i) what is Speech

* It is an ability of human beings to interact with other humans through spoken language that differentiates humans from other living beings (like animals) and it is also a natural mode of communication among humans

* In technical terms, Speech signal is a quasi-stationary i.e characteristics of signal will not vary over time for a certain period, usually 20-25 ms.

Relationship between FT & ZT

Z transform → $X(z) = \sum_{n=-\infty}^{\infty} x(n) z^{-n}$

FT transform → $X(\omega) = \sum_{n=-\infty}^{\infty} x(n) e^{-j\omega n}$

(DTFT)

The relationship is if we replace the complex variable z by $e^{-j\omega}$, then Z transform will reduce to Fourier transform

ie $z = r e^{j\omega}$

, where $r = |z|$

* In other words, the DTFT is nothing but Z-transform evaluated along unit circle centred at origin.

~~If $r \neq$~~

$$X(z) = X(re^{j\omega}) = \sum_{n=-\infty}^{\infty} x(n)(re^{j\omega})^{-n}$$

$$= \sum_{n=-\infty}^{\infty} [x(n)\, r^{-n}]\, e^{-j\omega n}$$

$\sum_{n=-\infty}^{\infty} x(n)\, r^{-n} < \infty$ -> to be summable/ to exist Z transform

~~$\therefore X(z) =$~~

$$\therefore Z[x(n)] = F[x(n)\, r^{-n}]$$

If $r = 1$ -> $Z[x(n)] = F[x(n)]$

Co-articulation :

* When speech sounds are produced, articulatory movements for one sound overlap with those of surrounding (either

Succeeding / preceding) sound. This process of inter twining of information about speech sounds is called co-articulation

Ex: In word happy,

→ when we are saying /h/, it will sound a bit like a whispered sound /a/

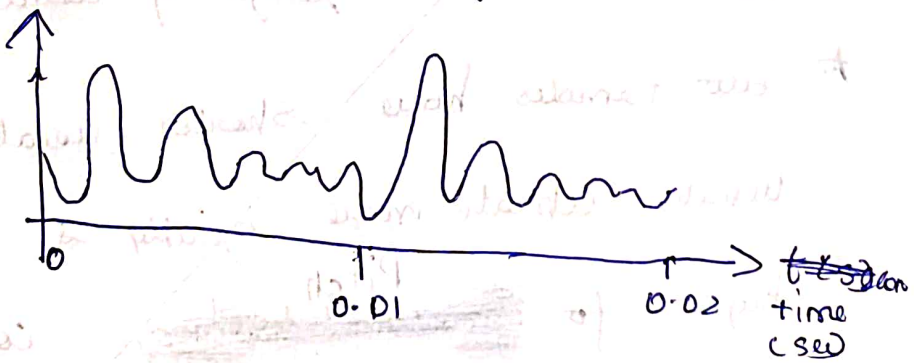
→ when we stop saying /h/, we will start to pronounce /a/

i e Co-articulation is also said as the organizing sequences of vowels & consonants

Fundamental freq

* A term that refers to the lowest freq component in a sound wave (Here it is speech signal)
* It is also called as first harmonic.

Ex:



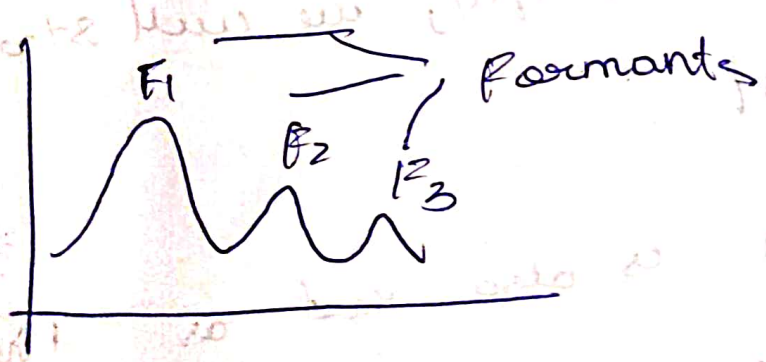
Here, the waveform repeats itself for every 0.01 seconds.

Therefore fundamental freq $f_0 = \frac{1}{T} = \frac{1}{0.01}$

$$\boxed{f_0 = 100 \text{ Hz}}$$

Formant

* Formants are nothing, but the resonant frequency of sounds. ie the freq which a medium ~~(sound)~~ vibrates at highest amplitude



3) Female pitch is more when compared to male pitch ?

* Yes, it is true. The above question depends on the length of vocal cords.

* Since, females have shorter length of vocal cords which vibrate more quickly they have higher pitch compared to males.