Indian Institute of Technology, Kharagpur
Advanced Technology Development Centre

Class Test-2 (2024-25)

Subject: INTRODUCTION TO DIGITAL SPEECH PROCESSING Code: ET60007

Time: 0:45 Hours **Full Marks: 10+10 =20**

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1. (a) Using autocorrelation method, a voiced signal frame is analyzed and 3 PARCOR coefficients $\{k_1, k_2, k_3\}$ are calculated. Now, the same speech signal segment is generated using lossless tube modeling. If the cross-sectional area of the first tube section is $2\ cm^2$, the calculate the cross-sectional area of the other tubes. Given $k_1 = 0.62$; $k_2 = -0.15$; $k_3 = 0.46$

   (b) If the voiced signal is *x[n] = {1, 2, 1, -1,2}* order of the LPC analysis is *3* and LPC coefficients are as given in question 1(a) determine the model gain.

2. A causal LTI system has system function is given in equation-1. Equation 2 represents the expression of prediction error filter *A(z)*. Lattice Formulations of Linear Prediction as given in equation 3(a) and 3(b)

   Where *e[m]* represents the forward prediction error, *b[m]* represents the backward prediction error and k_i is the PARCOR coefficient

$$H(z) = \frac{A}{1 - \sum_{k=1}^{p} \alpha_k z^{-k}} \quad (1) \qquad A(z) = 1 - \sum_{k=1}^{p} \alpha_k z^{-k} \quad (2)$$

$$e^i[m] = e^{i-1}[m] - k_i b^{i-1}[m-1] \quad (3a)$$

$$b^i[m] = b^{i-1}[m-1] - k_i e^{i-1}[m] \quad 3(b)$$

If the signal *s[n] = {1,-2, 2}* applied in the design error filter *A(z)* (as in question no. 2) where *p=2*, calculate the value of the forward prediction error at the output of the *1*st lattice.

$$k_i^{PARCOR} = \frac{\sum_{m=0}^{L-1+i} e^{i-1}[m] b^{i-1}[m-1]}{\left(\sum_{m=0}^{L-1+i} [e^{i-1}[m]]^2 \sum_{m=0}^{L-1+i} [b^{i-1}[m-1]]^2 \right)^{1/2}}$$