Lecture-7
SDe

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Quantization error

The value of the error for any sample is less than $\Delta/2$.

i.e., $-\Delta/2 < \text{error} \leq +\Delta/2$

$$SNR_{dB} = 6.02\,nb + 1.76\ dB$$

SNR_{dB} ↓ signal to noise ratio

nb ↓ no. of bits in one sample (bit rate)

Q.) A telephone subscriber line must have an SNR_{dB} above 40. What is the min. no. of bits per sample?

$$SNR_{dB} = 6.02\,nb + 1.76 = 40$$
$$\Rightarrow nb = (40 - 1.76)/6.02$$
$$= 6.35$$

* Telephone companies usually assign 7 to 8 bits per sample.

Sampling rates:

$f_s = 4f$ (2 times the Nyquist rate, 4 times the max frequency)
→ oversampling, almost same as Nyquist rate sampling

$f_s = 2f$ (at Nyquist rate, sampling is the best)

$f_s = f$ (at half the Nyquist rate, sampling output is not quite sinusoidal.)

* Telephone companies digitizes voice by assuming max frequency of 4000 Hz. The sampling rate is therefore 8000 samples per second.

Q. Low pass signal has bandwidth = 200 kHz. Find minimum sampling rate.

Bandwidth of low pass signal goes from 0 to f where f = max frequency of the signal.

So we can sample this signal at 2 times the highest frequency (200 Hz). So sampling rate = 400,000 samples per second.

Bit rate = sampling rate × number of bits per sample

Bit rate = $f_s \times nb$

Q. Digitize human voice assuming ~~sampling rate of~~ 8 bits per sample. Find bit rate.

Normally human voice contains frequency from 0 to 4000Hz.

f_s = sampling rate = $2 \times f$ = 8000 samples

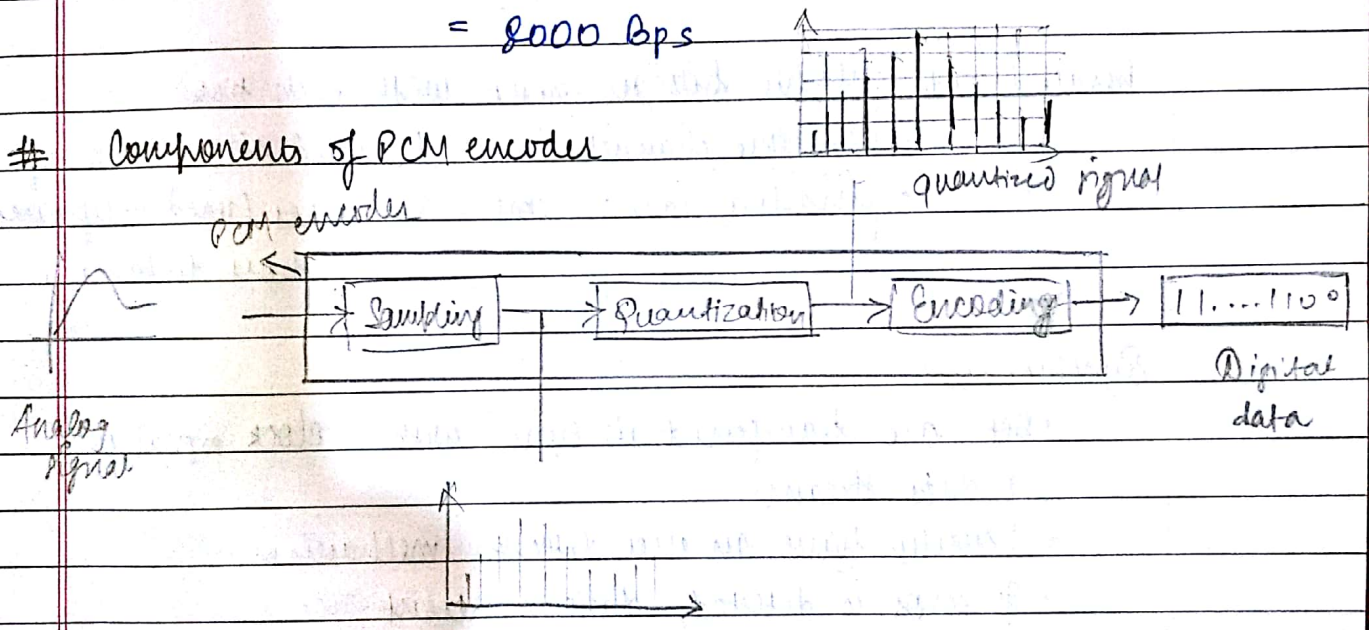
$\therefore$ Bit rate = $f_s \times nb$

= 8000×8

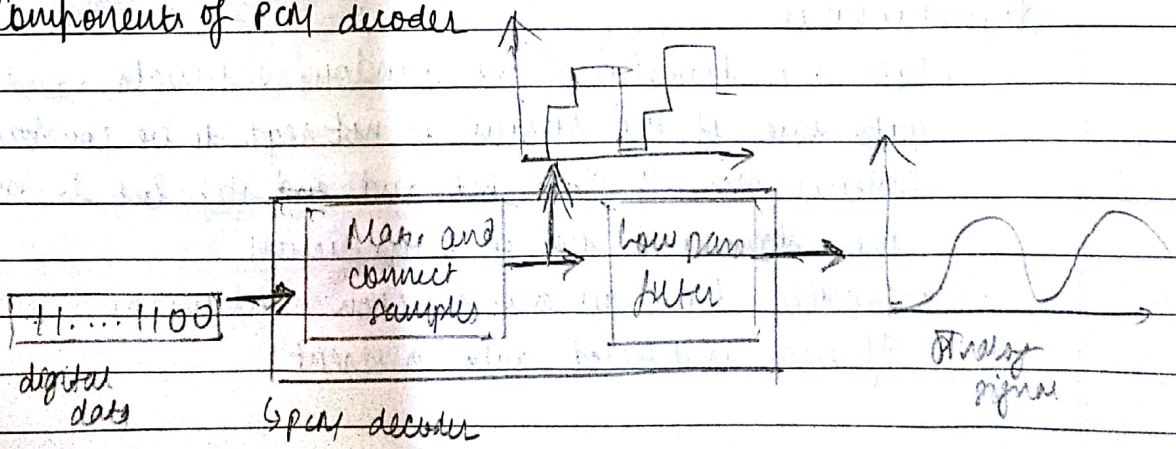
= 64000 bits per second

= 8000 Bps

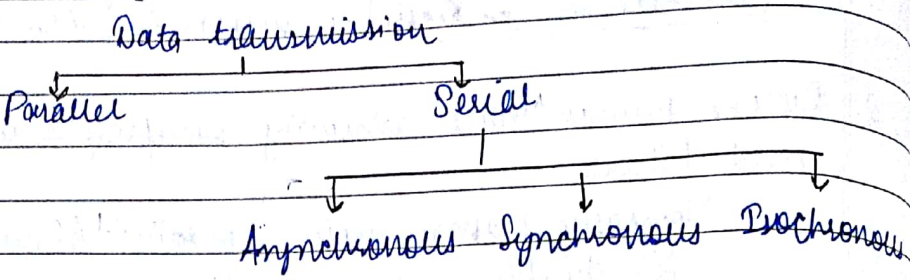
Components of PCM encoder



Components of PCM decoder



Digital transmission modes



Serial mode: 1 bit is sent with each clock tick.
- one comm^{n} channel/wire is needed

Parallel mode: multiple bits are sent with each tick
- multiple channels/wires, bundled in one cable reqd.
- disadvantage: cost = 8x wires (used only over short distances).

Synchronous:
- Bit are transferred in sync with a clock signal in a data stream.
- Usually have an error-detection mechanism.
- If error is detected, data is resent.

Asynchronous:
- Bits are transferred at random intervals and the data rate of the stream is not reqd. to be constant.
- Systems use a start bit and ~~end~~ stop bit to signal the start and end of transmission.
- Usually have an error-detection mechanism.
- If error is detected, data is resent.