Assignment-4

1. Linear prediction analysis is used to obtain a *6-order all-pole model* for a segment of voiced speech that was sampled at a rate of F_S = ***10000 Hz***. Determine the root angle of the pole corresponding to first two formant. ***F_1=288Hz, F_2=719Hz, F_3, =2294Hz BW_1=92 Hz, BW_2=65Hz, BW_3=50Hz***

A. Range of 20^0 to 21^0 and range of 35^0 to 36^0 .

B. Range of 10^0 to 11^0 and range of 25^0 to 26^0 .

C. Range of 15^0 to 16^0 and range of 30^0 to 31^0 .

D. Range of 18^0 to 19^0 and range of 28^0 to 29^0 .

[F_1 = 288 Hz, F_2 = 719 Hz, F_s= 10 KHz, θ_1=(F_1×2π) /Fs = 10.36^0 ; θ_2=(F_2×2π) /Fs = 25.88^0]

2. *5 sec*. speech segment is encoded using LPC coefficient and the LPC coefficient are extracted for each frame (frame length (L) = 5 pitch period) with a frame rate ***100 frame/s***. How many frames's LPC coefficient can be extract from the above speech signal? Where the F_0 of the speech segment is ***250 Hz*** and sampling frequency ***Fs=16 kHz***

A. 450 Frames
B. 600 Frames
C. 500 Frames
D. 550 Frames

[No. of frames in 5 sec. = 5 × 100 = 500 frames]

3. *2 sec*. speech segment is encoded using LPC coefficient and the LPC coefficient are extracted for each frame (frame length (L) = 5 pitch period) with a frame rate ***100 frame/s***. Determine the required order of the LPC analysis. Where the F_0 of the speech segment is ***250 Hz*** and sampling frequency ***Fs=16 kHz.***

A. 15 - 17
B. 32 - 34
C. 25 - 27
D. 20 - 22

[Fs = 16 KHz; Order of LPC = (Fs/1000) + 2 + 2 = ($16\times10^3/10^3$) +2 +2 = 20;
and (Fs/1000) + 2 + 4 = ($16\times10^3/10^3$) +2 +4 = 22]

4. A signal is sampled at ***16 KHz, 16 bit***, encoded with ***16^{th} order LPC***. Each of the LPC coefficients is encoded with ***2 byte***, ***Gain in 2 byte***. Voiced unvoiced F_0 information is encoded using ***1 byte***. Calculate the compression ratio if frame rate is 100 frame /sec?

A. 3 : 32
B. 5 : 41
C. 7 : 60
D. 9 : 70

5. A speech signal frame has energy $E_n^0 = 2000$ using the autocorrelation method the frame is analyzed and 3 PARCOR coefficient {k1, k2, k3} are computed. Find the energy of the liner prediction residual $E_n^3 = \sum_m e_n^2[m]$ that would obtain by inverse filtering the speech signal frame. The inverse filter is designed using the above 3 PARCOR coefficient. Where

$$k_1 = 0.52; \quad k_2 = -0.25; \quad k_3 = 0.36$$

A. Range of 1150 to 1200
B. Range of 950 to 1000
C. Range of 1300 to 1350
D. Range of 1450 to 1500

$$E_n^3 = E_n^0(1-K_1^{\,2})(1-K_2^{\,2})(1-K_3^{\,2})$$

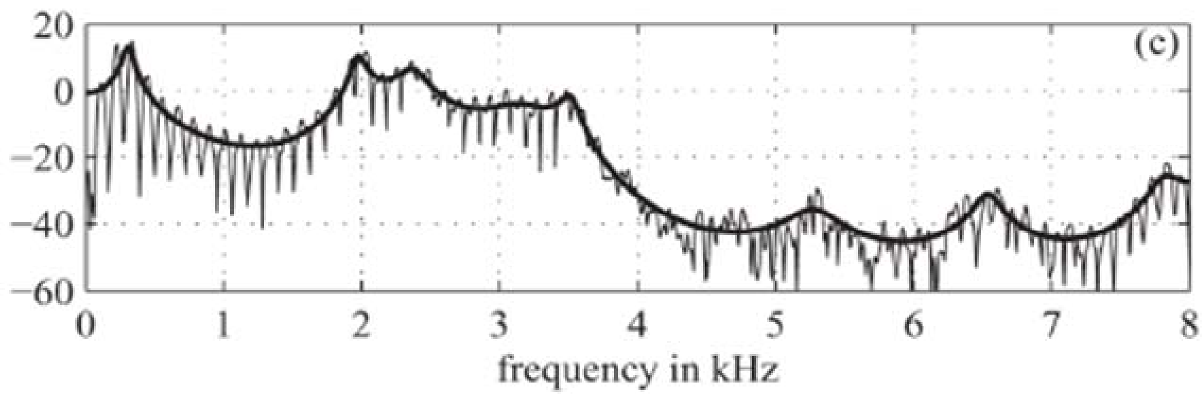
=2000(1-(0.52)^2(1-(-0.25)^2(1-(0.36)^2 = 2000×0.73×0.937×0.871 = 1191.54

6. If the order of the LPC analysis is 3 and LPC coefficients are {α1, α2, α3} compute the model gain for a signal *x[n] = {1, 2, 1,-1,2}* where $\alpha_1 = 0.52; \quad \alpha_2 = -0.25; \quad \alpha_3 = 0.36$

A. Range of 1 to 1.5
B. Range of 2 to 2.5
C. Range of 5 to 5.5
D. Range of 3 to 3.5

[G^2 = 5.36; So, G = √(5.36) = 2.315]

7. Figure-1 represent the LPC Spectrum of a speech segment determine the order of the LPC analysis



A. 14
B. 18
C. 20
D.10

8. A voiced speech signal frame analyzed using the autocorrelation method and 3 PARCOR coefficients $\{k_1, k_2, k_3\}$ are computed. If the same speech signal segment is generated from using lossless tube modeling and cross sectional area of the first tube section is ***1*** derive the cross sectional area of the other tubes. Where

$$k_1 = 0.52; \quad k_2 = -0.25; \quad k_3 = 0.36$$

A. $A_1 = 1$; A_2 = Range of 7 to 8; A_3 = Range of 5 to 6; A_4 = Range of 8 to 9
B. $A_1 = 1$; A_2 = Range of 5 to 6; A_3 = Range of 3 to 4; A_4 = Range of 6 to 7
C. $A_1 = 1$; A_2 = Range of 3 to 4; A_3 = Range of 1 to 2; A_4 = Range of 4 to 5
D. $A_1 = 1$; A_2 = Range of 9 to 10; A_3 = Range of 7 to 8; A_4 = Range of 10 to 11

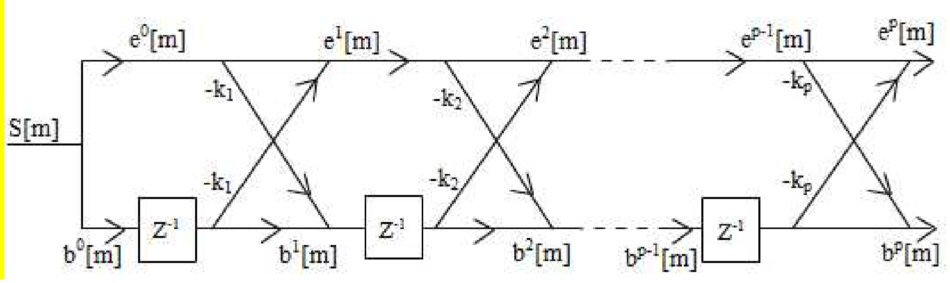
[$A_1 = 1$; $A_2 = 3.166$; $A_3 = 1.9$; $A_4 = 4.036$]

9. Lattice formulation of i^{th} order prediction error filter was define as given in equations. Which one of the following figure indicates the signal flow graph of the error filter?

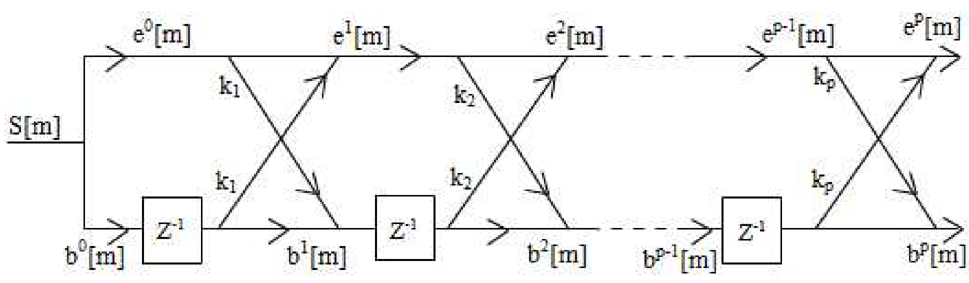
$$e^{i}[m] = e^{i-1}[m] - k_i b^{i-1}[m-1]$$

$$b^{i}[m] = b^{i-1}[m-1] - k_i e^{i-1}[m]$$

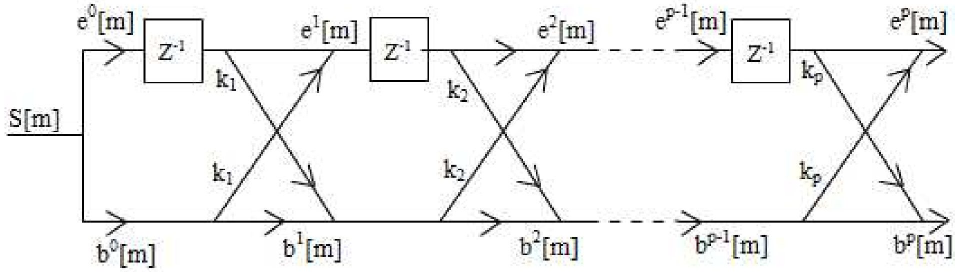
$$e^{0}[m] = b^{0}[m] = s[m]$$



A.



B.

C. 

10. Autocorrelation method based ***20th*** order LPC analysis was performed for a voiced speech signal with the frame rate of ***100 frame/sec***. If the length of the window used for this analysis is ***20 ms*** determine length of the error signal [where sampling frequency of the speech signal is ***16 kHz***].

A. 253
B. 551
C. 153
D. 341