Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

SEVENTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION
JANUARY/FEBRAURY 2021
SUBJECT: DIGITAL SPEECH PROCESSING (ECE - 4007)

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

Instructions to candidates
- Answer **ALL** questions.
- Missing data may be suitably assumed.

1A. A commonly used approximation to the glottal pulse is, $g[n] = \begin{cases} na^n, & n \geq 0 \\ 0, & n < 0 \end{cases}$.

i. Find the z-transform of *g[n]*.
ii. Sketch the Fourier transform $G(e^{j\omega})$, as a function of ω.
iii. Write your comments on part (i) and (ii) above.
iv. The value of *'a'* is normally chosen using the criteria:
$20log_{10}(|G(\omega)|)_{\omega=0} - 20log_{10}(|G(\omega)|)_{\omega=\pi} = 40\text{dB}$
Using this criteria, find the value of *'a'*.

1B. By proving that $1 - az^{-1} = \dfrac{1}{\sum_{n=0}^{\infty} a^n z^{-n}}$, show that a zero can be approximated as closely as desired by multiple poles.

(7+3)

2A. Consider a vocal fold oscillation in a vocal fry or diplophonic state, where a secondary glottal flow pulse occurs within a glottal cycle. We model this condition over one pitch period as $\tilde{g}[n] = g[n] - \alpha g[n - n_0]$, where n_0 is the delay between primary and secondary pulses. The resulting periodic glottal flow waveform is given by, $u[n] = \sum_{k=-\infty}^{\infty} \tilde{g}[n - kN]$ where N is the pitch period.

i. Determine the spectrum of *u[n]* in terms of spectrum of *g[n]*. Write the Fourier transform of the periodic glottal flow waveform *u[n]*.
ii. Suppose that in a diplophonic state, $n_0 = N/2$. Describe how the presence of $g[n-n_0]$ affects at the harmonic frequencies, the squared magnitude of $U(\omega)$. Describe the effect as α changes from 0 to 1.

2B. A certain vocal tract is represented by three resonance frequencies at 1 KHz, 2 KHz and at 3KHz. Give an all-pole model representation for vocal tract and show cascade (second order) implementation of the all-pole transfer function. Assume sampling frequency of 8 KHz.

(5+5)

3A. Explain the basic principles of linear predictive analysis. How all-pole model for vocal tract can be obtained through LPC? Also show that the total minimum predictor error consists of a fixed component and a component which depends on the predictor coefficients.

3B. Describe the Fourier transform and linear interpretations of short-time Fourier transform (STFT). Give the necessary block diagrams and mathematical steps.

(5+5)

4A. With the help of block-diagram, describe the simple inverse filtering tracking (SIFT) algorithm for pitch estimation. What are its advantages and disadvantages?

4B. Describe the cepstral vocoder algorithm (Homomorphic vocoder) for speech coding. What are its disadvantages?

(5+5)

5A. With the help of block diagram, explain analysis and synthesis operations of filter bank coders. What are its limitations? Also give the principle of working of sub-band coder (SBC).

5B. What are the considerations in an unrestricted text-to-speech system? Explain with block diagram how synthetic speech output can be produced by a general TTS system.

(5+5)