$
$$= 11{,}033 \text{ km/hr}$$
$$v = 6840 \text{ mph}$$

Round-Trip Time Delay of Geosynchronous Satellites

The round-trip propagation delay between a satellite and an earth station located directly below it is

$$t = \frac{d}{c}$$
$$= \frac{2(35{,}768 \text{ km})}{3 \times 10^5 \text{ km/s}}$$
$$= 238 \text{ ms}$$

Including the time delay within the earth station and satellite equipment, it takes more than a quarter of a second for an electromagnetic wave to travel from an earth station to a satellite and back when the earth station is located at a point on Earth directly below the satellite. For earth stations located at more distant locations, the propagation delay is even more substantial and can be significant with two-way telephone conversations or data transmissions.

PART-B

UNDERSTAND:

1. **i)** List the advantages of using optical fiber as a medium of communication in a telephone network. (6)
   ii) Draw the block diagram of fiber optical communication link. Explain the Principle of operation of light sources and detectors. (10)

2. i) Briefly describe the losses associated with fiber cables. (8)
   ii) List and describe the primary characteristics of light detectors. (8)

3. Briefly describe the functional characteristics of an up- link, a transponder and a Down-link model for a satellite system. (16)

4. i) Briefly describe losses associated with fiber cables. (8)
   ii) Explain the satellite system link models. (8)

5. i) Explain the principle operation of avalanche photodiode. (12)
   ii) Define numerical aperture and derive the expression for it. (4)

6. Describe the functional characteristics of an uplink, transponder and a down-link

model for a satellite system **(MAY-JUNE 2016)** (16)

7. List the merits and demerits of optical communication systems. What are the essential components required for establishing an optical link. What are the various losses associated with it. (16)

8. Explain how the light beam propagates through fiber. What are the different types of optical link losses and discuss their adverse effects? (16)

10. Briefly describe the functional characteristics of an uplink, a transponder and a downlink model for a satellite system. (16)

11. Explain types and multiple access techniques in satellite communication (16) (MAY-JUNE 2014) (NOV/DEC 2014)

12. What are the modes of operation suggested in optical fibers? How are optical fibers classified according to this? Discuss elaborately. (MAY-JUNE 2014) (10)

13. Describe the following: (MAY-JUNE 2014) (16)

1. Optical detectors and their types.
2. Satellite types.
3. Digital filters used in satellite systems
4. Optical link.

14.Classify the communication satellites along with their band of frequency allocation? **(MAY-JUNE 2014)**

15. Derive the satellite system link equation. (12)

16. With neat sketch for the ray propagation into and down an optical fiber cable, derive an expression for the acceptance angle. **(NOV/DEC 2015) .** **(**8)

17. Compare the three types of optical fiber configuration **(MAY-JUNE 2015)** (8)

18. Explain Satellite subsystem and power line carrier systems **(MAY-JUNE 2015)** (8)

19. Draw and Explain the optical fiber communication link **(NOV/DEC 2015) (MAY-JUNE 2016)** (8)

20. Explain the multiple Access techniques used in satellite Communication systems(NOV/DEC 2015) (8)

21.What are the modes of operation suggested in optical fiber ? How are optical fiber classified according to it? **(NOV/DEC 2015)** (8)

22. Explain in detail about any one of the optical fiber source and detector **) (MAY-JUNE 2016)** (8)

23. Explain in detail about Satellite communication system **(MAY-JUNE 2016)** (8)

ASSIGNMENT:

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REMEMBER:

1. What are the special characteristics of LASER
2. List and explain the characteristics of Light detectors.
3. Show the frequency band designations used for satellites.

UNDERSTAND:

1. List the merits and demerits of optical communication systems. What are the essential components required for establishing an optical link. What are the various losses associated with it.
2. Explain how the light beam propagates through fiber. What are the differen types of optical link losses and discuss their adverse effects?
3. Explain the multiple Access techniques used in satellite Communication systems
4. Explain in detail about Satellite communication system

Compare the three types of optical fiber configuration

APPLY:

1. Give the orbital velocity and round trip propagation delay of GEO satellite.

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