Principles of Communication

ASSIGNMENT No. 5

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CLASS : D10A
ROLL NO : 62

PCOM Assignment 5

Question 1.

What is Multiplexing in communication systems ?

Answer :

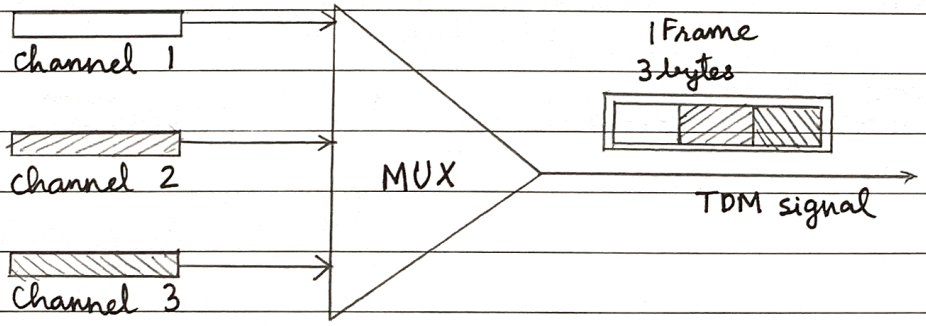
Multiplexing is the process of simultaneously transmitting two or more individual signals over a single communication channel. Due to multiplexing it is possible to increase the number of communication channels so that more information can be transmitted.

Question 2.

Define TDM. Draw the block diagram of a TDM system and explain each block.

Answer :

TDM is the multiplexing technique in which many signals are sent in a sequential manner but they occupy the same band in the frequency spectrum.



Block diagram of TDM system.

The data flow of each channel is divided into units. Then one unit from each source is taken and combined to form one frame. The size of each unit such used can be 1 bit or more. For 3 inputs being multiplexed, a frame of TDM will consist of 3 units. Similarly for n number of inputs, each TDM frame will consist of n units.

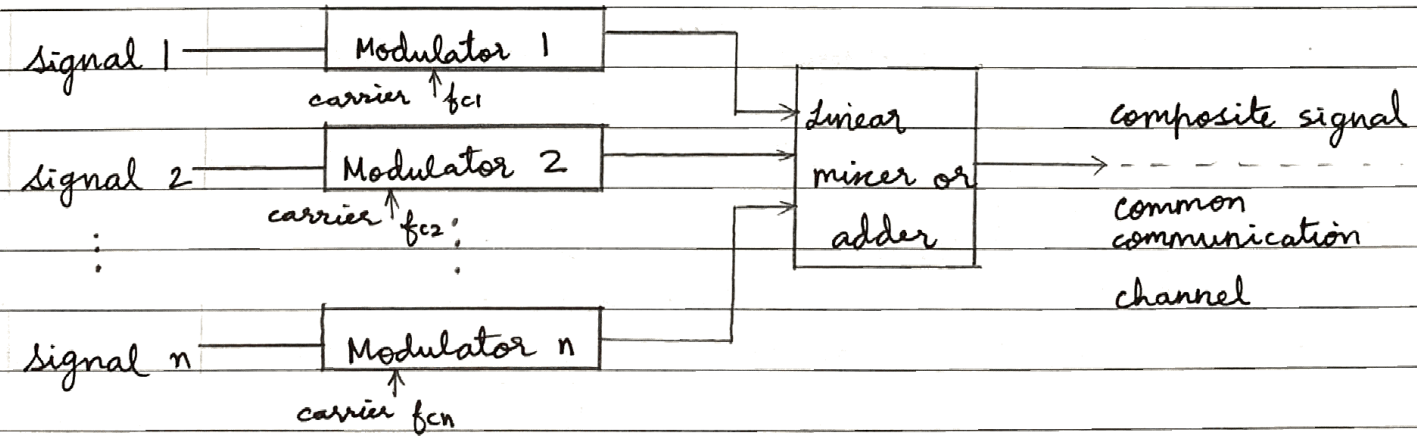
Question 3.

Explain the concept of FDM. Draw and explain block diagram of FDM system. Draw the spectrum of FDM signal.

Answer:

FDM is the multiplexing technique in which many signals are sent simultaneously in time domain but are separated from each other in frequency domain.

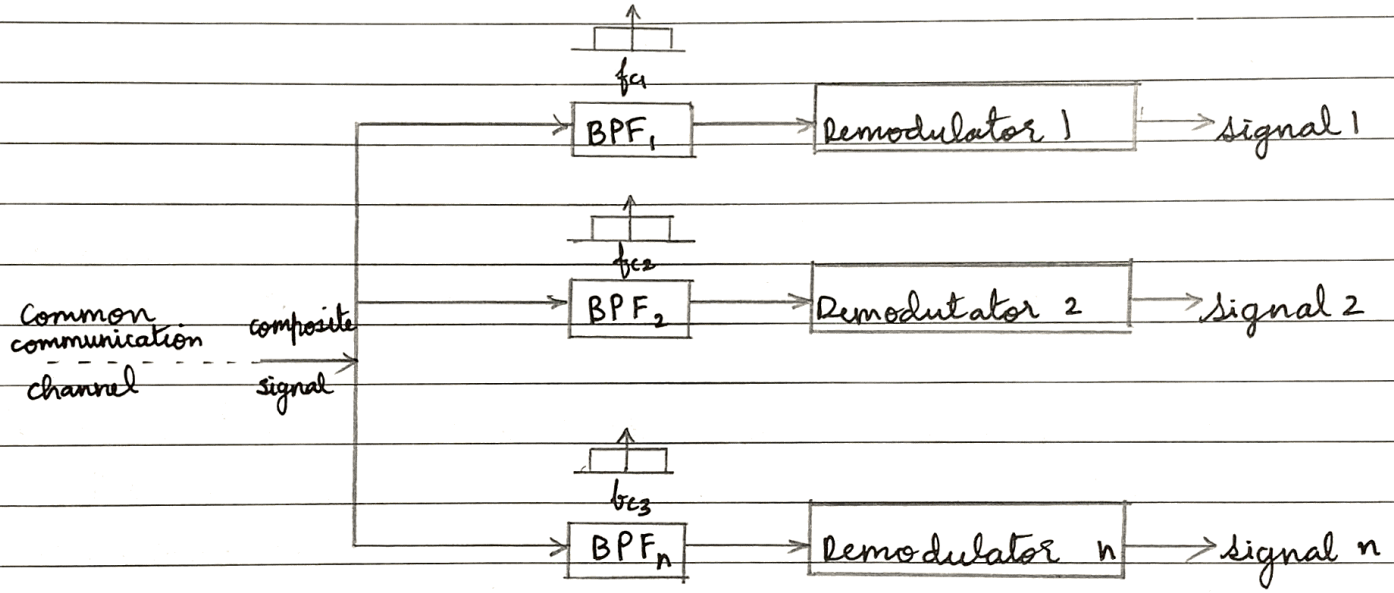
FDM Transmitter:



Block diagram of FDM transmitter

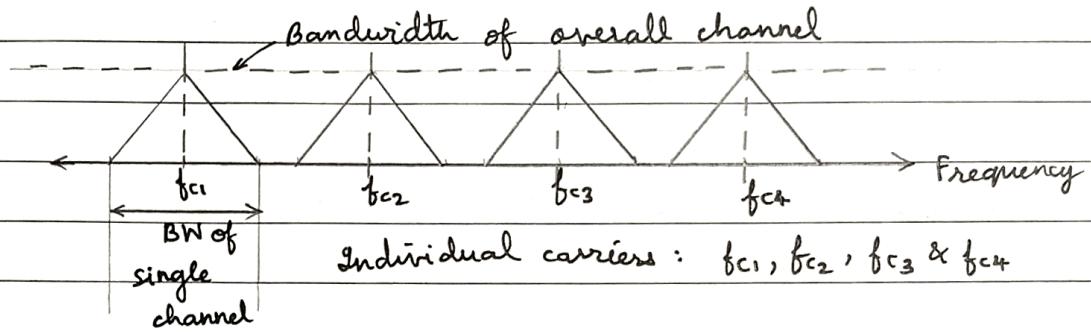
Operation : Each signal modulates a separate carrier. The modulator outputs, containing sidebands of corresponding signal, are added together in a linear mixer or adder, in which only the algebraic addition of modulated outputs takeplace. The composite signal at the output of mixer is transmitted over the single communication channel.

FDM Receiver



Block diagram of FDM receiver

Operation : The composite signal is applied to a group of band pass filters (BPF). Each BPF has a center frequency corresponding to one of the carriers. The BPFs have an adequate bandwidth to pass all the channel information without any distortion. Each filter will pass through only its channel and reject all other channels. The channel demodulator then removes the caerrier and recovers the original signal back.



Spectrum of FDM signal

Question 4.

Compare TDM and FDM.

Answer:

FDM	TDM
i) The signal to be multiplexed are in time domain but occupy different frequency domains.	i) The signals to be multiplexed can occupy entire bandwidth but are isolated in time domain.
ii) Preferred for analog signals.	ii) Preferred for digital signals
iii) Synchronization not required	iii) Synchronization is required.
iv) Requires complex circuitry	iv) Circuitry is not very complex.
v) Suffers from problem of crosstalk.	v) Problem of crosstalk is not severe.

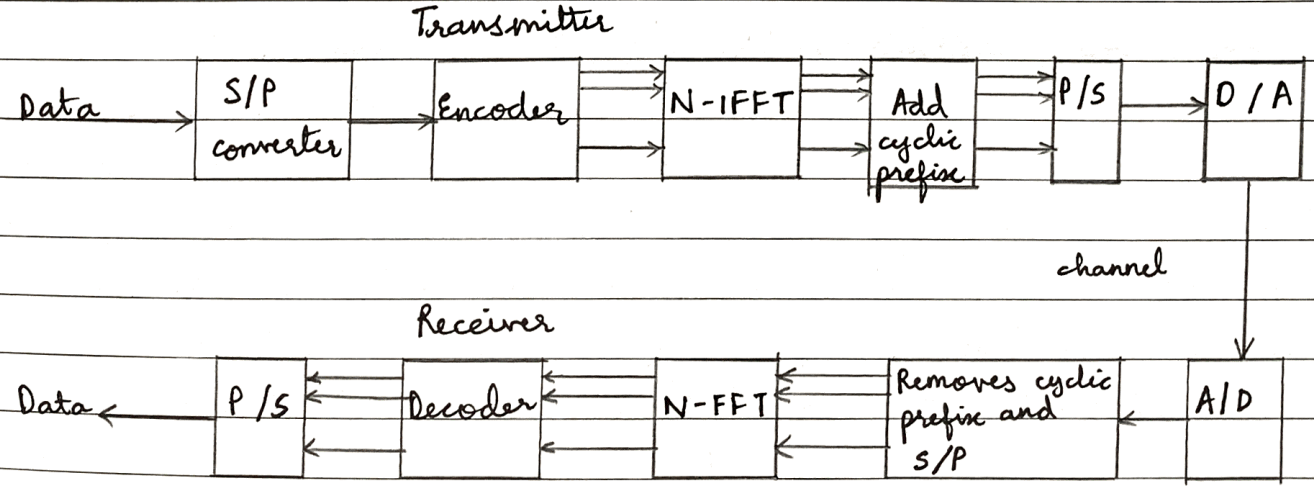
vi) Due to wide band fading, all channels are affected.	vi) Due to fading, only a few channels are affected.
vii) Due to slow narrowband fading only a single channel is affected.	vii) Due to slow narrowband fading, all channels may get wiped out.

Question 5.

Explain the concept of OFDM. Draw block diagram of OFDM transmitter and receiver and explain each block.

Answer:

OFDM stands for Orthogonal Frequency Division Modulation. It is a technique in which bandwidth is divided into several orthogonal frequency sub-carriers. It can be used for high speed video and audio communication without any inter symbol interference. (ISI).

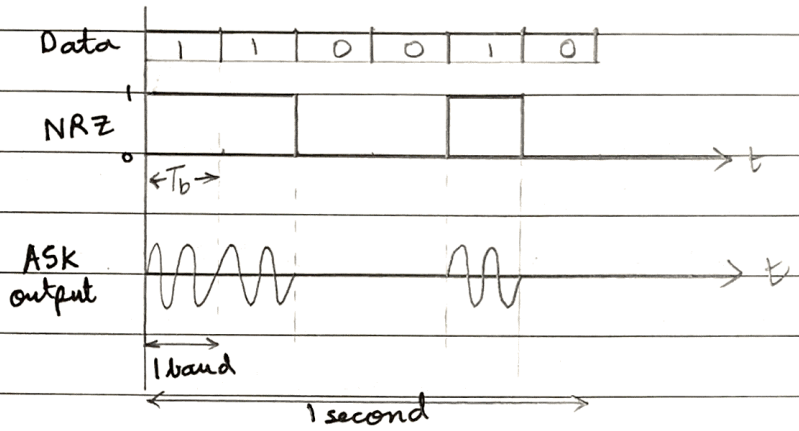


Block diagram of OFDM transmitter & receiver

Serial to parallel conversion : The input data is made compatible for transmission by converting it into suitable word size and then transmitting it parallely using carrier for each word.
Modulator : Each carrier to be used is allotted with the data whose amplitude and phase are chosen according to the modulation scheme used.
IFFT : IFFT on transmitter and FFT on receiver's side are used to reduce the use of I/Q modulators. They are used for modulation & demodulation respectively.
Cyclic prefix: Since the bandwidth is broken into N sub-carriers, the symbol rate is N times lower than normal. This makes OFDM naturally resistant to ISI caused by multipath propagation. Cyclic prefix makes signal periodic & discards the guard interval at the receiver.
The receiver basically does the reverse operation to the transmitter to retrieve the information signal.

Question 6.
What is ASK? Explain with the help of suitable waveforms.

Answer:
ASK or Amplitude Shift Keying is the digital carrier modulation in which the amplitude of the sinusoidal carrier will take one of the two predetermined values in response to 0 or 1 value of digital input signal. ASK is the simplest type of digital CW modulation.



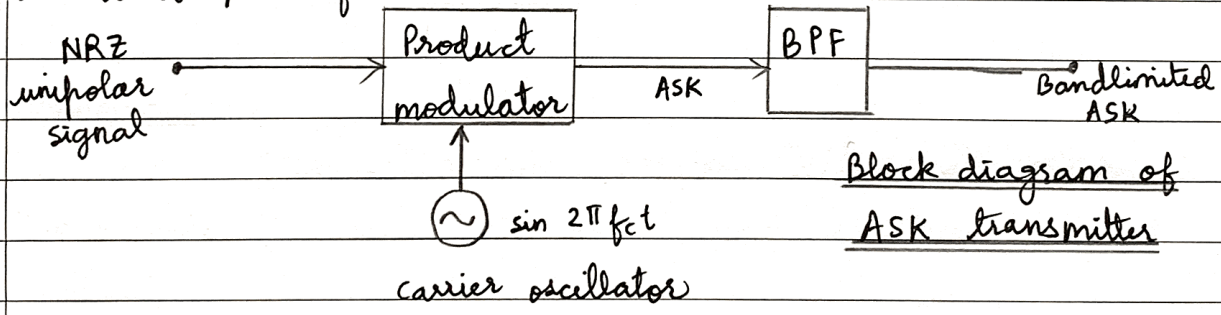
ASK waveforms

Question 7.

Explain ASK transmitter and receiver with neat block diagram. Draw the frequency spectrum.

Answer:

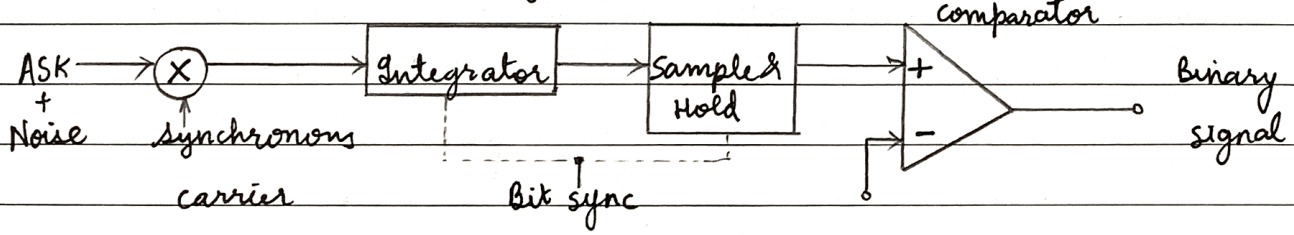
ASK transmitter: It is nothing but a multiplier followed by a band pass filter.



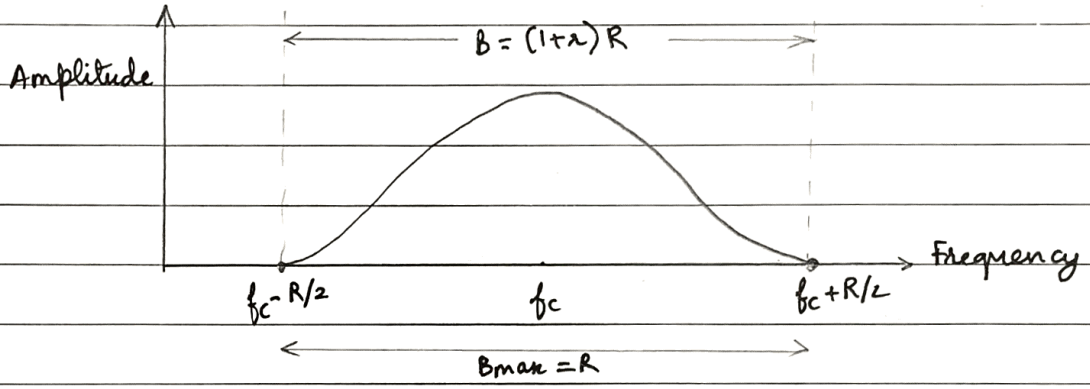
Block diagram of ASK transmitter

ASK Receiver:

Block diagram of ASK Receiver



Operation: The ASK signal along with noise is also applied to the multiplier, whose output is then applied to an integrator which is integrated over one bit duration T_b. Its output is sampled at a particular instant and this sampled value is held by the sample & hold circuit. This value is compared with reference voltage V by a comparator. If S/H output is less than V the output is 0, otherwise it is 1. Thus the original signal is recovered.



Frequency spectrum of an ASK signal

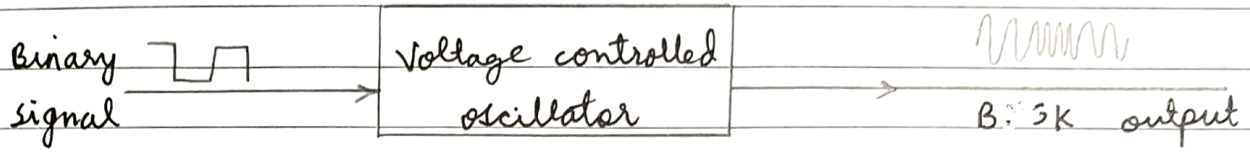
Question 8.

Explain FSK transmitter and receiver with neat block diagram. Draw the frequency spectrum / power spectrum.

Answer:

FSK is a digital modulation system in which, the frequency of a sinusoidal carrier is shifted between two discrete values in responses to the value of the digital input signal.

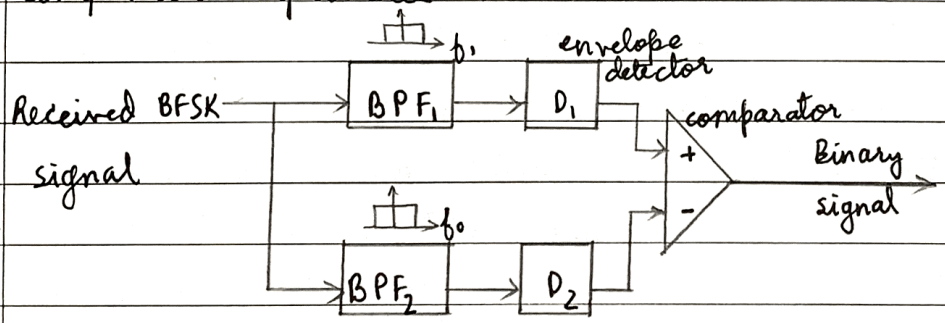
FSK Transmitter:



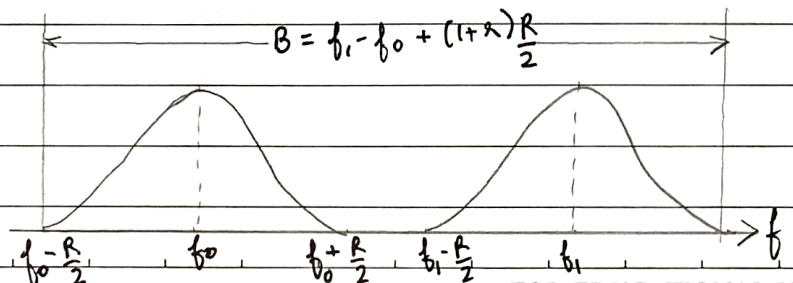
Block diagram of FSK transmitter

An FSK generator is basically a voltage controlled oscillator which produce sinewaves at frequencies f_1 and f_0 respectively. Corresponding to binary 0 input, the VCO produces a sinewave of frequency f_0 & for binary 1 input it produces a sinewave of frequency f_1. Thus we obtain the binary FSK at the output of VCO.

FSK Receiver: It consists of 2 band pass filters one for each of the frequency f_0 and f_1. The envelope detectors are simple diode detectors which rectify and filter their inputs, to generate a dc voltage proportional to the ac input. Suppose binary 1 is received, D_1 will pass the signal & D_2 will produce output as zero & hence comparator produces 1.



Block diagram of FSK receiver



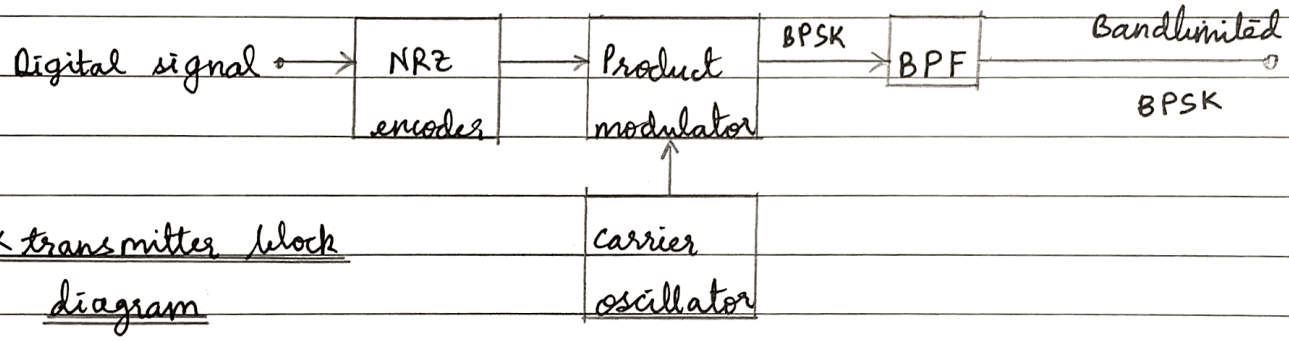
Frequency spectrum of FSK signal

Question 9.

Explain PSK transmitter and receiver with neat block diagram. Draw the power spectrum.

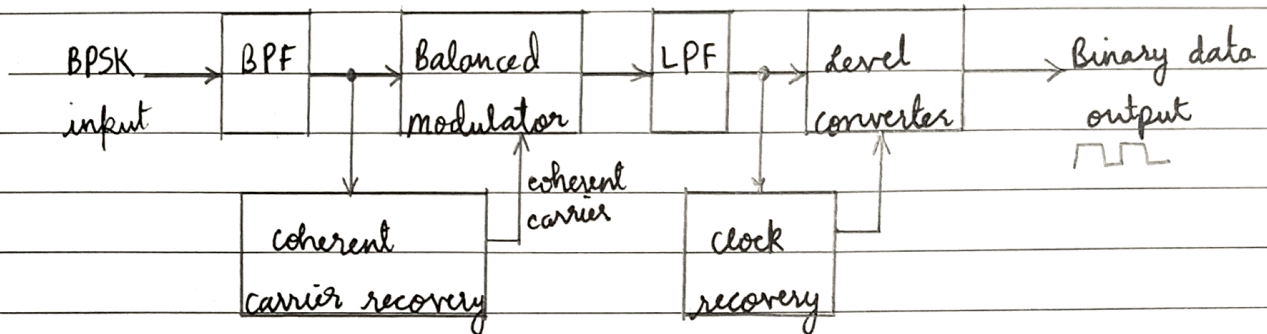
Answer:

PSK transmitter: The binary data signal is converted into a NRZ bipolar signal by an NRZ encoder, which is then applied to a multiplier. The other input to the multiplier is the carrier signal.

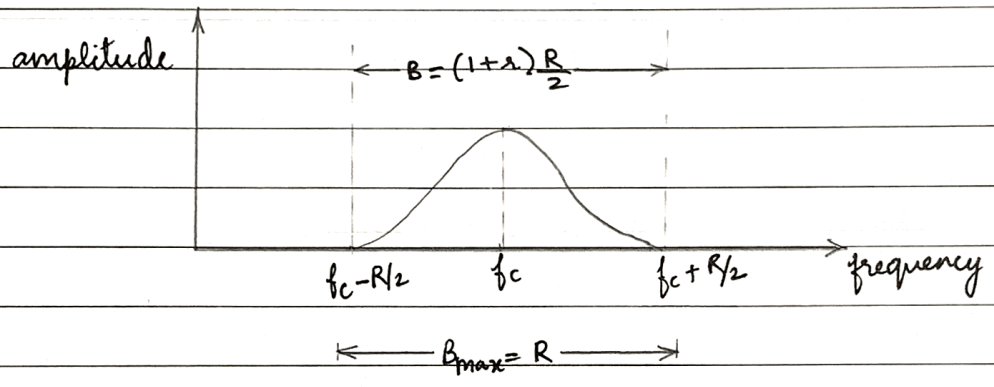


PSK transmitter block diagram

PSK Receiver: The coherent recovery circuit detects and regenerates the carrier signal, which has same frequency as the carrier at transmitter. The filtered PSK along with the regenerated carrier is applied to a balanced modulator which acts as product detector. Its output is passed through LPF which allows only the second harmonic term to pass through and blocks the dc component. The LPF output is applied to the level detector and clock recovery circuit. The output of level detector is $\pm \frac{V}{2}$ (0 or 1). Thus the binary signal is obtained at the output.



Block diagram of BPSK receiver



Spectrum of PSK/BPSK signal

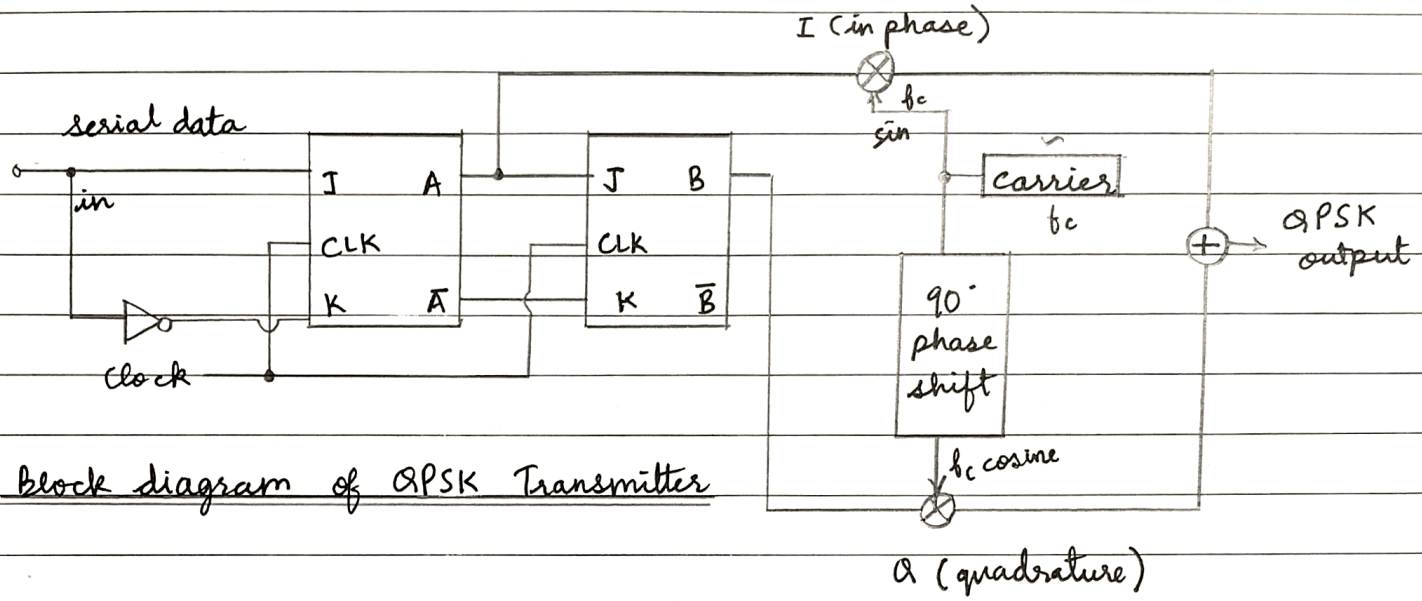
Question 10.

Explain QPSK transmitter and receiver with neat block diagram and waveform. Draw the power spectrum.

Answer:

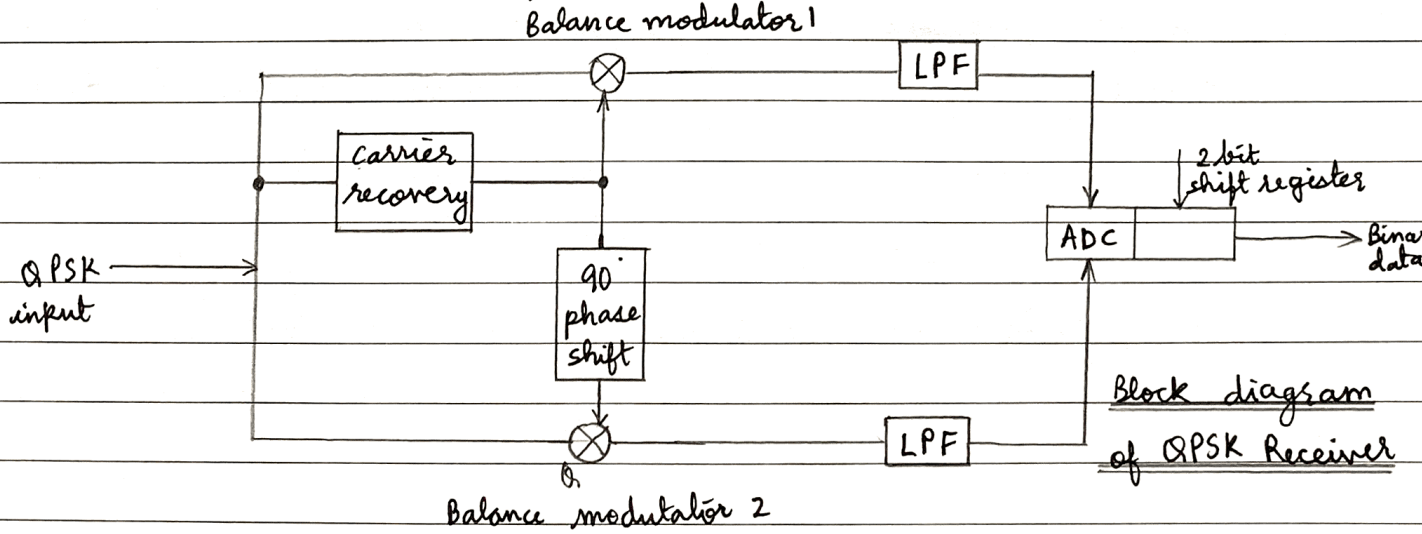
QPSK Transmitter: The input serial data stream is sampled as an entire character by a 2 bit shift register and converted to a parallel output signal by a clock pulse. The output of Most significant bit register of the bit splitter is channel to I modulator. The Least significant bit of the register is directed to Q-modulator. The output of each modulated (I and Q) is a BPSK signal where there is no phase shift for '0' &

180° phase shift for bit '1'. The output of modulators are linearly added to produce QPSK signal.



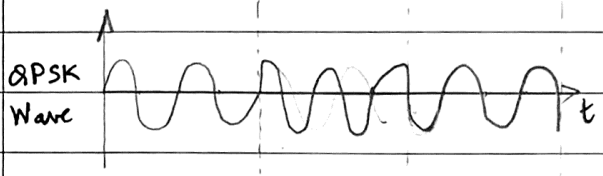
Block diagram of QPSK Transmitter

QPSK Receiver : It consists of carrier recovery circuit that senses the carrier frequency and suppress it to balance modulator I and after 90° phase shift to the other balance modulator. The output of two modulators is filtered and then analog information is converted into digital two bit data i.e. dibit. The dibits combine in a shift register & shifted out to produce the original data.

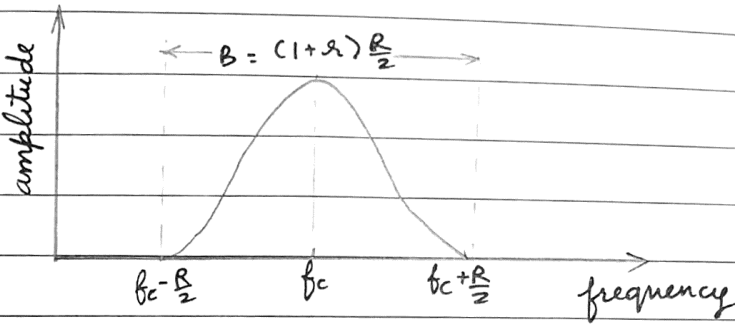


Block diagram of QPSK Receiver

Data	00	01	10
Phase shift	0°	90°	180°



Waveform of QPSK



Spectrum of QPSK signal

Question 11.

Compare ASK, PSK, FSK.

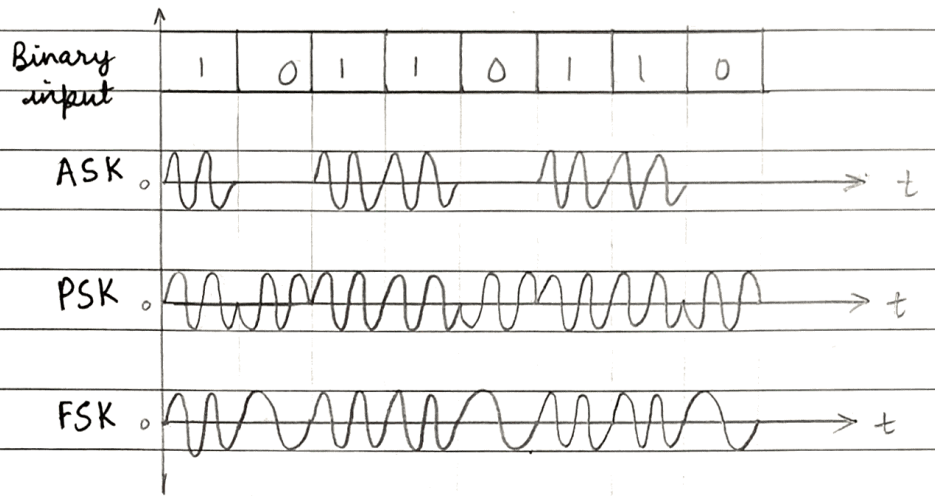
Answer:

Parameter	ASK	FSK	PSK
i) Variable characteristic	Amplitude	Frequency	Phase
ii) Bandwidth (Hz)	2R	$(f_1 - f_0) + (1+r)R$	$(1+r)R$
iii) Noise immunity	Low	High	High
iv) Error probability	High	Low	Low
v) Complexity	Simple	Moderately complex	Very complex
vi) Bit rate	Upto 100 bits/sec.	Upto 1200 bits/sec	Very high bit rates
vii) Detection method	Envelope	Envelope	Coherent

Question 12.

Draw the ASK, PSK and FSK waveforms for digital data: 10110110.

Answer:

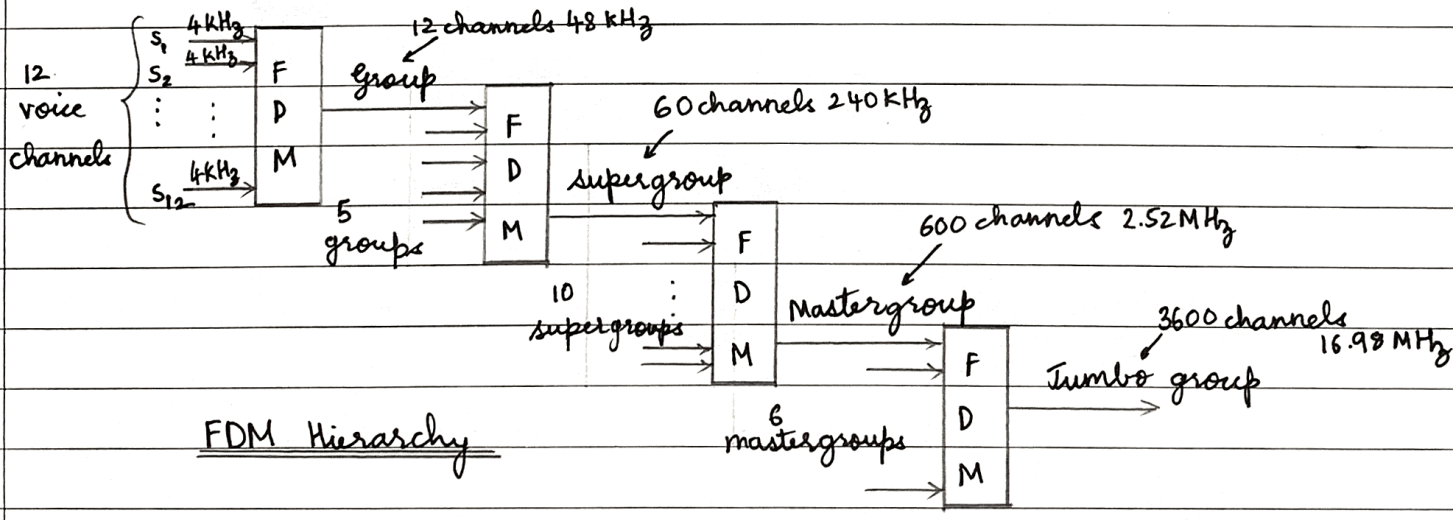


Question 13.

Describe the multiplexing hierarchy for an FDM system.

Answer:

In FDM Hierarchy different levels of the multiplexer are shown in a combined manner. The various levels are shown below:



FDM Hierarchy

Level 1 denotes the basic group in which 12 voice channels are multiplexed together. Level 2 is the supergroup in which 5 basic groups are multiplexed together and as each group has 12 channels hence we have 60 voice channels. Level 3 is the master group

in which 10 supergroups are mixed together and have up to 600 voice channels. Level 4 denotes jumbo group which has 6 multiplexed master groups and up to 3600 voice channels.