F – 55011

Register No. | | | | | | | | |

BTech Degree Examination December 2022

Fourth Semester

Information Technology

20ITT41 – PRINCIPLES OF COMMUNICATION

(Regulations 2020)

Bessel Function Table and ASCII Table are to be provided

Time: Three hours Maximum: 100 marks

Answer all Questions

Part – A ($10 \times 2 = 20$ marks)

1. Draw the envelope and spectrum of DSB-FC amplitude modulation. [CO1,K1]
2. For an AM-DSBFC wave, the carrier signal power is 5W. If the modulation index is 0.8, determine the total transmitted power. [CO1,K3]
3. Consider the modulation index of an FM modulator is 5. If the peak frequency deviation is doubled and the maximum frequency of the message signal is halved, what will be the modulation index? [CO2,K3]
4. Differentiate narrowband FM and wideband FM. [CO2,K2]
5. Mention the reason for aliasing. [CO3,K2]
6. Draw the amplitude shift keying waveform for the given binary sequence {1 0 1 1 0 1}. [CO3,K2]
7. What is meant by Bar codes? Give the types of Bar codes. [CO4,K1]
8. List the types of line coding. [CO4,K1]
9. Justify the run length property of PN sequence. [CO5,K2]
10. Find the processing gain of a spread spectrum system having 1.2 MCPS chip rate. Consider the signal bandwidth is 40kHz. [CO5,K3]

Part – B ($5 \times 16 = 80$ marks)

11\. a. i) Draw the block diagram of low level AM transmitter and interpret the working of each block. (10) [CO1,K2]

ii) An amplitude modulated signal is described through the following specification. (6) [CO1,K3]

$V_c(\text{peak}) = 120\text{V}$, $V_m(\text{peak}) = 60\text{V}$, $f_c = 120\text{MHz}$, $f_m = 100\text{kHz}$.

Determine the modulation index, upper and lower sideband frequencies.

(OR)

b. i) Draw the super heterodyne receiver and briefly explain its blocks. (10) [CO1,K2]

ii) The IF frequency used in a super heterodyne receiver is 455kHz. If the received RF signal frequency is 1345kHz, at which frequencies the local oscillator has to be tuned to receive high-side injection and low-side injection AM signals. (6) [CO1,K3]

12. a. i) With a neat sketch explain the working principles of Crosby Direct FM transmitter. (10) [CO2,K1]

ii) For an FM modulator, the carrier signal amplitude is 10V. If the modulation index is 1 find the relative amplitudes of the carrier of 500kHz and the sideband frequency components. Consider the modulating signal frequency of 10kHz. Draw the spectrum. (6) [CO2,K3]

(OR)

b. i) Describe the working of Armstrong Indirect FM Transmitter with its block diagram. (10) [CO2,K1]

ii) Determine the modulation index and Carson's bandwidth for an FM signal with a maximum frequency deviation $\Delta f = 25kHz$ and a maximum modulating signal $f_{m(max)} = 12.5kHz$.. (6) [CO2,K3]

13. a. i) Narrate the functioning of a simplex PCM transmission system with its block diagram. (8) [CO3,K1]

ii) Differentiate the working of non-coherent FSK demodulator and coherent FSK demodulator with their block diagrams. (8) [CO3,K2]

(OR)

b. i) Sketch the T_1 digital carrier system with 24 channels TDM multiplexer, and describe its functionalities. (8) [CO1,K1]

ii) Obtain the bandwidth required to transmit a BPSK signal by considering balanced modulator as a BPSK modulator. (8) [CO3,K2]

14. a. i) Determine the VRCS and LRC for the following ASCII- encoded message: THE CODE. Use odd parity for the VRCS and the even parity for the LRC. (10) [CO4,K3]

ii) With a simplified diagram, briefly explain the ISDN architecture. (6) [CO4,K2]

(OR)

b. i) Determine the block check sequence (BCS) for the following data and CRC generating polynomials (10) [CO4,K3]

$G(x) = x^7 + x^4 + x^2 + x^0 = 10010101$

$P(x) = x^5 + x^4 + x^1 + x^0 = 110011$

ii) Elucidate the RS-232 logic levels and noise margin. (6) [CO4,K2]

15. a. i) With a suitable block diagram elucidate the generation of DSSS signal with BPSK modulation. (8) [CO5,K1]

ii) Narrate the properties of PN sequence used in the generation of spread spectrum signals. (8) [CO5,K2]

(OR)

b. i) Describe the generation of fast frequency hopping spread spectrum signal. (8) [CO5,K1]

ii) Obtain the expression for processing gain of spread spectrum communication system. (8) [CO5,K2]

Bloom's Taxonomy Level	Remembering (K1)	Understanding (K2)	Applying (K3)	Analysing (K4)	Evaluating (K5)	Creating (K6)
Percentage	32	40	28	-	-	-

Kongu Engineering College-638060

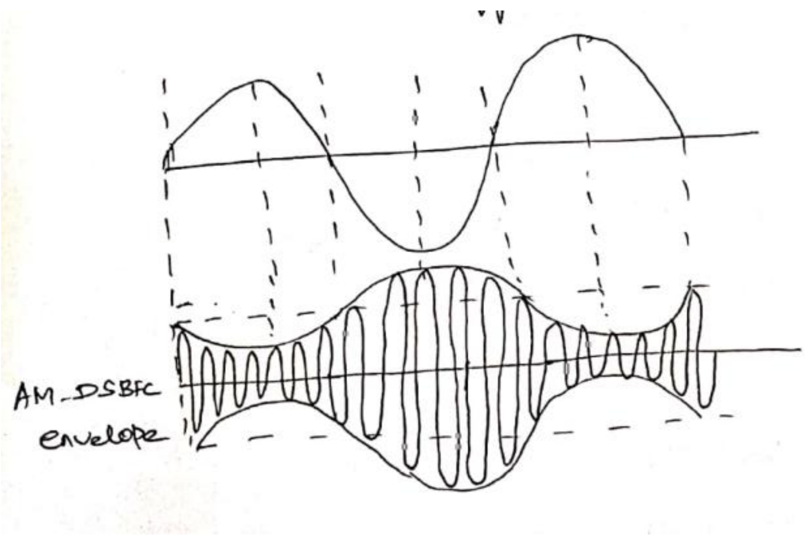
Department of Information Technology

20ITT41- Principles of Communication

Key for Evaluation

Part - A

1. DSBFC



2. For an AM-DSBFC wave, the carrier signal power is 5W. If the modulation index is 0.8, (001) determine the total transmitted power.

SOLN:

P=5W

Modulation index=0.8

$P_t=P_c(1+\mu^2/2)$

$=5(1+0.8^2/2)$

=21W

3.Consider the modulation index of an FM modulator is 5. If the peak frequency deviation is 100, doubled and the maximum frequency of the message signal is halved, what will be the modulation index?

SOLN:

$\Delta f = m * f_m$

$2\Delta f = 5 * f_m/2$

$\Delta f = 5f_m/4$

$5f_m/4 = mf_m$

$m = 5/4$

$m = 1.25$

4)

Sr No.	Narrow Band FM	Wide Band FM
1	Modulation index is less than 1	Modulation index is greater than 1
2	Frequency Deviation = 5KHz	Frequency Deviation = 75KHz
3	Modulating Frequency = 3KHz	Modulating frequency range from 30 Hz to 15KHz
4	Bandwidth = 2fm	Bandwidth 15 times NBFM, Bandwidth = $2(\delta + fm_{max})$
5	Maximum modulation index is slightly greater than 1	Maximum modulation index between 5 to 2500

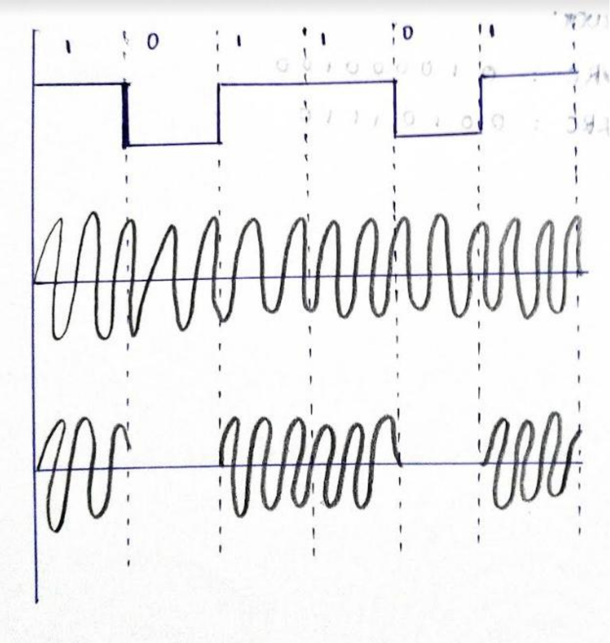
5) Reason for aliasing

* when an analog input frequency greater than fs/2 modulates fs.

* 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 “foldover distortion”)

6)



7) what is meant by bar codes? Types of barcodes?

*A bar code is a series of vertical black bars separated by vertical white bars (called spaces).

* The widths of the bars and spaces along with their reflective abilities represent binary 1s and 0s, and combinations of bits identify specific items.

Types:

discrete, continuous, or two-dimensional (2D)

8)types of coding

*unipolar

*polar

*bi-polar

9)run length property of pn sequence

In PN sequences about half of the runs are of length 1, about a quarter of the runs are of length 2, about an eighth of the runs are of length three and so on.

10. Find the processing gain of a spread spectrum having 1.2 MCPS chip rate. Connder the signal bandwidth is 40kHz

SOLN:

Bandwidth=40

Rate=1.2

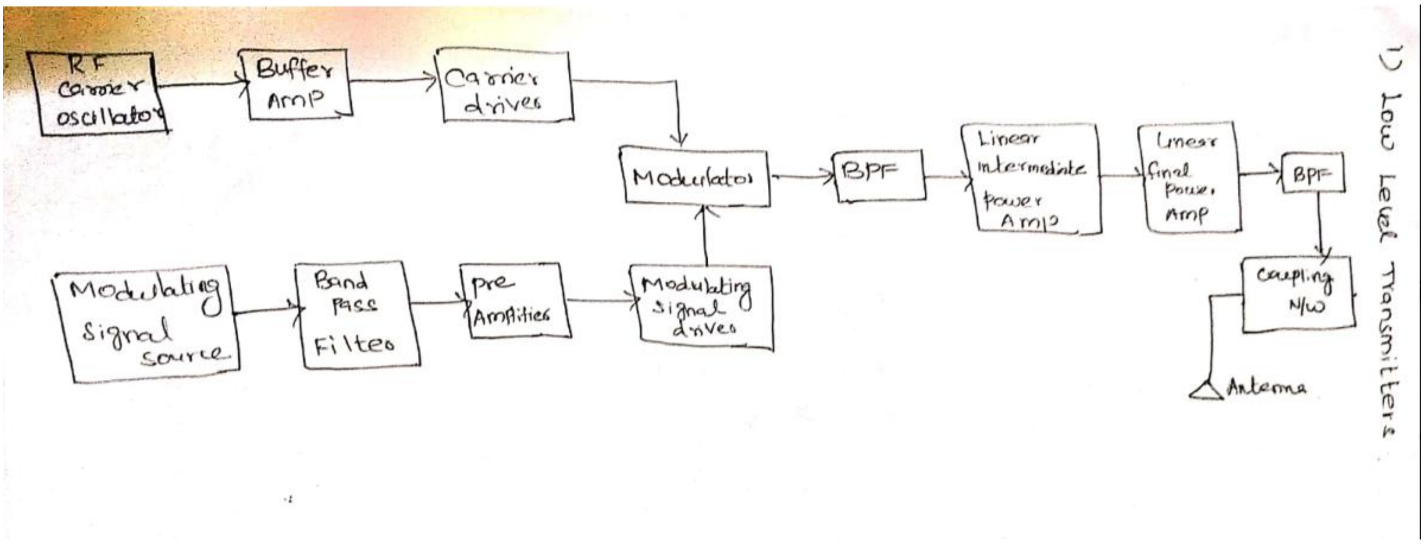
Processing gain=bandwidth/spectrum rate

=40/1.2

=33.33

PART-B

11.a.i)



Signal source:

Source of message signal is accoustical transducer i.e., microphone

Pre Amplifier:

Sensitive, class A amplifier with high input impedence

Used to raise the amplitude of the source signal into uasble level

Driver:

Non linear amplifier

Simply amplifies the signal to an adequate level

RF Carrier Oscillator:

Crystal Controlled Oscillator

Power Amplifier:

Low gain high impedence linear amplifier

Isolate oscillator from high power amplifier

Gives constant load to the oscillator

11.a.ii)An amplitude modulated signal is described through the following Specification V (peak)=120V V (peak)-60V .f-120MHz. f 100kHz.

Determine the modulation index, upper and lower sideband frequencies

SOLN:

V_c=120

V_m=60

F_c=120

F_m=100

$F_{lsb}= F_c- F_m$

=120-100

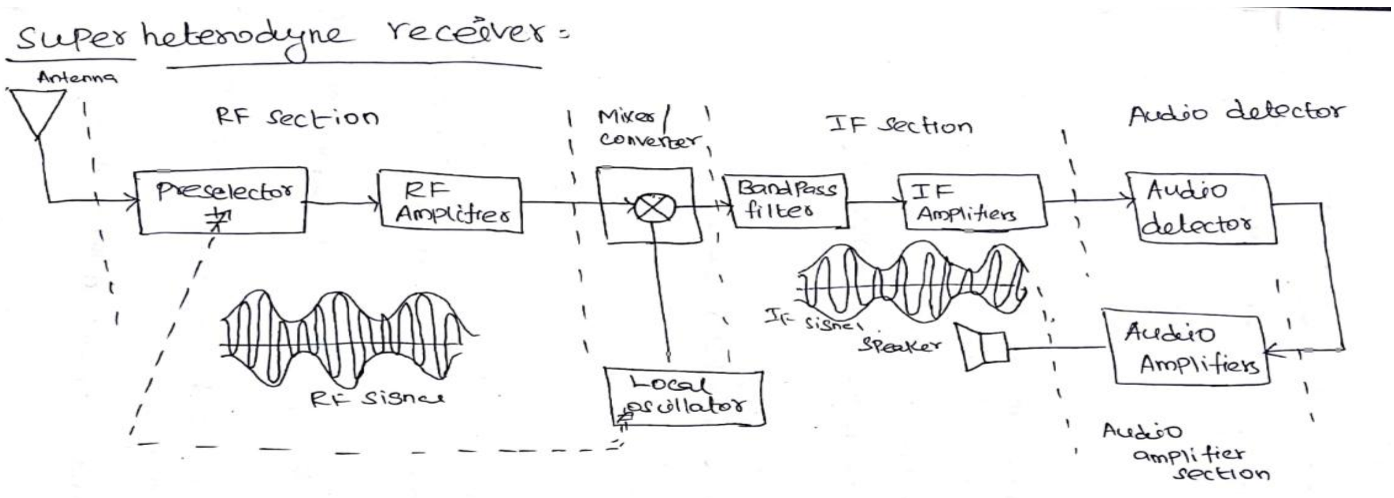
=20

$F_{usb}= F_c+ F_m$

=120+100

=220

11.b. i)



RF Section:

consist of preselector and an amplifier stage
preselector is a broad tuned bandpass filter with an adjustable center frequency

RF Amplifier:
Determines the sensitivity of the receiver
First active device identified by received signal
Advantages: greater gain, better sensitivity, improved SNR Ratio, better selectivity
Mixer:
Includes radio frequency oscillator stage and a mixer converter stage
Based on accuracy and stability desired, can use any one of oscillator
Converts **radio frequency into intermediate frequencies**
Common intermediate frequency in AM is 455KHz.
IF Section:
Most of gain and selectivity achieved in this stage
IF is always less than RF
Detector Section:
Convert the IF Signals bck to the original source
Also called as audio detector
Audio Amplifier section:
Consist of several amplifier

11.b) ii) Given

IF frequency of Superhet = 455 kHz

RF signal frequency = 1345 kHz

for high side injection f_{LO} is greater than f_{RF} by the amount f_{IF}. So, the local oscillator has to be tuned to

$$f_{LO} = f_{RF} + f_{IF}$$
$$= 1345 + 455 \text{ kHz}$$
$$= 1800 \text{ kHz}.$$

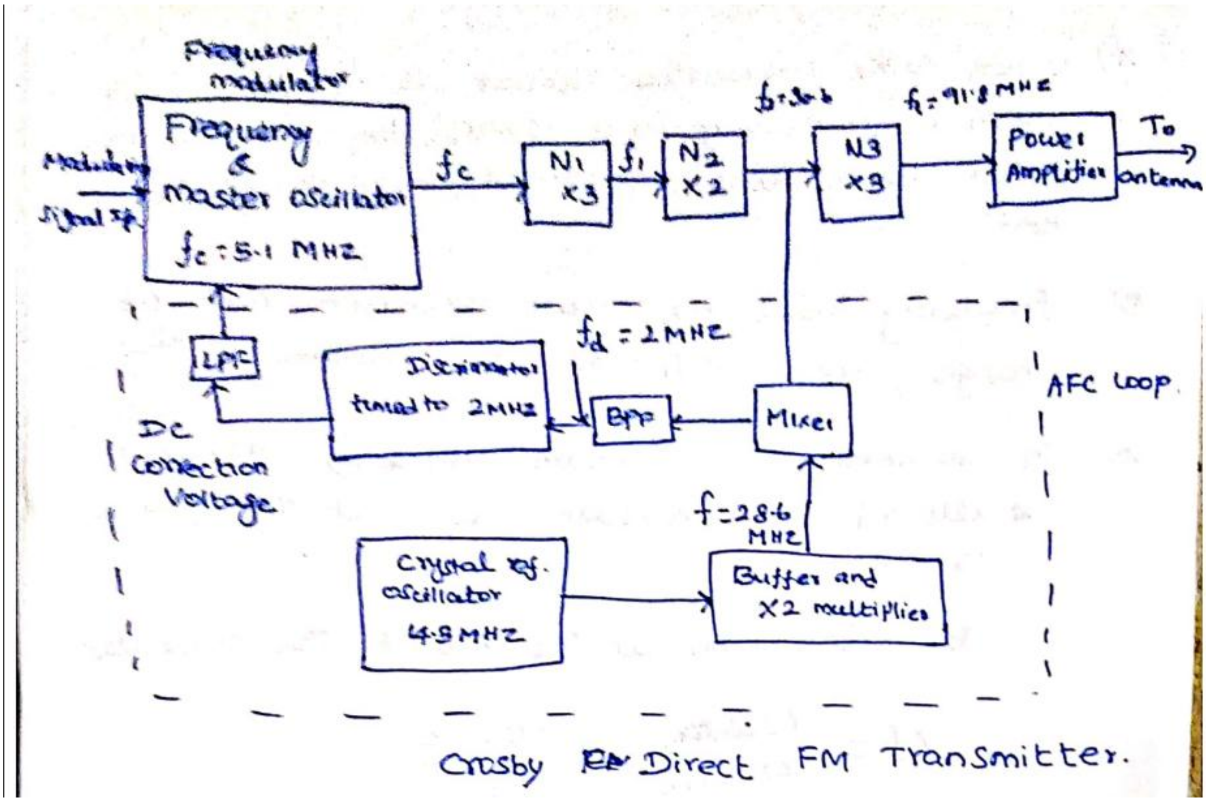
— 3 marks

For low side injection f_{LO} is less than f_{RF}

$$f_{LO} = f_{RF} - f_{IF}$$
$$= 1345 - 455 \text{ kHz}$$
$$= 890 \text{ kHz}.$$

— 3 marks

12.a.i) Crossby Direct FM Transmitter



The frequency modulator can be either reactance modulator or voltage controlled oscillator.

The carrier rest frequency is the unmodulated output frequency from the oscillator.

fc = 5.1MHz

The fc is multiplied by 18 in 3 steps and produce final transmit frequency

ft = 91.8 MHz

To achieve the maximum frequency deviation allowed FM broadcast band at the antenna **75KHz**

The deviation at the o/p of the modulator

$$\Delta f = \frac{\Delta f_{(max)}}{\Delta f_{(actual)}} = \frac{75\ KHz}{18}$$

$$= 4166.7\ Hz.$$

modulation index

$$m = \frac{\Delta f}{f_m}$$

For the maximum modulating signal frequency allowed $f_m = 15\ KHz$

$$m = \frac{4166.7}{15{,}000\ Hz} = 0.2778$$

modulation index at the antenna

$$m = 0.2778 \times (18)$$

$$= \underline{\underline{5}}$$

12.a.ii)For an FM modulator, the carrier signal amplitude is 10V. If the modulation index is 1 find the relative amplitudes of the carrier of 500kHz and the sideband frequency components. Consider the modulating signal frequency of 10kHz.

SOLN:

$\mu=1$

$\mu=v_m/v_c$

$1=v_m/10$

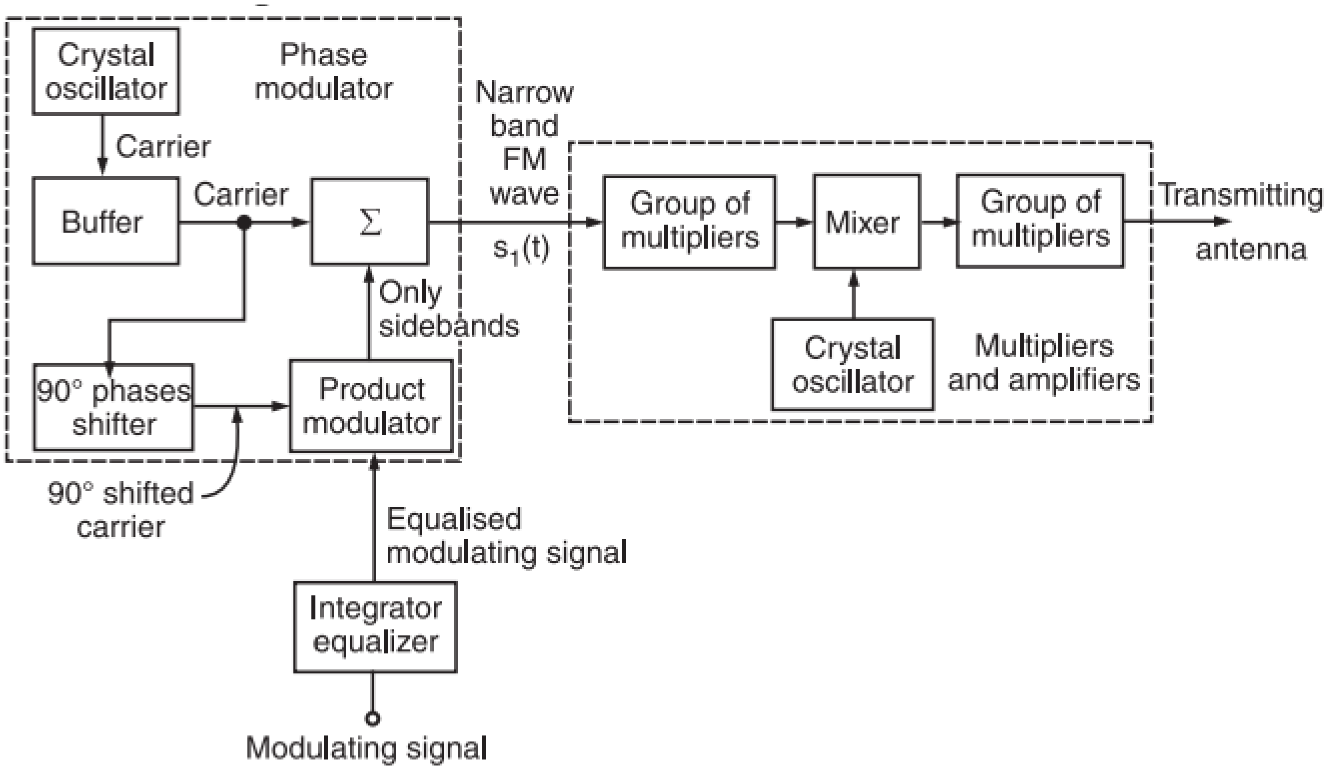
$V_m=10$

$F_{lsb}= V_m/2=10/2=5kHz$

$F_{usb}=5$ (as m=1, $F_{lsb}=F_{usb}$)

12.b.i)

Armstrong Indirect FM Transmitter:



The modulating signal x(t) is passed through an integrator before applying it to the phase modulator as shown in figure

Let the narrow band FM wave produced at the output of the phase modulator be represented by $s_1(t)$ i.e.,

$$s_1(t) = V_{c1}\cos [2\pi f_1 t + \phi_1(t)]$$

where V_{c1} is the amplitude and f_1 is the frequency of the carrier produced by the crystal oscillator.
The phase angle $\Phi_1(t)$ of $s_1(t)$ is related to x(t) as follows:

$$\phi_1(t) = 2\pi k_1 \int_0^t x(t)\, dt$$

where k_1 represents the frequency sensitivity of the modulator.
If $\Phi_1(t)$ is very small then,

$$\cos [\phi_1(t)] \cong 1 \quad \text{and} \quad \sin [\phi_1(t)] \cong \phi_1(t)$$

Hence, the approximate expression for $s_1(t)$ can be obtained as follows:

$$\begin{aligned} s_1(t) &= V_{c1} \cos [2\pi f_1 t + \phi_1(t)] \\ &= V_{c1} [\cos (2\pi f_1 t) \cos \phi_1(t) - \sin (2\pi f_1 t) \sin \phi_1(t)] \end{aligned}$$

After approximation, we get,

$$s_1(t) = V_{c1}\,[\cos(2\pi f_1 t) \times 1 - \phi_1(t)\sin(2\pi f_1 t)$$
$$s_1(t) = V_{c1}\cos(2\pi f_1 t) - V_{c1}\phi_1(t)\sin(2\pi f_1 t)$$

Substituting,

$$\phi_1(t) = 2\pi k_1 \int_0^t x(t)\,dt, \quad \text{we obtain}$$

$$s_1(t) = V_{c1}\cos(2\pi f_1 t) - 2\pi k_1 V_{c1}\sin(2\pi f_1 t)\int_0^t x(t)\,dt$$

This expression represents a narrow band FM. Thus, at the output of the phase modulator, we obtain a narrow band FM wave.

12.b.ii)Determine the modulation index and Carson's bandwidth for an FM signal

with a maximum frequency deviation Af=25kHz and a maximum

modulating signal m(max)=12.5kHz.

SOLN:

$\Delta f = mf_m$

25=m x 12.5

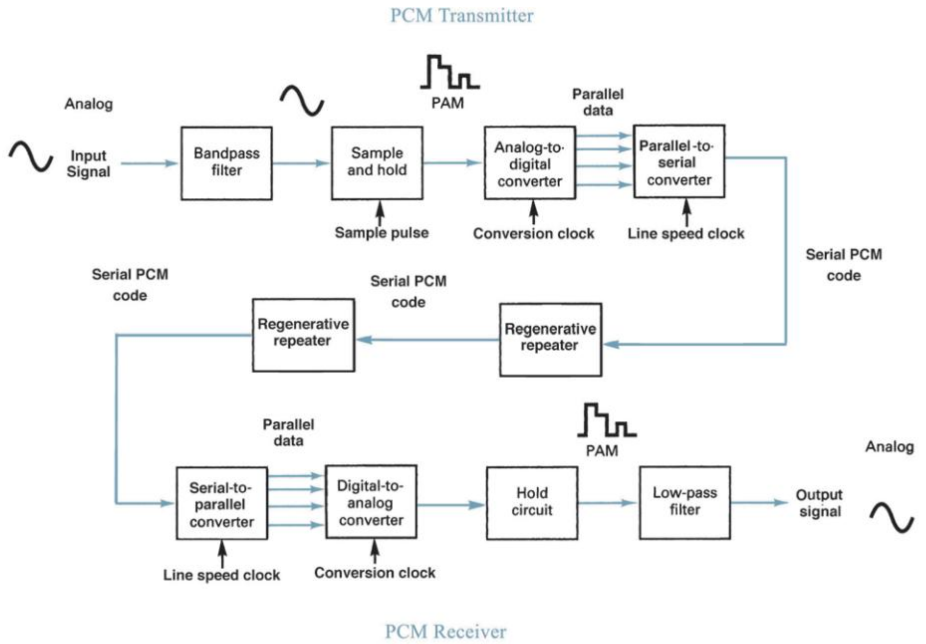
m=25/12.5=2

Carson’s bandwidth=2(f_m+f_c)

=2(25+12.5)

=75 Bps

13. a. i. Simplex PCM transmission



i) The bandpass filter limits the frequency of the analog input signal to the standard voice-band frequency range of 300 Hz to 3000 Hz.

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

iii) The analog-to-digital converter (ADC) converts the PAM samples to parallel PCM codes, which are converted to serial binary data in the parallel-to-serial converter and then outputted onto the transmission line as serial digital pulses

iv) In the receiver, the serial-to-parallel converter converts serial pulses received from the transmission line to parallel PCM codes.

v) The digital-to-analog converter (DAC) converts the parallel PCM codes to multilevel PAM signals

13.a.ii)

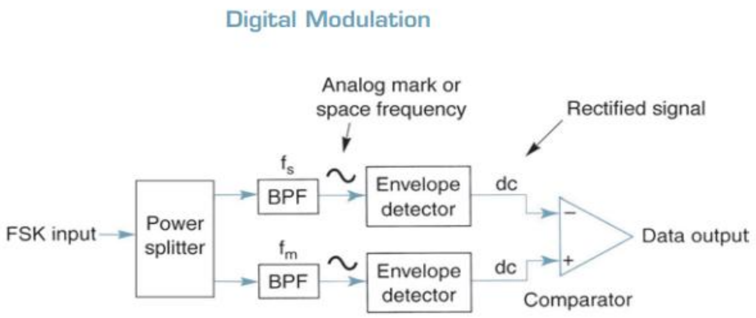


FIGURE 7 Noncoherent FSK demodulator

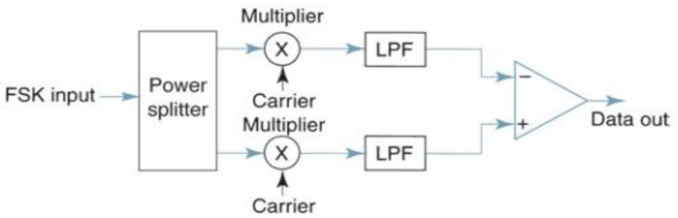


FIGURE 8 Coherent FSK demodulator

i) The FSK input signal is simultaneously applied to the inputs of both bandpass filters (BPFs) through a power splitter. The respective filter passes only the mark or only the space frequency on to its respective envelope detector. The envelope detectors, in turn, indicate the total power in each passband, and the comparator responds to the largest of the two powers. This type of FSK detection is referred to as noncoherent detection;

ii) The incoming FSK signal is multiplied by a recovered carrier signal that has the exact same frequency and phase as the transmitter reference. However, the two transmitted frequencies (the mark and space frequencies) are not generally continuous; it is not practical to reproduce a local reference that is coherent with both of them. Consequently, coherent FSK detection is seldom used.

13.b.i)

Pulse Code Modulation

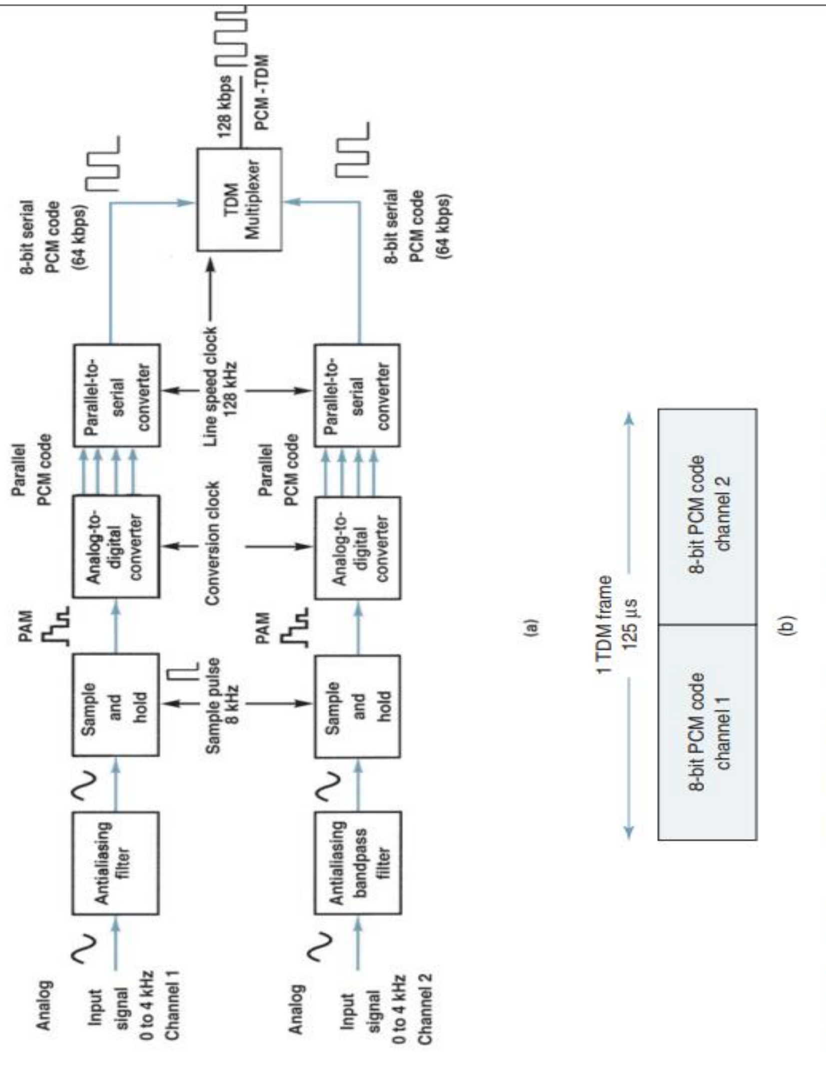


FIGURE 2 Two-channel PCM-TDM system: (a) block diagram; (b) TDM frame

i) With a T1 carrier system, D-type (digital) channel banks perform the sampling, encoding, and multiplexing of 24 voice-band channels

ii) Each channel contains an eight-bit PCM code and is sampled 8000 times a second.

iii) Each channel's sample is offset from the previous channel's sample by 1/24 of the total frame time.

iv) Therefore, one 64-kbps PCM-encoded sample is transmitted for each voice-band channel during each frame (a frame time of 1/8000 ———————————— 125 μs). The line speed is calculated as follows:

$$\frac{24\text{ channels}}{\text{frame}} \times \frac{8\text{ bits}}{\text{channel}} = 192\text{ bits per frame}$$

thus
$$\frac{192\text{ bits}}{\text{frame}} \times \frac{8000\text{ frames}}{\text{second}} = 1.536\text{ Mbps}$$

Later, an additional bit (called the *framing bit*) is added to each frame. The framing bit occurs once per frame (8000-bps rate) and is recovered in the receiver, where it is used to maintain frame and sample synchronization between the TDM transmitter and receiver. As a result, each frame contains 193 bits, and the line speed for a T1 digital carrier system is

$$\frac{193\text{ bits}}{\text{frame}} \times \frac{8000\text{ frames}}{\text{second}} = 1.544\text{ Mbps}$$

13.b.ii)

i) In a BPSK modulator, the carrier input signal is multiplied by the binary data. If +1 V is assigned to a logic 1 and -1 V is assigned to a logic 0, the input carrier (sin ωct) is multiplied by either a + or -1.

ii) Consequently, the output signal is either +1 sin ωct or -1 sin ωct; the first represents a signal that is in phase with the reference oscillator, the latter a signal that is 180° out of phase with the reference oscillator.

iii) The fundamental frequency (fa) of an alternative 1/0 bit sequence is equal to one-half of the bit rate (fb/2). Mathematically, the output of a BPSK modulator is proportional to

BPSK output = [sin(2πfat)] * [sin(2πfct)]

where f_a = maximum fundamental frequency of binary input (hertz)
f_c = reference carrier frequency (hertz)

Solving for the trig identity for the product of two sine functions,

$$\frac{1}{2}\cos[2\pi(f_c - f_a)t] - \frac{1}{2}\cos[2\pi(f_c + f_a)t]$$

Thus, the minimum double-sided Nyquist bandwidth (B) is

$$\begin{array}{r} f_c + f_a \\ -(f_c + f_a) \\ \hline \end{array} \quad \text{or} \quad \begin{array}{r} f_c + f_a \\ -f_c + f_a \\ \hline 2f_a \end{array}$$

and because $f_a = f_b/2$, where f_b = input bit rate,

$$B = \frac{2f_b}{2} = f_b$$

14. a. i)

VRC and LRC for the ASCII encoded message: THE CODE.
Use odd parity for VRC and even parity for LRC.

		T	H	E	space	C	O	D	E	LRC
Character		T	H	E	space	C	O	D	E	LRC
Hex		54	48	45	20	43	4F	44	45	
LSB	1	0	0	1	0	1	1	0	1	0
	2	0	0	0	0	1	1	0	0	0
	4	1	0	1	0	0	1	1	1	1
	8	0	1	0	0	0	1	0	0	0
MSB	1	1	0	0	0	0	0	0	0	1
	2	0	0	0	1	0	0	0	0	1
	4	1	1	1	0	1	1	1	1	1
parity bit (VRC)		0	1	0	0	0	0	1	0	0

∴ Answer:
VRC : 0 1 0 0 0 0 1 0 0
LRC : 0 0 1 0 1 1 1 0

VRC: 01000010

LRC: 00101110

14. a. ii)

ISDN Architecture

i) A common physical is defined to provide a standard interface connection. A single interface will be used for telephones, computer terminals, and video equipment. Therefore, various protocols are provided that allow the exchange of control information between the customer’s device and the ISDN network.

ii) There are three basic types of ISDN channels:
1. B channel: 64 kbps
2. D channel: 16 kbps or 64 kbps
3. H channel: 384 kbps (H0), 1536 kbps (H11), or 1920 kbps (H12)

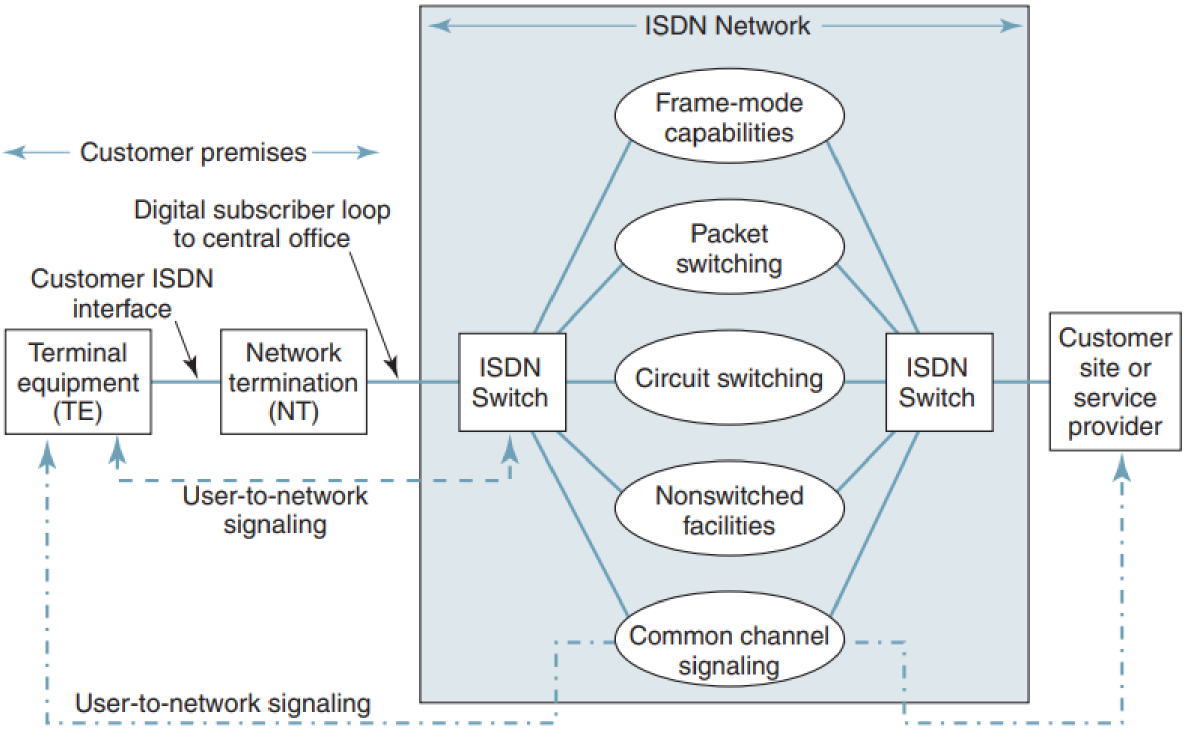


FIGURE 14 ISDN architecture

One B channel is used for digitally encoded voice and the other for applications such as data transmission, PCM-encoded digitized voice, and videotex.

The 2B + D service is sometimes called the basic rate interface (BRI).

The H channels are used to provide higher bit rates for special services such as fast facsimile, video, high-speed data, and high-quality audio.

There is another service called the primary service, primary access, or primary rate interface (PRI) that will provide multiple 64-kbps channels intended to be used by the higher-volume subscribers to the network.

14.b.i) Determine the block check sequence (BCS) for the following data and CRC

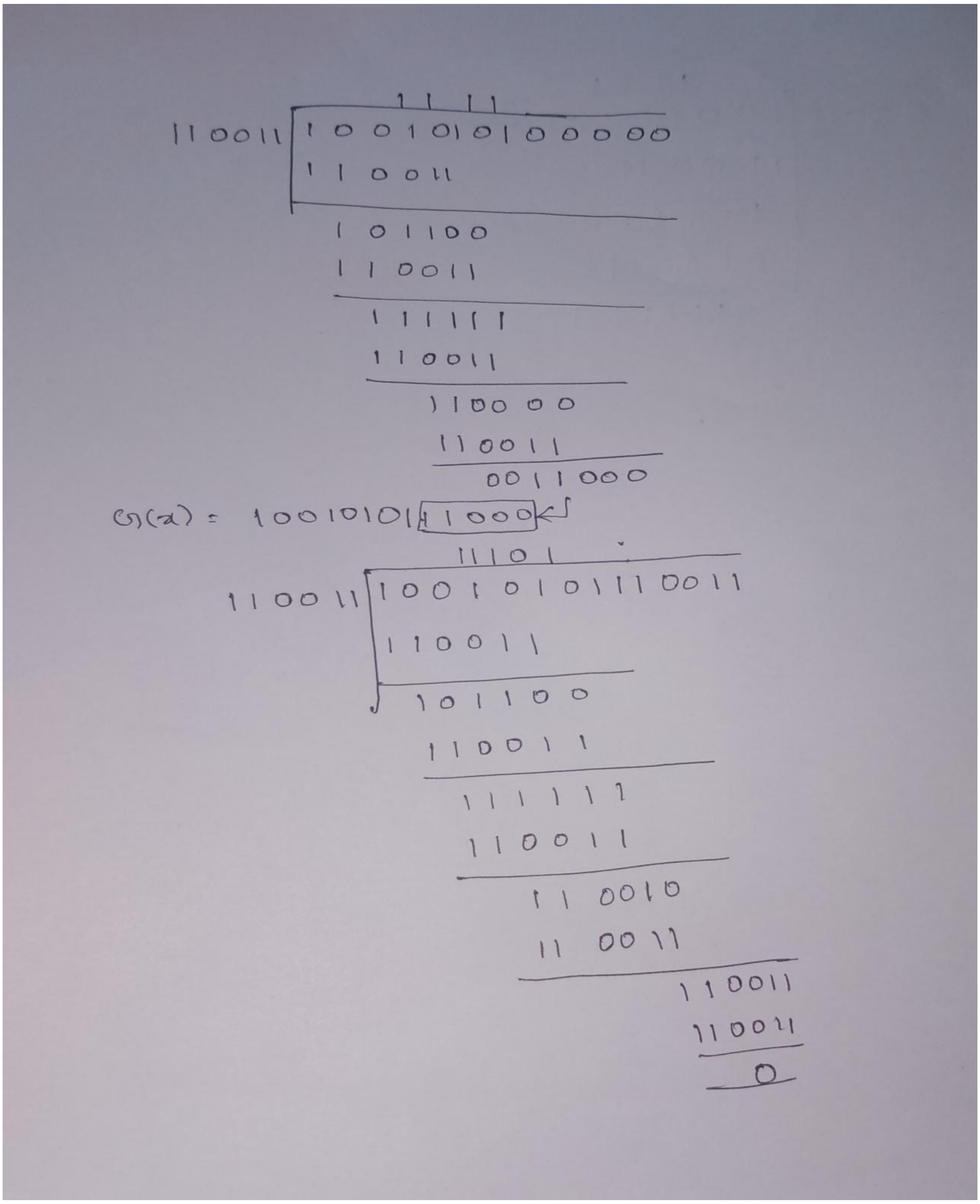
generating polynomials

$G(x) = x^2+x^4+x^2+x^0$

$=10010101$

$P(x) = x^5+x^4+x^1+x^0$

$=110011$



14. b. ii)

i)Voltage-leveling circuits convert the internal voltage levels from the DTE and DCE to RS-232 values.

ii)A voltage leveler is called a driver if it outputs signals onto the cable and a terminator if it accepts signals from the cable.

iii) In essence, a driver is a transmitter, and a terminator is a receiver

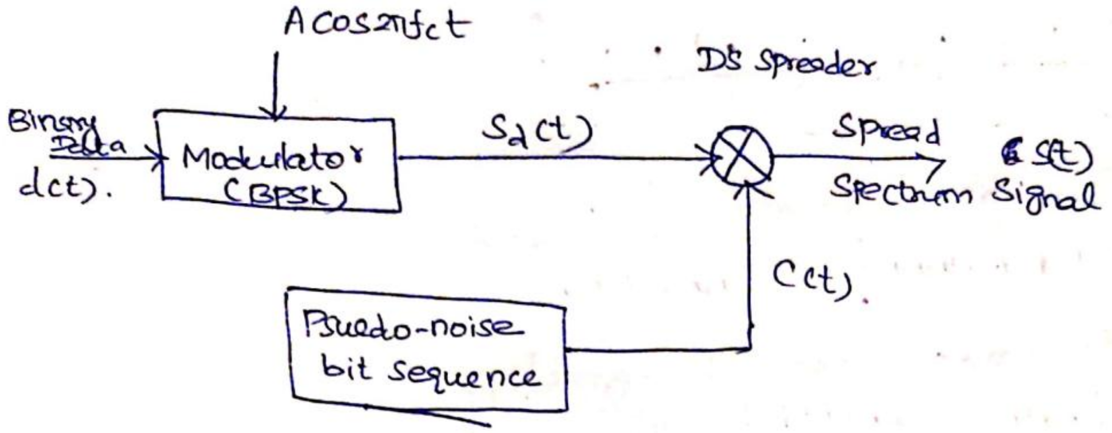
iv) The difference in the voltage levels between the driver output and the terminator input is called noise margin (NM).

v) The noise margin reduces the susceptibility to interface caused by noise transients induced into the cable.

vi) When the noise margin of a circuit is a high value, it is said to have high noise immunity, and when the noise margin is a low value, it has low noise immunity

15. a. i)

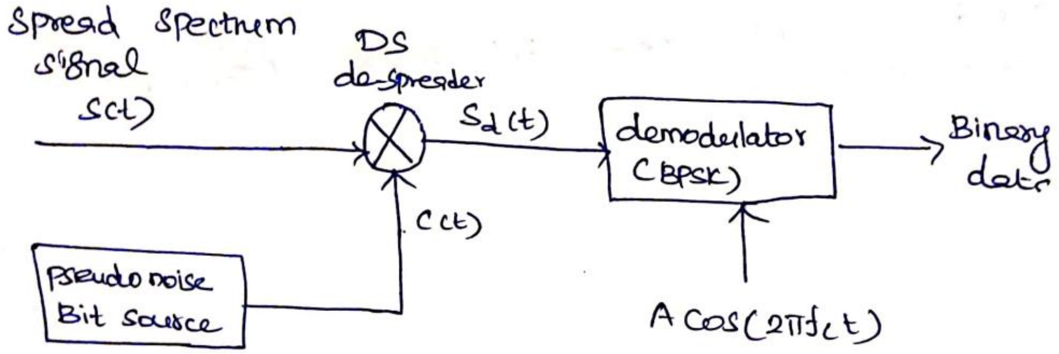
DS - BPSK Transmitter:



*) To Produce the DSSS signal, multiply the BPSK signal by c(t), which is the PN sequence taking on values of +1 and -1.

$$S(t) = A \cdot d(t)\, c(t) \cos(2\pi f_c t)$$

DS - BPSK Receiver



*) At the receiver, the incomming signal is multiplied by the modulato by $c(t)$.

The o/p is $= A \cdot d(t)\, c(t) \cos 2\pi f_c t \times c(t)$

$= A \cdot d(t)\, c^2(t) \cos 2\pi f_c t$

$= A \cdot d(t) \cos 2\pi f_c t. \qquad [\because c^2(t) = 1$

*) It performs de-spreading operation.

*) The o/p of product modulator is passed through BPSK ~~modulator~~ demodulator

15. a. ii)

Properties of PN sequences:

In order for PN sequences to be considered random they exhibit a number of randomness properties.

Balance Property:

In the balance property, the number of output binary ones and the number of binary output zeros in a single period differs by at most one.

Run Length Property:

A run is defined as a continuous sequence of the same type of binary digit. A new run commences with the appearance of a different binary digit. The length of a run is the number of digits contained in a given run. In PN sequences about half of the runs are of length 1, about a quarter of the runs are of length 2, about an eighth of the runs are of length three and so on.

15. b. i)

FHSS

Signal broadcast over seemingly random series of frequencies

• Receiver hops between frequencies in sync with transmitter

• Eavesdroppers hear unintelligible blips

• Jamming on one frequency affects only a few bits

Typically 2k carriers frequencies forming 2k channels

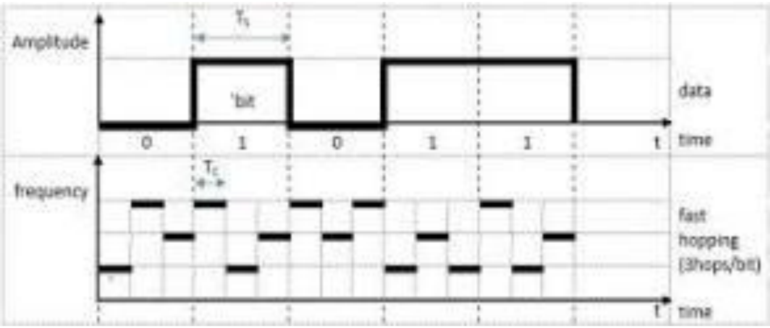
• Channel spacing corresponds with bandwidth of input

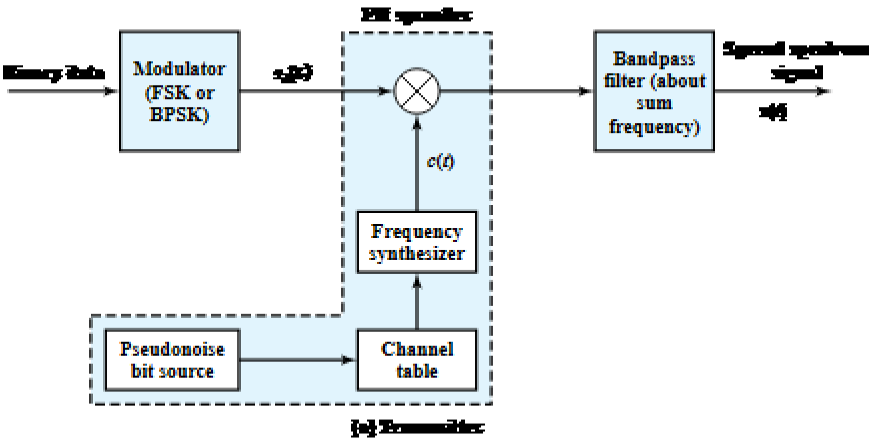
• Each channel used for fixed interval —300 ms in IEEE 802.11 —Some number of bits transmitted using some encoding scheme

• May be fractions of bit (see later) —Sequence dictated by spreading code

Slow and Fast FHSS

- Frequency shifted every Tc seconds
- Duration of signal element is Ts seconds
- Slow FHSS has Tc ≥ Ts
- Fast FHSS has Tc < Ts
- Generally fast FHSS gives improved performance in noise (or jamming)





15.a)ii.

Processing Gain

Fundamental issue in SS systems is how much protection spreading can provide against interference.

- SS technique distribute low dimensional signal into large dimensional signal space (hide the signal).
- Jammer has only one option; to jam the entire space with fixed total power or to jam portion of signal space with large power.

Consider set of orthonormal basis functions;

$$\varphi_k(t) = \begin{cases} \sqrt{\dfrac{2}{T_c}} \cos(2\Pi\, f_c t) & kT_c \le t \le (t+1)T_c \\ 0 & Otherwise \end{cases}$$

$$\widetilde{\varphi_k}(t) = \begin{cases} \sqrt{\dfrac{2}{T_c}} \sin(2\Pi\, f_c t) \;\; kT_c \le t \le (t+1)T_c \\ 0 \;\; Otherwise \qquad = 0,1 \dots \dots \dots \dots \dots N-1 \end{cases}$$

Where **T_c** is chip duration, **N** is number of chips per bit.

Transmitted signal x(t) for the interval of an information bit is

$$x(t) = c(t)s(t)$$

$$\varphi_k(t) = \pm \sqrt{\frac{2}{T_c}}\, \mathrm{c(t)cos}(2\Pi\, f_c t)$$

$$\varphi_k(t) = \pm \sqrt{\frac{E_b}{N}} \sum_{\mathrm{k=0}}^{\mathrm{N-1}} \mathrm{c_k \varphi_k\,(t)} \qquad 0 \le t \le T_b$$

where, Eb is signal energy per bit.

The average signal power at receiver input is E_b/T_b hence input SNR

$$(SNR)_i = \frac{E_b/T_b}{J}$$

$$(SNR)_0 = \frac{2T_b}{T_c}\,(SNR)_i$$

Expressing SNR in decibels

$$10log_{10}(SNR)_0 = 10log_{10}(SNR)_i + 3 + 10log_{10}(PG), dB$$

Where $PG = \frac{T_b}{T_c}$

3db term on right side accounts for gain in SNR due to coherent detection. Last term accounts for gain in SNR by use of spread spectrum. **PG is called Processing Gain.**