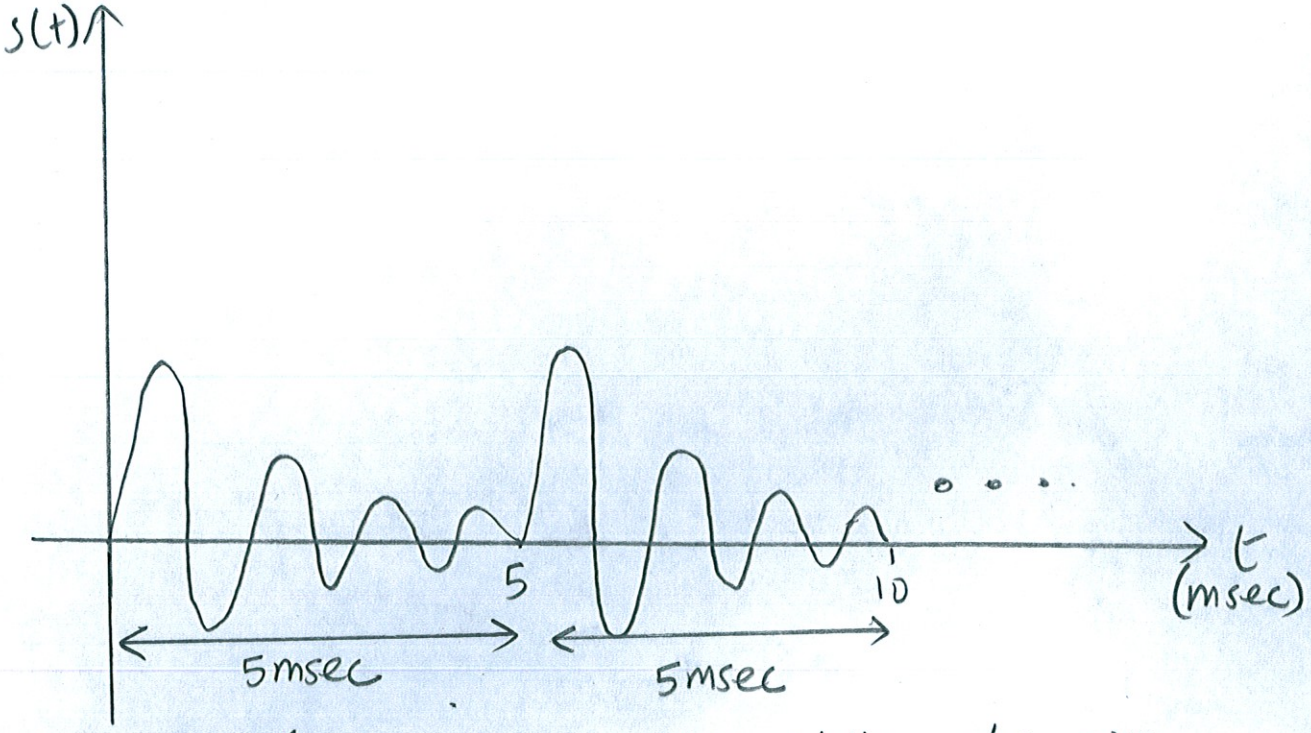
SPECTROGRAMS - PAST EXAMS.

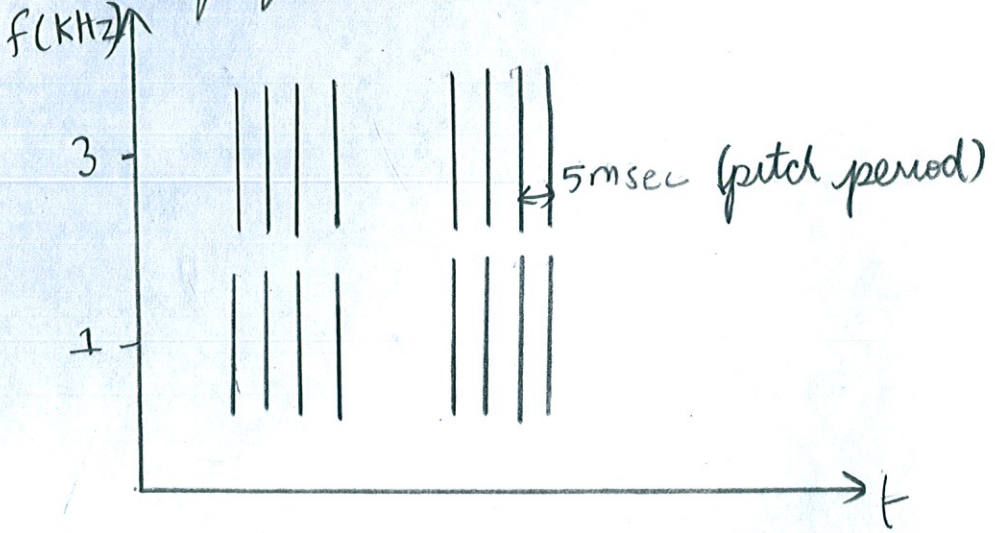
(SPRING 2010)

QUESTION 4

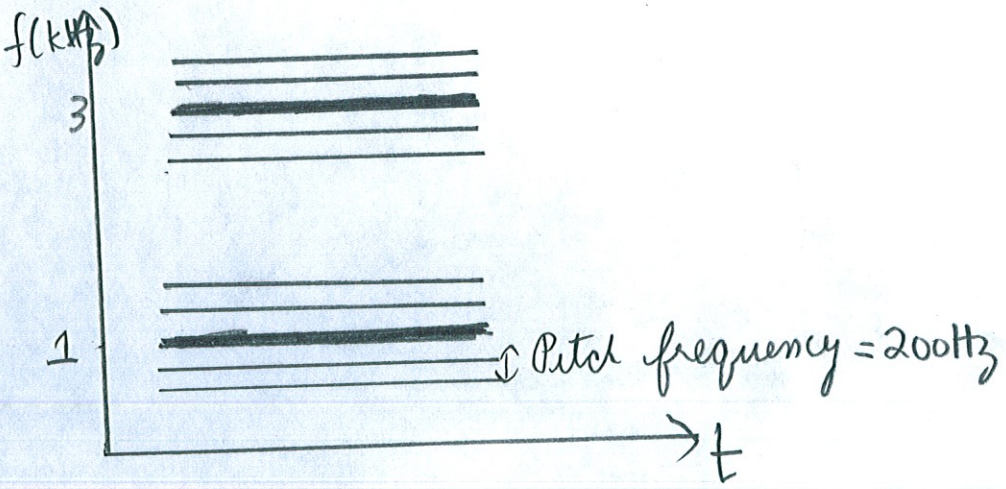
a). pitch period = $\frac{1}{200}$ = 5msec



b). formant frequencies are at $F_1 = 1\,kHz$ and $F_2 = 3\,KHz$



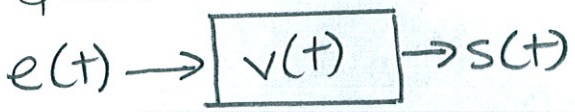
This is a wideband spectrogram which gives good time domain resolution but poor frequency resolution

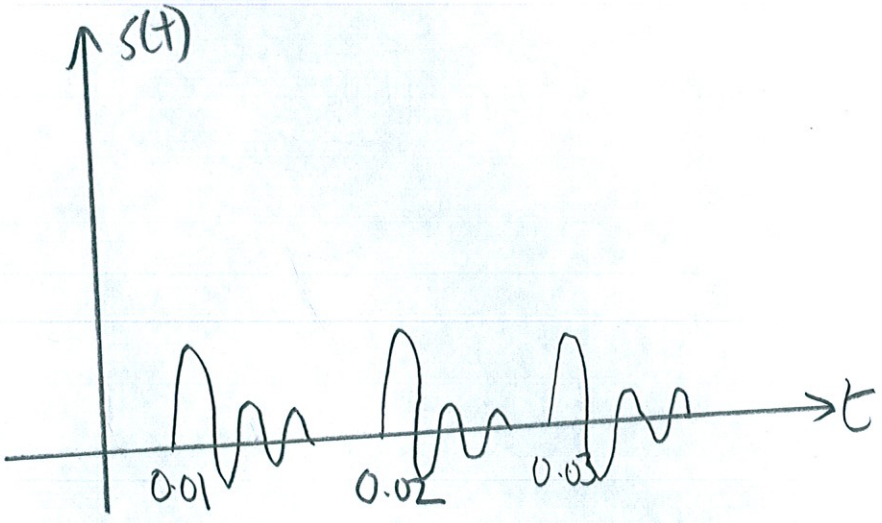
c). 

This is a narrow-band spectrogram which gives good frequency domain resolution but poor time domain resolution.

Fall 2008

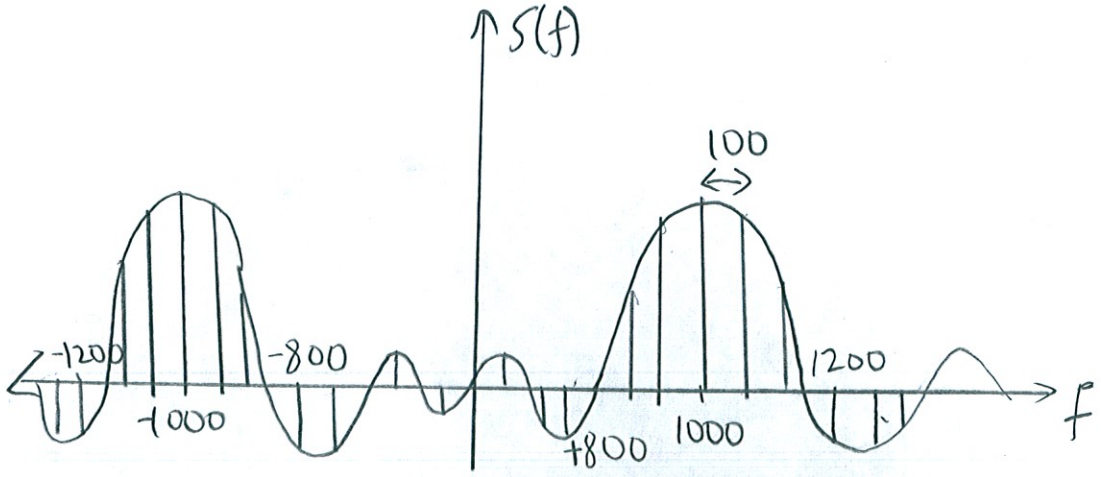
QUESTION 3

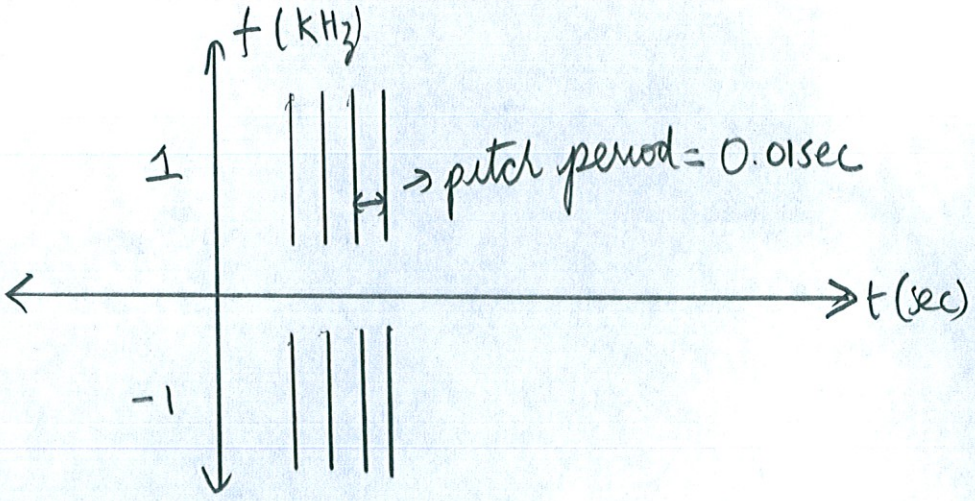
(a) 

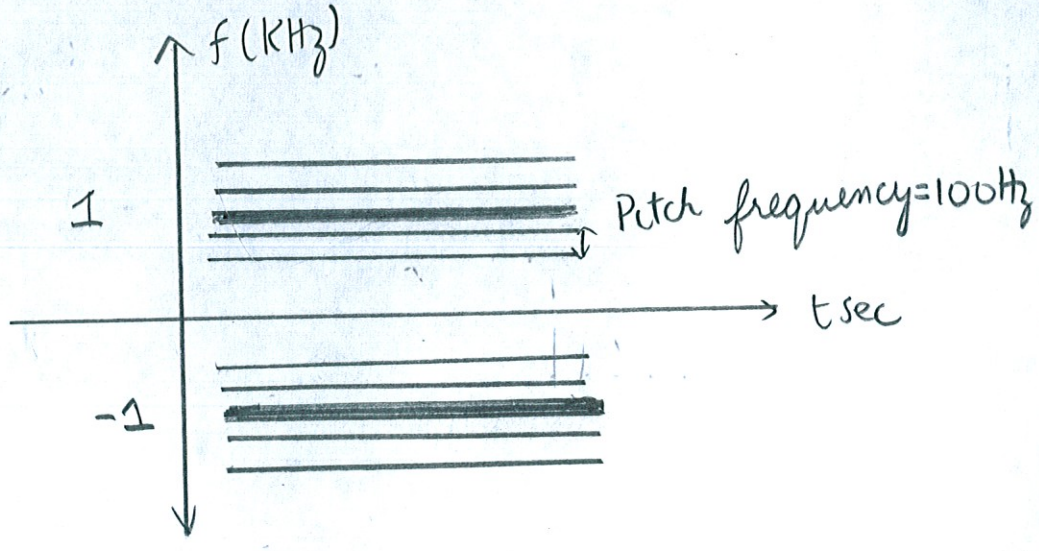


$$S(f) = e(f)v(f)$$

$$= \frac{1}{0.01} comb_{100} V(f) = 100\, comb_{100} V(f)$$


S(f)
100
-1200
-800
-1000
+800
1000
1200
f


f (KHz)
1
pitch period = 0.01sec
t (sec)
-1


f (KHz)
1
Pitch frequency=100Hz
t sec
-1

SPRING 08

QUESTION 2

(a) $N_p = 100$ samples per pitch period

$$T_p = \frac{N_p}{f_s} = \frac{100}{8000} = 12.5\text{ms}$$

(b) $\angle p_1 = 45^\circ$

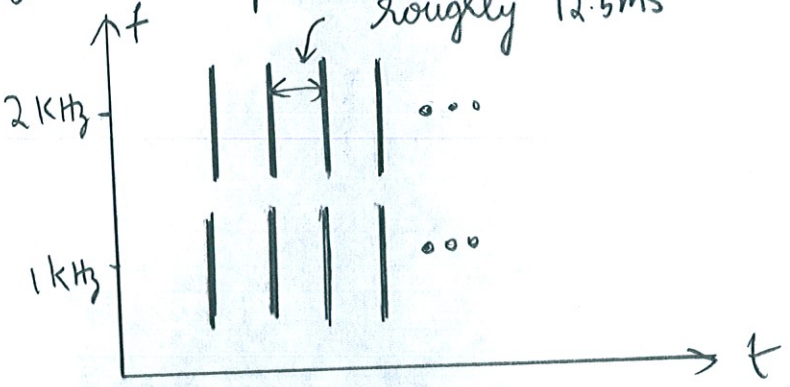
$$F_1 = \frac{45}{360} f_s = \frac{1}{8} \times 8000 = 1000\text{Hz}$$

$\angle p_2 = 90^\circ$

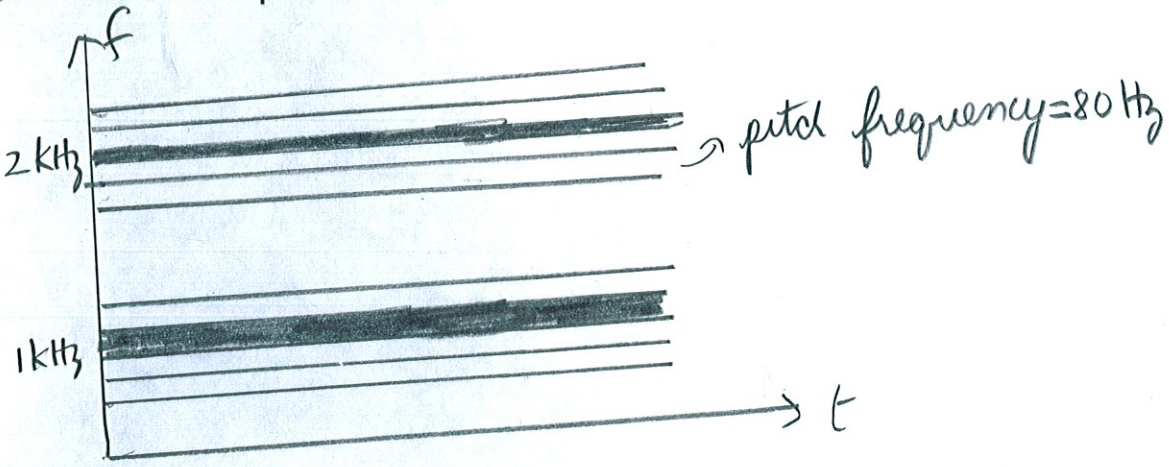
$$F_2 = \frac{90}{360} \times f_s = \frac{1}{4} \times 8000 = 2000\text{Hz}$$

P_1 is closer to unit circle than P_2 ∴ formant at 1KHz is stronger than formant at 2KHz

(c). wideband spectrogram

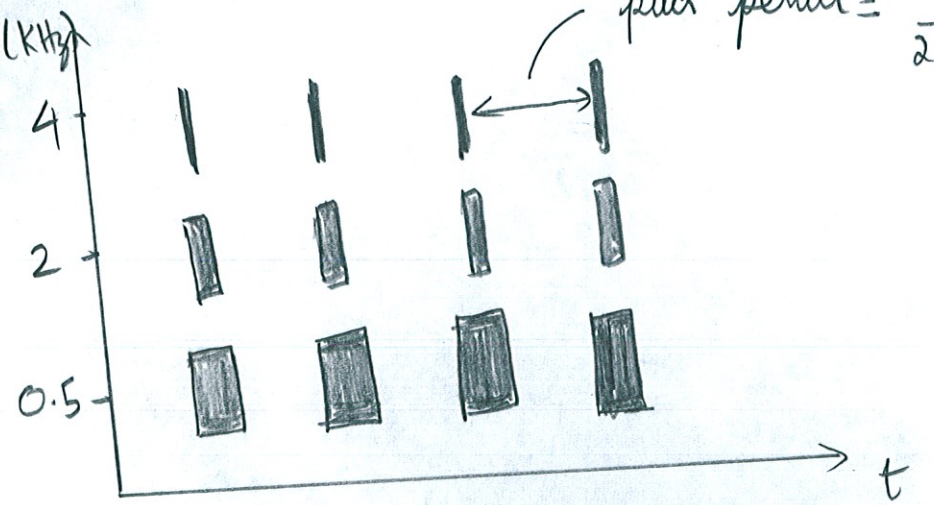


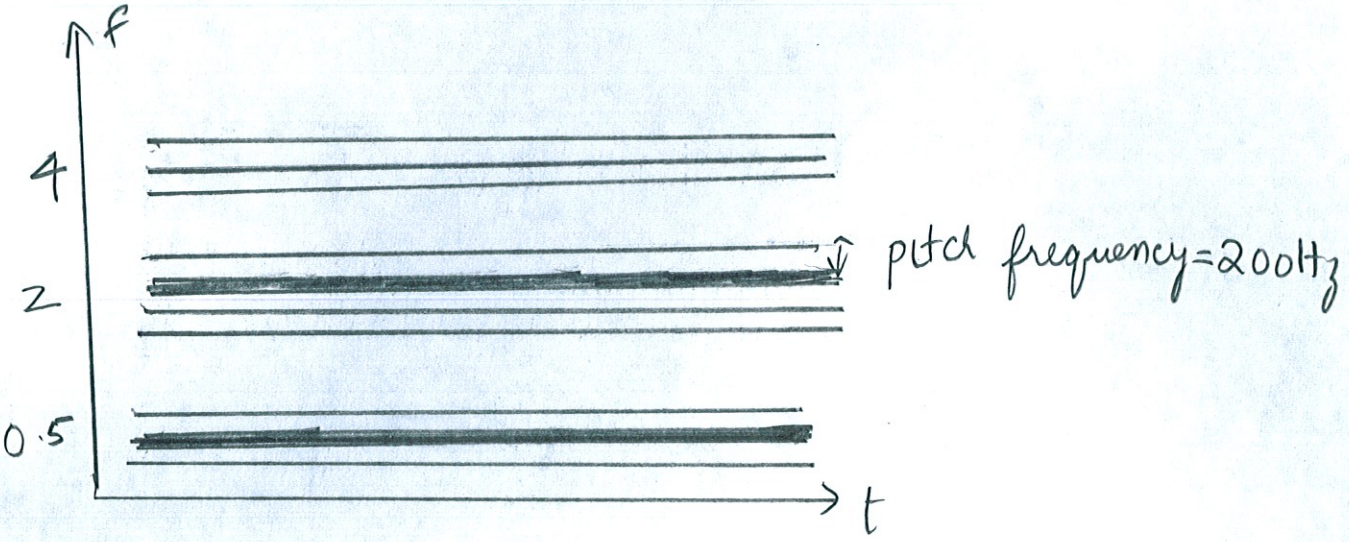
(d). narrowband spectrogram

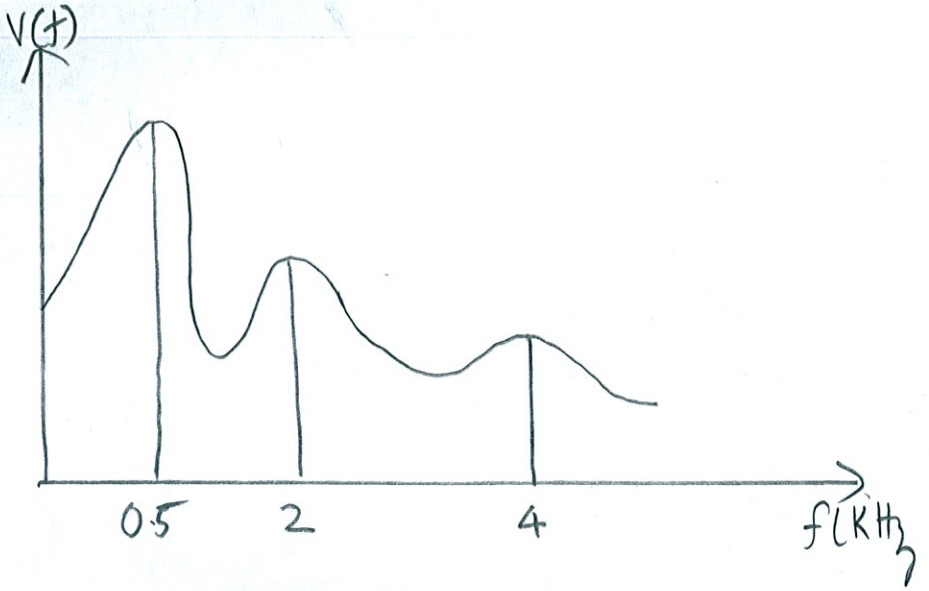


SPRING 2005

QUESTION 2.

a). 

b). 

2c. 

The vocal tract response will have the form

$$V(z) = \frac{k}{(z-Ae^{jw_1})(z-Ae^{-jw_1})(z-Be^{jw_2})(z-Be^{-jw_2})(z-Ce^{jw_3})(z-Ce^{-jw_3})}$$

where A, B, C, K are constants

From sampling theory, $\omega = \frac{2\pi f}{f_s}$

$f_1 = 500Hz \rightarrow w_1 = \frac{2\pi 500}{20k} = \frac{\pi}{20}$

$f_2 = 2000Hz \Rightarrow w_2 = \frac{2\pi 2000}{20k} = \frac{\pi}{5}$

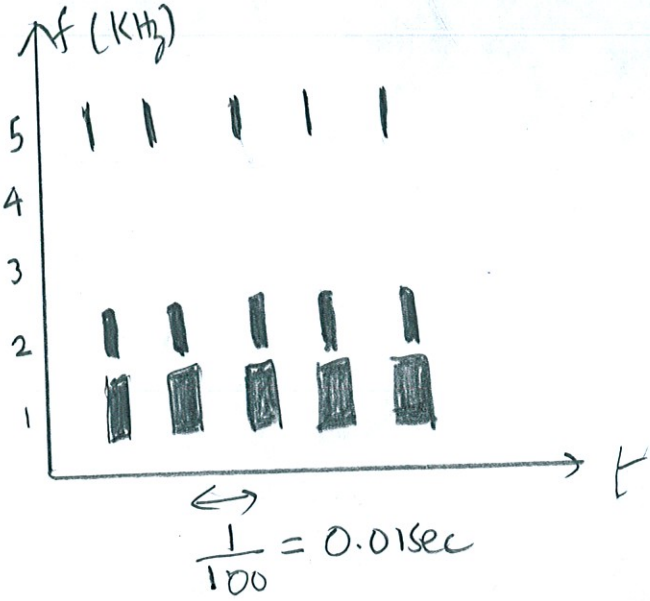
$f_3 = 4000Hz \rightarrow w_3 = \frac{2\pi 4000}{20k} = \frac{2\pi}{5}$

Since pitch period is $\frac{1}{200} = 5ms$, we need $N = 5ms \times 20000 = 100$ to make the excitation have the right period.

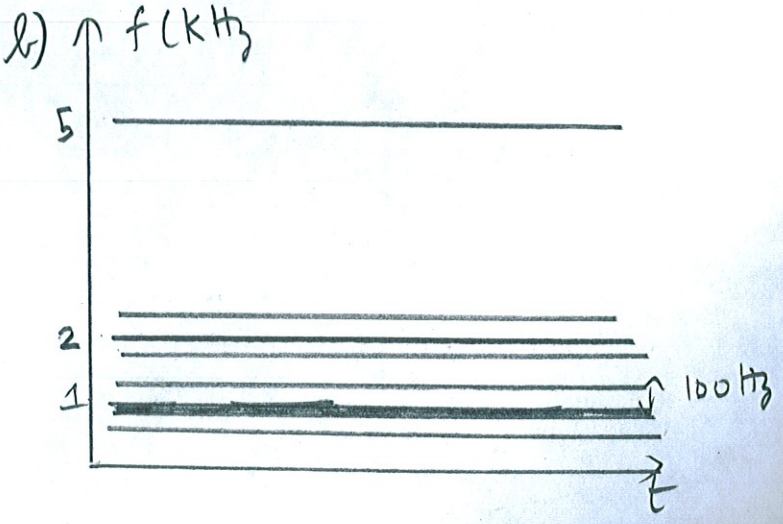
SPRING 04

QUESTION 3

a)



b)



c). $e[n] \rightarrow \boxed{V(z)} \rightarrow s(t)$

$$e[n] = \sum_{K=-\infty}^{\infty} \delta[n-kP]$$

pitch period $= \frac{1}{100\text{Hz}} = \frac{P}{20\text{kHz}} \Rightarrow P = \frac{20}{.1} = 200$

$$e[n] = \sum_{K=-\infty}^{\infty} \delta[n-k200]$$

$V(z)$ has poles at frequencies $\omega_1, \omega_2, \omega_3$ and $-\omega_1, -\omega_2, -\omega_3$

$$\omega_1 = \frac{2\pi \cdot 1\text{kHz}}{20\text{kHz}} = \frac{\pi}{10}$$

$$\omega_2 = \frac{2\pi \cdot 2}{20} = \frac{\pi}{5}$$

$$\omega_3 = \frac{2\pi 5}{20} = \frac{\pi}{2}$$