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B.Tech.
PET6J010

6th Semester Regular Examination 2017-18
Advanced Digital Signal Processing
BRANCH: ETC, ECE
Time: 3 Hours
Max Marks: 100
Q.CODE: C443
Answer Part-A which is compulsory and any four from Part-B.
The figures in the right hand margin indicate marks.

Part – A (Answer all the questions)

Q1 Answer the following questions: ***multiple type or dash fill up type*** **(2 x 10)**

a) A three stage sub-band speech coder has ____ number of decimators.
b) Down-sampling is a _____ process. (time-variant/ time-invariant)
c) The noise whitening filter for generating the innovation process for an moving average process input is _____ filter(all-pole /all-zero).
d) The power density spectrum estimate is poor if its variance is _____.
e) A delay of k samples is equivalent to a phase shift of ____.
f) The Levinson-Durbin algorithms exploits the symmetry in ____matrix
g) Convolution of $W(f)$ with $X(f)$ smoothens spectrum of $X(f)$, provided the spectrum of $W(f)$ is _____ compared to $X(f)$.
h) Welch method is ____method of power spectrum estimation.
i) _____ is the maximum frequency that can be uniquely represented at a sampling rate Fs=40 Hz.
j) An adaptive linear combiner with 3-weights has a error surface plot of____ dimensions.

Q2 Answer the following questions: ***Short answer type*** **(2 x 10)**

a) Define what is a stationary random process.
b) Give the mathematical expressions for input-output relationships in the case of interpolation by a factor I, in both time-domain and frequency-domain.
c) A discrete signal x(n) is sampled at a rate of 20 KHz. What analog frequency component does discrete frequency $\omega = \frac{\pi}{4}$ of the signal represent?
d) What is a noise whitening filter?
e) What is periodogram? Write the expression for it.
f) Draw the block diagrams of open loop and closed loop adaptive filters respectively.
g) Give the difference equation for an MA process.
h) Give the relationship between system function for forward linear predictor and backward linear predictor.
i) Define gradient for a performance function, and give the mathematical expression for it.
j) What is the orthogonality principle in linear mean square estimation?

Part – B (Answer any four questions)

Q3 **a)** In the context of decimation by a factor D, explain what the scope of its efficient implementation. Obtain the efficient implementation of decimation, when D=3, using polyphase structure and noble identities with required block-diagram representation. **(10)**

b) Plot the signals and their corresponding spectra for rational sampling rate conversion by $\frac{I}{D} = \frac{5}{3}$ and $\frac{I}{D} = \frac{3}{5}$. Assume the spectrum of the input signal $x(n)$ occupies the entire range $-\pi \leq \omega \leq \pi$. **(5)**

Q4 **a)** Derive the time-domain expression for the output of Forward Linear Prediction Error filter and draw the direct form-1 structure for the filter. Explain what Normal Equations are in reference to this error function expression. **(10)**

b) Consider the ARMA process generated by the difference equation: **(5)**

$$x(n) = 1.6x(n-1) - 0.63x(n-2) + w(n) + 0.9w(n-1)$$

Determine the system function of the whitening filter and power spectral density of the signal $x(n)$.

Q5 **a)** Explain sub-band coding of speech signal with proper block diagram. **(10)**

b) What do you mean by uniform analysis filer bank? Give the expressions for impulse response, frequency response and system function of such a filter. Draw the frequency response of a 4-component analysis filer bank. **(5)**

Q6 **a)** Differentiate between parametric and non-parametric methods for power spectrum estimation, explaining one method of each class. **(10)**

b) Prove that periodogram is not a consistent estimate of the true power density spectrum. **(5)**

Q7 **a)** Differentiate between direct method and indirect method of energy density spectrum estimation. Explain the leakage problem encountered in the computation of energy density spectrum from a finite–duration signal. **(10)**

b) Explain the Bartlett method of power spectrum estimation with supporting mathematical expressions. **(5)**

Q8 **a)** Prove that the error signal is uncorrelated (orthogonal to) with the input signal in a linear adaptive filter, when the mean square error is minimum i.e. the filter is optimum. **(10)**

b) Explain *Least Mean Square* algorithm in reference to its special estimate of gradient. Use it to derive the weight updation rule for *LMS*. **(5)**

Q9 **a)** What do you understand by channel equalization? Explain adaptive channel equalization with block diagram. **(10)**

b) Define mean square error for an adaptive linear combiner. Hence derive the Wiener-Hopf equation for optimum filter coefficients for the same. **(5)**