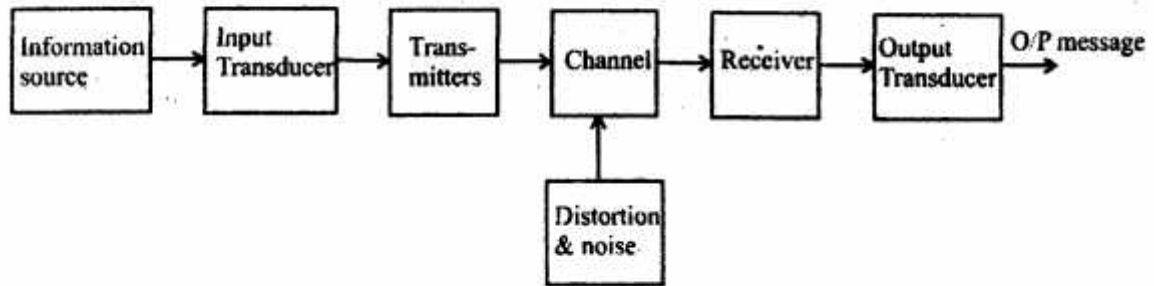# B. E.

Third Semester Examination, May-2009

DIGITAL AND ANALOG COMMUNICATION

Note : Attempt any five questions.

Q. 1. (a) Draw the basic block diagram of communication system.

Ans. Block Diagram of Communication System :

Block Diagram

Q. 1. (b) Write the properties of Fourier series.

Ans. Properties of fourier transform (series) :

1. Linearity (superposition) property :

$$F[a_1g_1(t)+a_2g_2(t)] \leftrightarrow a_1G_2(f)+a_2G_2(f)$$

2. Time shifting property :

If
$$F[g(t)] \leftrightarrow G(f)$$

Then
$$g(t-t_0) \leftrightarrow G(f)e^{-j\omega t_0}$$

3. Frequency shifting property :

If
$$F[g(t)] = G(f)$$

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Then,
$$g(t)e^{j\omega_0 t} \leftrightarrow G(f - f_0)$$

4. Scaling property :

If
$$F[g(t)] \leftrightarrow G[f]$$

Then
$$F[g(at)] \leftrightarrow \frac{1}{|a|}G(f/a)$$

5. Duality property :

If
$$F[g(t)] \leftrightarrow G(f)$$

Then
$$F[G(t)] \leftrightarrow g(-f)$$

6. Time reversal property :

If $F[g(t)] \rightarrow G(f)$ then $F[g(-t)] \rightarrow G(-f)$

7. Time differentiation property :

If $F[g(t)] \rightarrow G(f)$ then $F[g'(t)] \rightarrow j2\pi f G(f)$

8. Frequency Differentiation property :

If $F[g(t)] = G(f)$ then $F[-j2\pi g(t)] \leftrightarrow \dfrac{dG(f)}{df}$

Q. 2. (a) Explain the definition, mathematical expression and application for Rayleigh's criterion.

Ans. Parseval's Theorem : (Rayleigh Energy Theorem)

Parseval' energy theorem gives a mathematical techniques to find out the energy of a signal in frequency demain by using Fourier transform. When we know the fourier transform of a signal, its energy can be calculated without connecting into time domain

$$E = \int_{-\infty}^{+\infty} |G(f)|^2 df \qquad \qquad ...(1.1)$$

Proof : As we know that energy of a signal in time domain,

$$E = \int_{-\infty}^{+\infty} |g(t)|^2 \, dt \qquad \qquad ...(1.2)$$

$$= \int_{-\infty}^{+\infty} |g(t) \cdot g(t)| \, dt \qquad \qquad ...(1.3)$$

As we know from inverse fourier transform

$$g(t) = \int_{-\infty}^{+\infty} G(f) e^{-j\omega t} \, df \qquad \qquad ...(1.4)$$

By putting value of $g(t)$ in above equation,

$$E = \int_{-\infty}^{+\infty} |g(t)| \left\{ \int_{-\infty}^{+\infty} G(f) e^{j\omega t} \, df \right\} dt \qquad \qquad ...(1.5)$$

By interchanging the order of integration,

$$E = \int_{-\infty}^{+\infty} |G(f)| \, df \int_{-\infty}^{+\infty} g(f) e^{j\omega t} \, dt \qquad \qquad ...(1.6)$$

By the concept of complex conjugate

$$\int_{-\infty}^{+\infty} g(t) e^{j\omega t} \, dt = G^*(f) \implies G(-f) \qquad \qquad ...(1.7)$$

Where $G^*(f)$ is the complex conjugate of $G(f)$.

By putting equation (1.7) in (1.6)

$$E = \int_{-\infty}^{+\infty} |G(f) \cdot G^*(t)| \, df \qquad \qquad ...(1.8)$$

$$E = \int_{-\infty}^{+\infty} |G(f)|^2 \, df \qquad \qquad ...(1.9)$$

Equation (1.9) is called Parseval's energy theorem for energy signla. It is also called Rayleigh is energy theorem.

Rayleigh's energy theorem tells that by the information of magnitude spectrum of signal, we can find the energy of that signal.

Q. 2. (b) What is the effect of limited band width on analog and digital signals? How this limitation can be overcome?

Ans. Effect of limited bandwidth :

In comm. theory, B.W. is very important parameter. Because, the speed, rate of information, capacity of channel, signal to noise ratio, all depend upon the bandwidth. Even number of channel accomodated in a given area. Coverage area also depends upon the bandwidth. There are many definition of B.W., based on type of B.W. B.W. of a signal is simply range of frequency that is used for transmission.

Systems B.W. is defined as range of frequency over which gain of system is constant, generally this term is used for amplifier, oscillator etc.

B.W. is defined in rate of information terms also, the max., rate of information, that can be pass through a channel called channel capacity or channel B.W.

So, it is reasoanble to expert that the frequency range (B.W.) required for a given transmission should depend upon the B.W. occupied by the modulation signals themselves. A Hi-Fi audio signals requires a range of 50Hz to 15 kHz but a B.W. of 300 Hz to 3.4 KHz is adequate for a telephone conversation.

Q. 3. (a) Explain the process used for AM generation.

Ans. Method for AM generation :

Non-linear modulator circuits (square law modulator) :

Any device like $_t{}^r$, diode, operating in its output character. Stics is capable to produce AM signals, if a modulating signal and carrier signal is fed to its input. Such non-linear circuits can be used as square law modulator and the output of square law modulator is given by the power series.
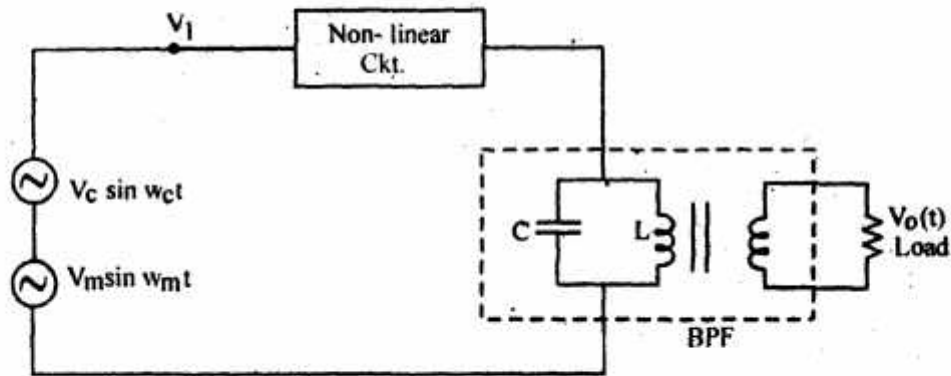
Let the output voltage across the load is V(t) then

$$V(t) = k_0 + k_1 v_1 + k_2 v_1^2 + k_3 v_1^3 + ... + \qquad \qquad ...(1)$$

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Where k_0, k_1 & k_2 are constants and v_1 is the input voltage to the device, by considering the non-linear circuit.

$$v_1(t) = v_c \sin \omega_c t + v_m \sin \omega_m t \qquad \text{...(2)}$$

Putting the value of $v_1(t)$ in equation (1)

$$V(t) = k_0 + k_1(v_c \sin \omega_c t + v_m \sin \omega_m t) + k_2 \qquad \text{...(2)}$$

$$= k_0 + k_1 v_c \sin \omega_c t + k_1 v_m \sin \omega_m t + k_2 v_c^2 \sin^2 \omega_c t + k_2^2 v_n^2 \sin \omega_m t \qquad \text{...(3)}$$

$$+ k_2 v_m \{\cos(\omega_c - \omega_m)t - \cos(\omega_c + \omega_m)t\} \qquad \text{...(4)}$$

The last term of equation (4) represent lower and upper sideband while term $k_1 v_c \sin \omega_c t$ is the carrier component. If we pass equation (4) th'a filter, AM wave can be obtained.

By passing equation (4) th' a BPF which rejects the higher (unwanted term).

$$v(t) - k_1 v_c \sin \omega_c t + k_2 v_m \{\cos(\omega_c - \omega_m)t - \cos(\omega_c + \omega_m)t\} \qquad \text{...(5)}$$

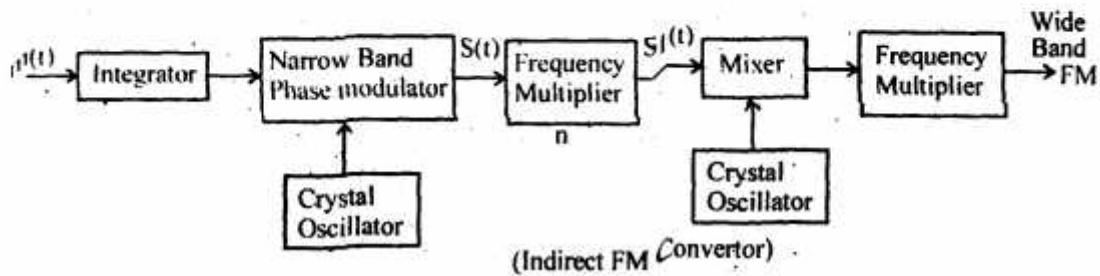which is the required modulated wave.

Q. 3. (b) Explain the process used for FM generation.

Ans. Process for FM generation :

Indirect method of FM generation (Armstrong method) :

This method is proposed by scientist Armstrong. In this method, first we produce the NBFM and then generate the desired frequency using frequency multimeter.

A simple block diagram is shown in fig.

(Indirect FM Convertor)

In the fig., s(t) will be NBFM wave while $s_1(t)$ will be FM wave with $f_c = nf_{c_1}$ and $\beta = \eta\beta_1$. So, by choosing proper value of η we may get FM of desired modulation index.

$$S_{FM}(t) = A_C \cos[2\pi n f_c t + \eta\beta_1 \sin 2\pi f_m t].$$

Q. 4. (a) Compare twisted pair cable with co-axial cables.

Ans. Twisted pair cable :

Consist of two conductors, each with its our plastic insulation, twisted together as shown in fig. (1).

One of the wires is used to carry signals to the receiver and the other is used only as a ground reference.

· The receiver uses a diff., between the two levels.

Coaxial cable :

Carries signal of higher frequency ranges than twisted pair cable, in part because the two media are constructed quite differently. Instead of having two wires, coase has a central core conductor of solid a stranded wire enclosed in an insulating sheath, which is in turn, encases in an outer conductor of metal foil, brad, or a combination of the two. The outer metallic wrappings serves both as a sheild against noise and as second conductor, which completes the circuit. This outer conductor is also enclosed in an insulating sheath, and whole cable is provited by a plastic cover.
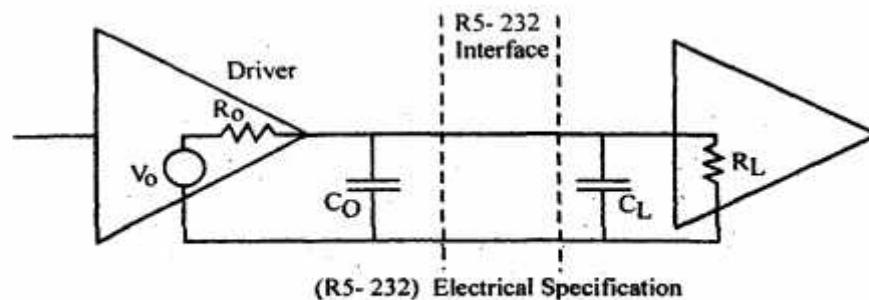
Q. 4. (b) Explain RS 232.

Ans. RS-232 :

The RS-232 interface specifies a 25-wire cable with a DB2SP/DB25S compatible connector. Fig. (1) shows the electrical characterstics of RS-232 interface. The terminal load capacitance of the cable is specified as 2500 Pf, which include cable capacitance. The impedance at the terminating end must be between 3000Ω and 7000Ω and the output impedance is specified as greater than 300Ω. With these electrical specifications anjd for a maximum bit rate of 20,000 bps, the nominal max., length of RS-232 interface is appox. 50 ft.

Although, the RS-232 interface is simply a cable and two connectors, the standard also specifies limitation on the voltage level that the DTE & DCE an output onto or receive from the cable. In both the DTE & DCE, there are circuits that convert their internal logic levels to RS-232 values.

For e.g., a DTE uses TTL logic and is interfaced to a DCE that uses ECL logic; they are not compatible. Voltage levelling circuit converts the internal voltage value of DTE & DCE to RS-232 values.

(R5- 232) Electrical Specification

(RS-232) electrical specification
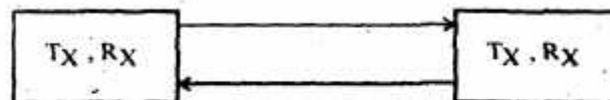
Q. 5. Write short notes on :

(a) Full duplex communication mode.

(b) Unrestricted simplex protocol.

(c) Virtual circuits.

Ans. Full duplex communication mode :

In full duplex mode, the data transmission is possible in both sides at the same time. For example, telephone communication, cell phone communication. But one condition is that both the transmitting and receiving station is connected to each other by physical link or wireless link.

Whenever your friend is an cell phone, he/she can response you immediately, there is no need to wait until your talk will be finish.

Q. 6. (a) Explain PSTN.

Ans. PSTN : is a highly integrated comm. n/w that connects over 70% of the worlds population. In 2001, the ITU estimated that there were 1 billion public landlines telephones no., as compared to 600 million cellular telephone no.'s.

In India, in 2005, the growth of using landline telephone number was 100% than year 2004.

Each country is responsible for the regulation of PSTN within the borders, some government telephone systems have become privatized by corporations which provide local and long distance service for profit.

In India, a single government department known as posts & telegraph (P&T) deptt. deal with mail, telegraph & telecommunication untill the end of 1984, with effect from Jan., 1985, the responsibility was divided between two departments, the department of post dealing with the mail and the department of telecomm., DOT dealing with telephone, telegraph and data communications. BSNL, MTNL is working under DOT, nation wide in 2002, govt. give the license to some of the private companies to provide the landline services, but they are bounded by the govt. rules like airtel, reliance etc.

With a number of different agencies in providing telecommunication services, there is clearly is a need to ensure compatability on a worldwide scale to enable internetworking.

Q. 6. (b) Compare and contrast TDM with FDM.

Ans. Comparison of TDM with FDM :

The involves simpier instrumentation, FDM requires an analog subcarrier modulator, bandpass filter and demodulator for every message signal. channel, all of which are replaced by the TDM commutator and decommulator switching circuits and TDM synchronization is more demanding that of suppressed carrier FDM.

Secondly, TDM is invulnerable to the usual causes of crosstalk in FDM, namely imperfect band pass filtering and non-linear cross modulation. However TDM cross-talk immunity depends upon the transmission B.W. and the absence of delay distortion.

Thirdly, the use of sub-multiplexer allows a TDM system to accomodate different signals where B.W. or pulse rates may differ by more than an order of magnitude.

This flexibility has particular value of multiplexing digital signals. Finally TDM may or magnet be advantageous when the transmission medium is subject to fading. Rapid wideband fading might strike only occasional pulses is a given TDM channel, whereas all FDM channels would be affected. But slow narrowband fading wipes out all the TDM channels, where as it might hurt only one FDM channel.

Q. 7. (a) Compare feed back system with feed forward system.

Ans. Error detection is a process of monitoring the transmission and reception. Error detection only determine the received data is corrupted but at which position data bit is corrupted and which data bit is corrupted, it cannot notify by error detection technique.

The purpose of error detection is not to prevent errors from occuring but to prevent undetected errors from occuring. If errors are detected, a mechanism is need to obtain a copy of the connect information. To achieve this following approaches used.

Forward error control :

It is the technique in which each transmitted character or frame contains additional information so that receiver cannot only detect when errors are present but also determine where in the received bit streams, the errors are. the connect data is obtained by inverting these bits.

Feedback error control :

It is the technique in which the each character (bit) or frame of message includes only sufficient additional information to enable the receiver to detect, when errors are present but not their location. A retransmission control scheme is used to request that another hopefully connect copy of information is to be sent.

Feedback error control is the predominant method over forward error control.

Q. 7. (b) What is data encryption? Explain any two methods.

Ans. Dat encryption :

Is a very important steps involved in data communication for information security.

Secret key method of encryption/decyption :

In this method, the transmitter and receiver both uses the same key algorithms for encryption and decreption resp. Key algorithm used for both in the inverse to each other; which means if transmitter uses division and subtraction to encode the data then receiver uses the addition and multiplication to decode the data. This is also names as symmetric key algorithms because same key algorithm is used for bidirectional communication.

Secret key algorithms are more useful if the secret key is used only one.

Public key encryption/decryption :

In this method, there are two keys, one is called private key and anothyer is public key. In this technique at one end public key may be used to encrypt the message and private key is used to decrypt the message.

For both key, algorithm is different and private key is used for individual and public key is available for all. The most common public key algorithm is RSA algorithm. RSA stands for (Rivest, Shamir, Adeleman) after invention this algorithm.

Q. 8. Write short notes on :

(a) Huffman Encoding

(b) Error detection

(c) Frame check sequences.

It is a dat compression techniquei which is based on statistical concept and uses the property in a frame sequence some character occurs more frequently and some character very rarely. So, instread of using a fixed number of bits per character, we use a different encoding scheme in which the most common character are enocded using fewer bits than less frequent character.

In this technique, firstly the character string to be transmitted is analyzed and the character types and their relative frequency determined.

Actually transmitter transmitts the data on the basis of probailiyt.

Let us suppose we transmitts a sentence.

"I am an Indian." Now, it is not necessary transmitter transmitts the above sentence in a given sequence.

There is a possibility that transmitter first transmitts the word Indian than am then I then an.

It depends upon probaility of each letter. The letter which is occur more frequently have less probability, so given more performance which rarely occur have higher probability gives lowest preference.

Information is related matheamtically with probability as follows :

$$I = -\log P(x)$$

or $$= \log \frac{1}{P(x)}.$$

(b) Error detection :

It is a process of mountoring the transmission and reception. Error detection only determine the received data is concepted but at which position data bit is corrupted and which data bit is corrupted, it cannot notify by error detection techniques.

The purpose of error detection is not to prevent errors from occuring but to prevent undetected errors from occuring.

The performance of a system when received data bit is corrupted, it varies system to system.

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To ensure that information received by a destination has high probability of being same as that transmitted by the transmitter. There must be same way for the receiver to deduce, to a high probability, when received information contains errors.

(c) Frame check sequences :

In parity check method, we have seen that if more than one bit is corrupted in data then it become very difficult to detect the error. Cyclic Check Redundancy (CRC) or frame check sequence (FCS) is somehow, one of the best method to detect the burst error in data. Instead of addition of bits as in parity, CRC is based on binary division method.

So, in CRC techniques to get the desired parity bits, a sequence of redundant bits called CRC or the CRC remainder is added to the end of the data unit so that the resulting data unit becomes axactly divisible by a second, predetermined binary number.

At receiver end, received data is devided by same divisor and if remainder is zero, it means data is connect and accepted but if remainder is not zero, it means data is corrupted and then data is discarded.