Multiplexing

1. Four analog signals is to be multiplexed and transmitted over a telephone channel that has a frequency band from 400Hz to 3100Hz. Each of the analog baseband signal is bandlimited to 500 Hz. Design a communication system (block diagram) that will allow the transmission of these four sources over the telephone channel using

   (a) Frequency-division multiplexing with SSB subcarriers.

   (b) Time-division multiplexing using PCM

   (Show the block diagrams of the complete system, including the transmission, channel, and reception portions. Include the bandwidths of the signals at the various points in the systems)

2. Twenty-four voice signals are to be multiplexed and transmitted over twisted pair. What is the bandwidth required for FDM? Assuming a bandwidth efficiency of 1bps/Hz, what is the bandwidth required for TDM using PCM?

3. Draw a block diagram for a TDM PCM system that will accommodate four 300-bps, synchronous, digital inputs and one analog input with a bandwidth of 500 Hz. Assume that the analog samples will be encoded into 4-bit PCM words.

Solution

1. a

   $f_{sc1} = 400$ Hz, $f_{sc2} = 1100$ Hz, $f_{sc3} = 1800$ Hz and $f_{sc4} = 2500$ Hz

   b

   Nyquist rate for each signal is 1000 Samples/s. Use two-level encoder for encoding.

   Multiplexed data rate is 4000 bps and the required minimum transmission bandwidth is 2000 Hz.

2. Assuming SSB is used. The minimum bandwidth is 24 x 4 kHz = 96 kHz. The data rate is 96 kbps.

3. Nyquist rate of the analog signal is 1000 samples / sec and the output data rate of the encoder is 4000 bps. Pulse stuffing is then used to increase the data rate to 4200 bps. 14-bit buffer is used for the analog source and 1-bit buffers are used for the digital sources.