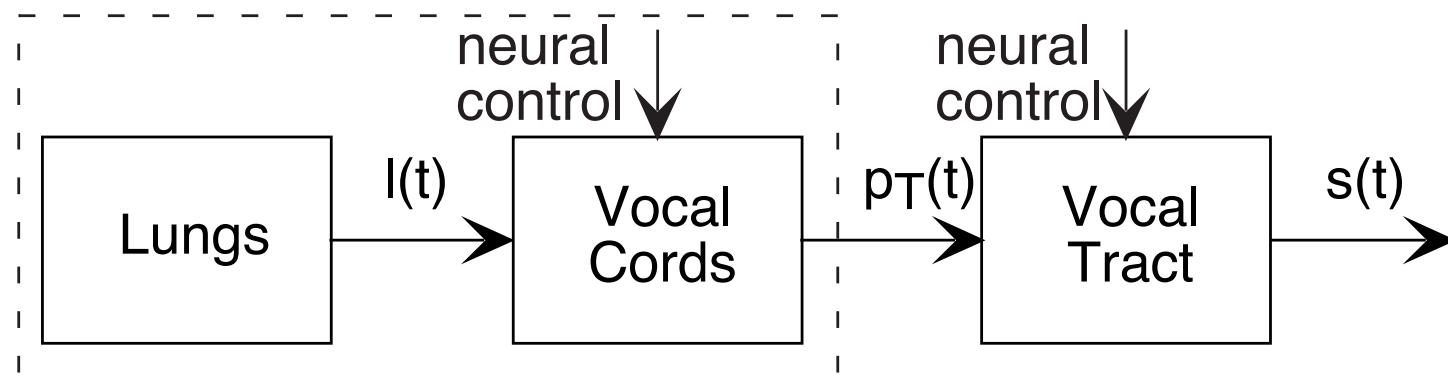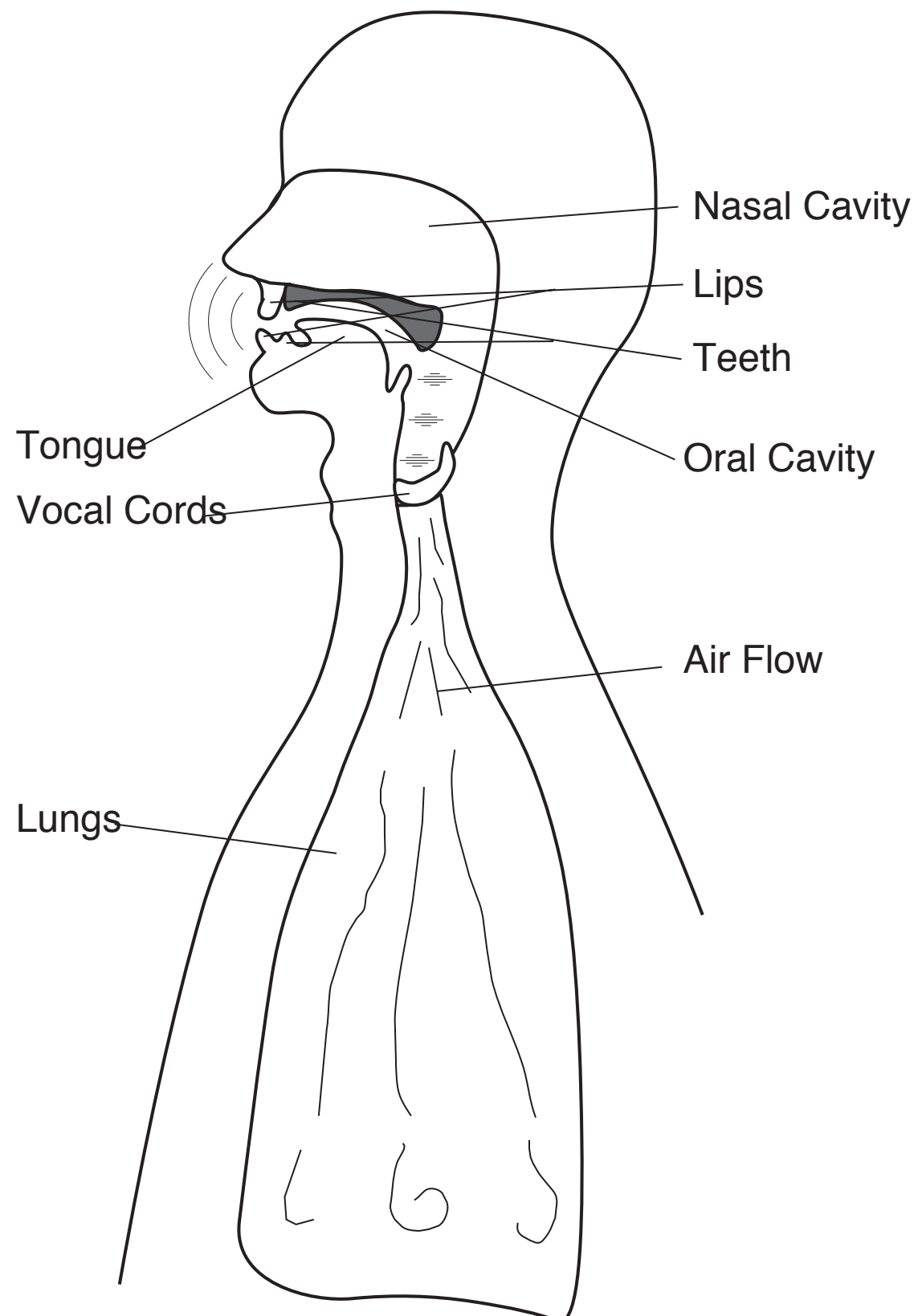# Fundamentals of Electrical Engineering
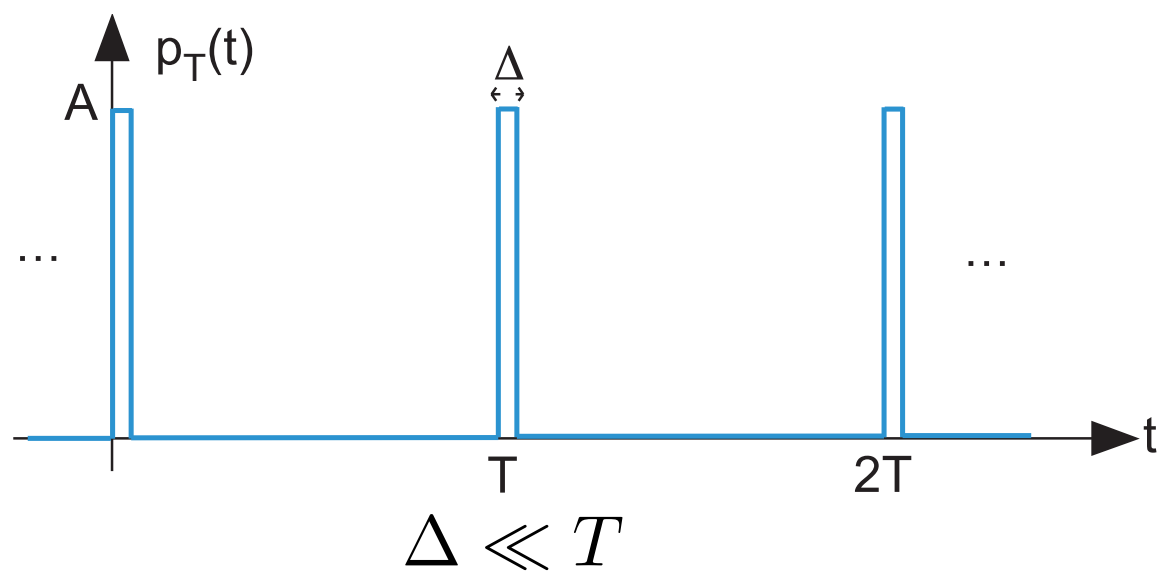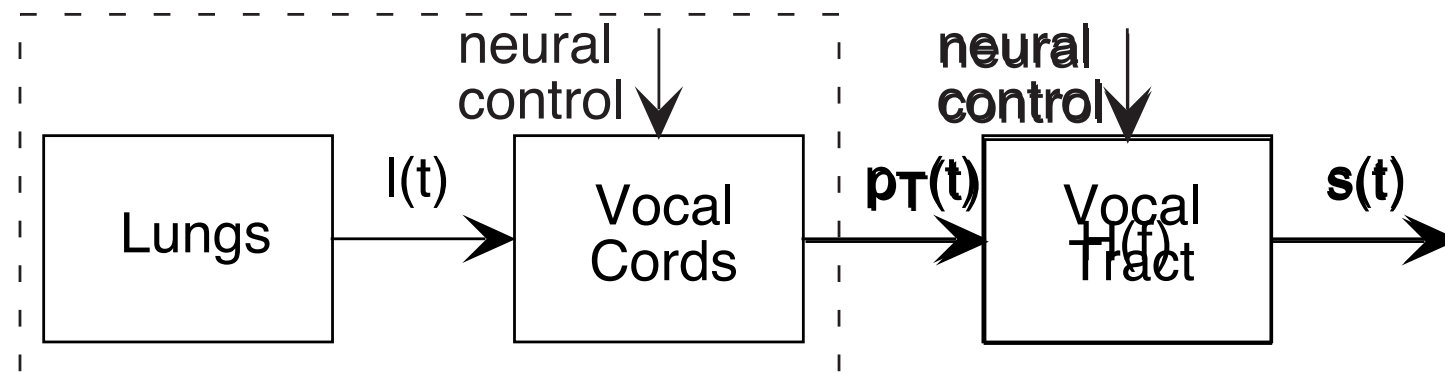
The Speech Signal

- Model of speech generation

- Spectral analysis of speech

Speech Production

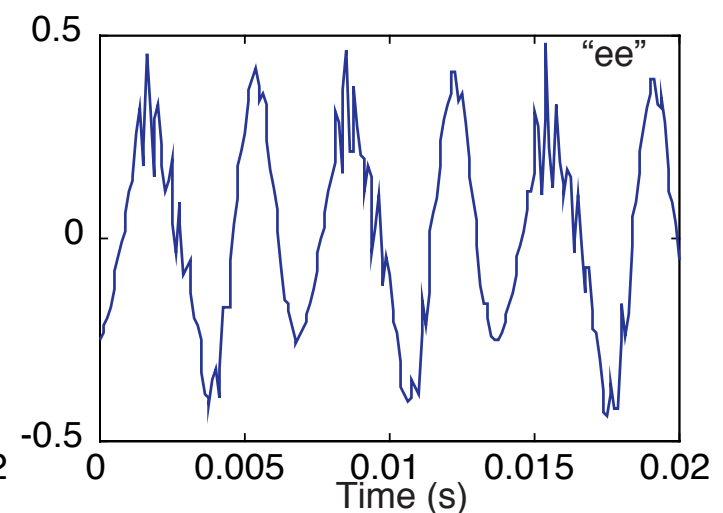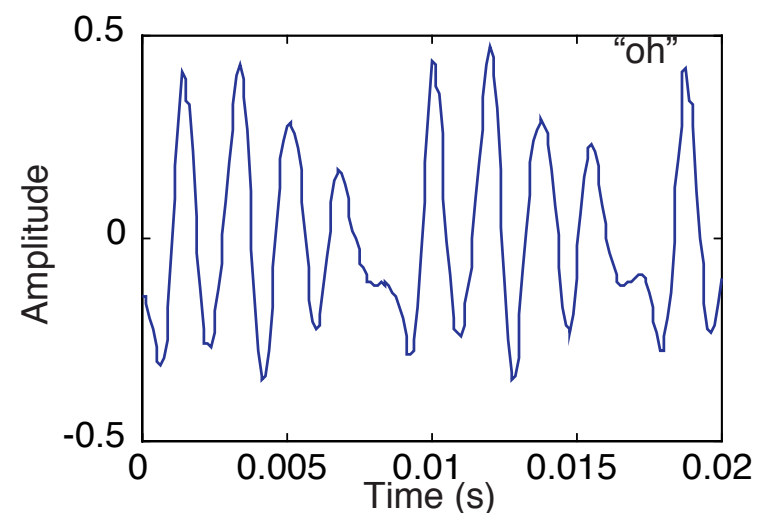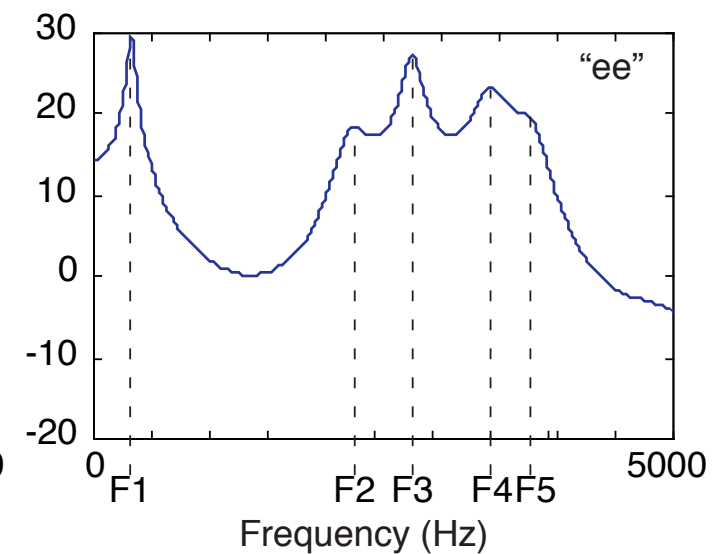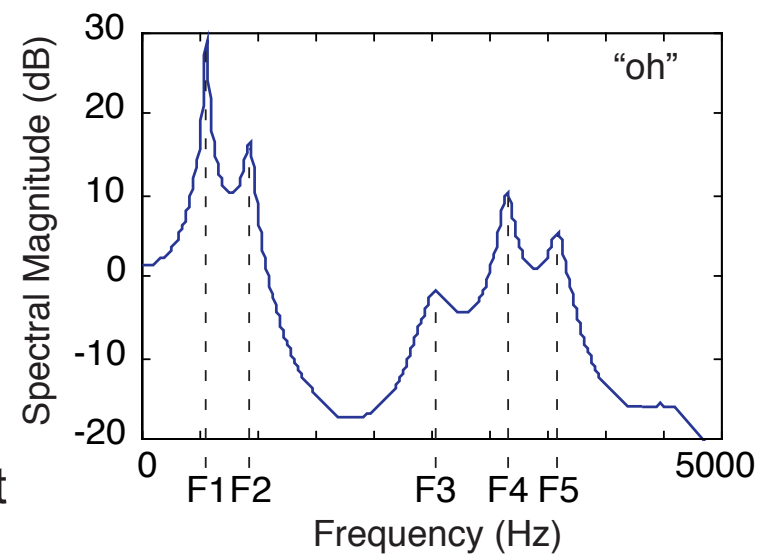Nasal Cavity

Lips

Teeth

Oral Cavity

Tongue

Vocal Cords

Air Flow

Lungs

	neural control		neural control	
Lungs	$\xrightarrow{l(t)}$	Vocal Cords	$\xrightarrow{p_T(t)}$	Vocal Tract $\xrightarrow{s(t)}$

RICE

Speech Model

Lungs → $l(t)$ → Vocal Cords → $p_T(t)$ → Vocal Tract $H(f)$ → $s(t)$

neural control

neural control

$p_T(t)$

A

Δ

$\Delta \ll T$

T $2T$ t

T − pitch period

$\dfrac{1}{T} \equiv F0$ − pitch (frequency)

"oh"

Spectral Magnitude (dB)

F1 F2   F3 F4 F5

Frequency (Hz)

"ee"

F1   F2 F3 F4 F5

Frequency (Hz)

"oh"

Amplitude

Time (s)

"ee"

Time (s)

RICE
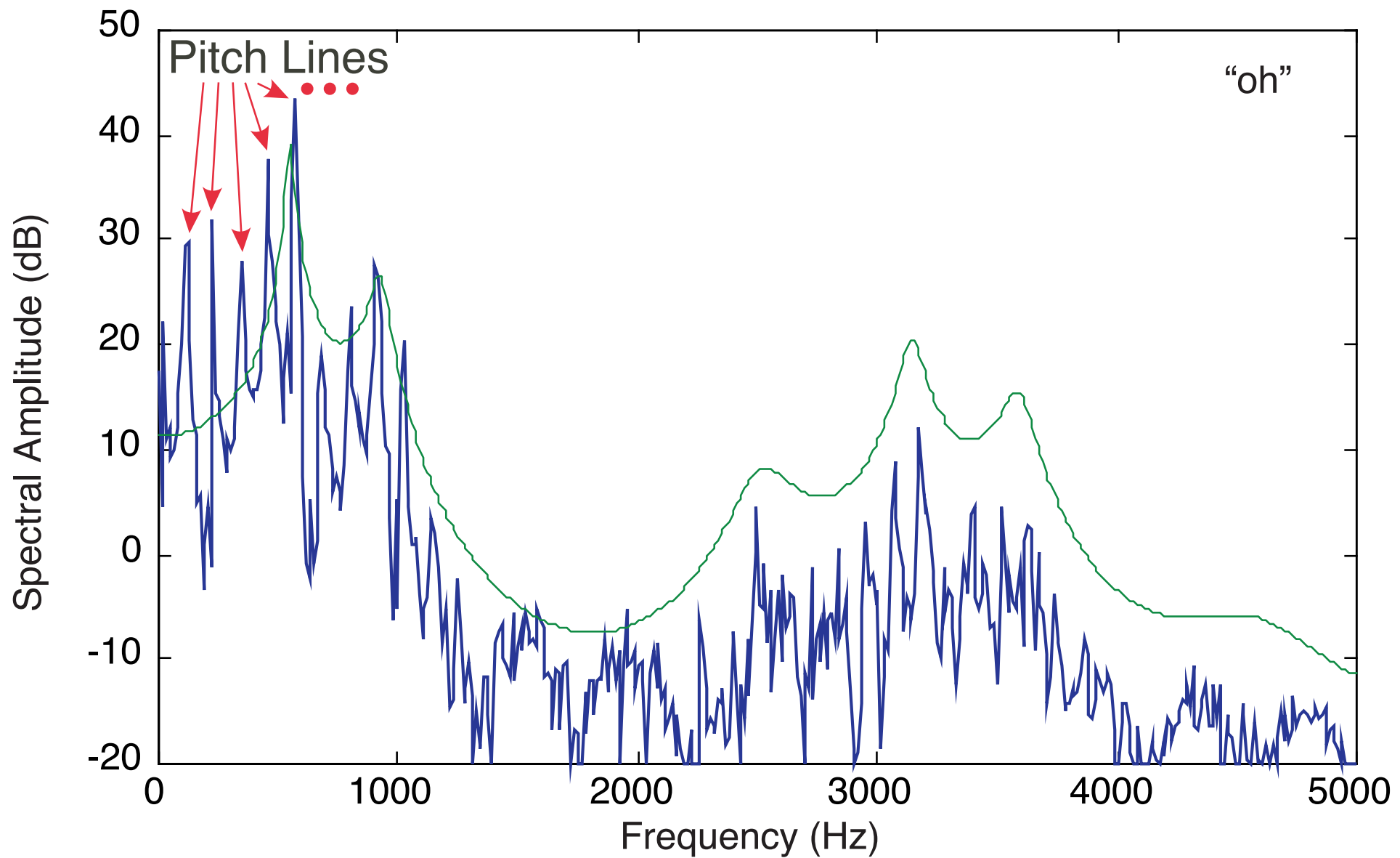
Speech Spectrum

Spectrogram
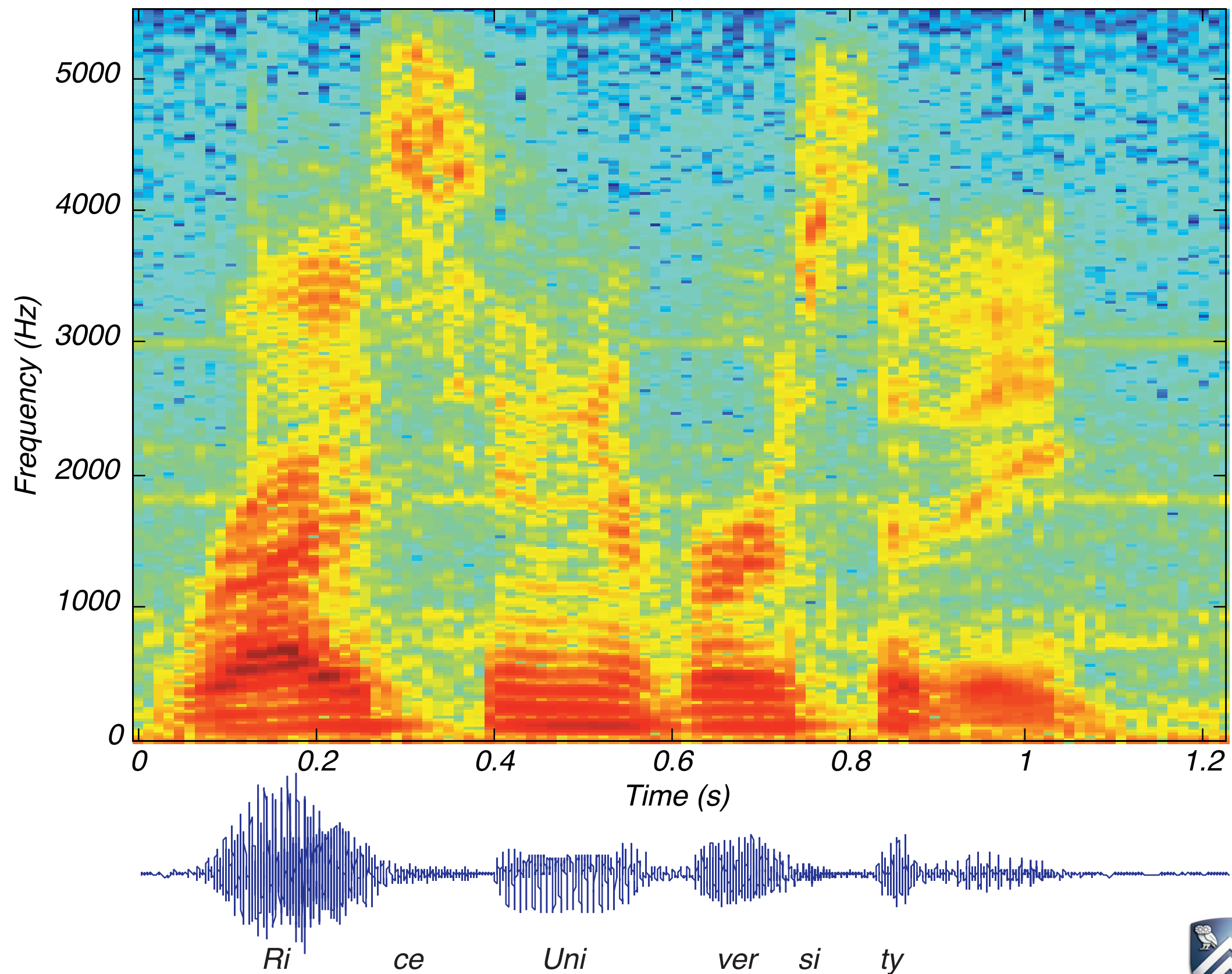
Structure of Speech

- Speech spectrum has a bandwidth of 6-7 kHz

- *Many* other signals span the same frequency range

- Speech processing systems, like vocoders embedded in cellular telephones, exploit the special structure of speech