Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
Manipal University

SIXTH SEMESTER B.Tech. (E & C) DEGREE END SEMESTER EXAMINATION
MAY/JUNE 2016
SUBJECT: Digital Speech Processing (ECE - 326)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates
- Answer **ANY FIVE** full questions.
- Missing data may be suitably assumed.

1A. Suppose that a speaker is holding a vowel steady and his pitch period is steady except for a small deviation of 'ε' that alternates in sign every pitch period as in figure Q.1A. Find the time domain expression for this periodic pulse train $p(n)$ assuming no glottal shaping. Also find the spectrum $P(w)$ and $\left|P(w)\right|^2$

1B. Briefly explain the role of vocal tract in speech production.

1C. Explain the effect of variation in pith period on the spectrum of speech signal.

(5+3+2)

2A. Derive the expression for the minimum mean squared prediction error of a linear predictor. Hence show that the minimum prediction error consists of a fixed component and a component that depends on the predictor coefficients.

2B. With a block diagram, explain the working of clipping autocorrelation pitch detector.

2C. Obtain the difference equation representation for short time average magnitude of a signal which is calculated using a window with impulse response h(n) given below.

$$h(n) = \begin{cases} a^n & for\ n \geq 0 \\ 0 & Otherwise \end{cases}$$

3A. Consider a sequence $x(n)$ with DTFT $X(e^{jw})$. Let $\tilde{X}(k)$ be the DFT of $x(n)$ obtained by sampling $X(e^{jw})$ at frequencies $w_k = \frac{2\pi k}{N}$, $k = 0,1,2,..N-1$. If $\tilde{x}(n)$ represent the inverse DFT of $\tilde{X}(k)$, show that $\tilde{x}(n) = \sum_{r=-\infty}^{\infty} x(n - rN)$.

3B. Consider a speech signal sampled at 12KHz. Find the minimum total sampling rate required to obtain a STFT representation in the following cases.

i) If a Rectangular window of length 25ms is used.

ii) If a Hamming window of length 25ms is used.

3C. Let $y[n] = x[n] - x[n-1]$. Show that STFT of the given signal can be represented as

$$Y_n(e^{jw}) = X_n(e^{jw}) - e^{jw}\, X_{n-1}(e^{jw})$$

4A. Compare the short time energy (STE) plot obtained using Rectangular and Hamming window. Which window is more preferred? Also explain the effect of variation in length of the window on STE plot.

4B. Compare the spectrum of speech signal with spectrum of LPC prediction error signal. Explain the reason for the difference between these two.

4C. Consider a first order linear predictor whose output is given by $y(n) = \alpha s(n-1)$.
Let $e(n) = s(n) - y(n)$ be the error signal. Derive the expression for the optimum value of α by minimizing the mean squared error.

(5+3+2)

5A. Explain how an isolated word recognition system can be implemented using HMM.

5B. Explain working of feedback adaptive quantier with time varying step size. How it is different from feed forward adaptive quantiser?

5C. Find the file size of an uncompressed stereo audio file with sampling frequency of 44.1KHz and bit depth 16 bits/sample. Assume duration of file as 2mins 30 seconds.

(5+3+2)

6A. With a block diagram explain the working of a channel vocoder.

6B. With an example explain the differences between Markov Models and Hidden Markov Models.

6C. Explain the advantages of modified short time autocorrelation function compared to normal autocorrelation function.

(5+3+2)

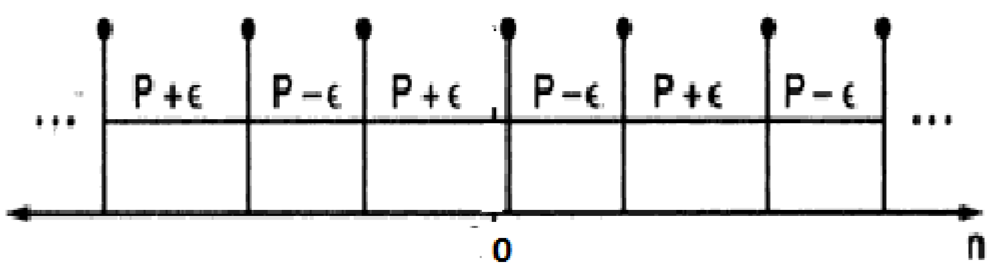

Figure: Q1A