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ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. (Full Time) - END SEMESTER EXAMINATIONS, NOV / DEC 2023

ELECTRONICS AND COMMUNICATION ENGINEERING
V Semester
EC5011&ADVANCED DIGITAL SIGNAL PROCESSING
(Regulation 2019)

Time:3hrs

Max.Marks: 100

CO1	To analyze statistical characteristics of random signals
CO2	To identify appropriate spectrum estimation method based on type of random signal
CO3	To design optimum filters for processing random signal
CO4	To design filters for quasi stationary signals
CO5	To analyze and design systems with varying sample rate

BL – Bloom’s Taxonomy Levels

(L1-Remembering, L2-Understanding, L3-Appling, L4-Analysing, L5-Evaluating, L6-Creating)

PART- A(10x2=20Marks)
(Answer all Questions)

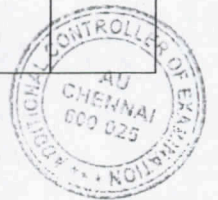
Q.No.	Questions	Marks	CO	BL
1	Determine whether the matrix $R = \begin{bmatrix} 3 & 4 \\ 4 & 3 \end{bmatrix}$ is a valid autocorrelation matrix.	2	1	3
2	Compute the variance of a Bernoulli random process $x(n)$ with $\Pr\{x(n) = 1\} = \Pr\{x(n) = -1\} = 0.5$.	2	1	3
3	State the expression for Periodogram and its Bias.	2	2	1
4	Define the figure of merit of Bartlett and Welch methods of power estimation.	2	2	2
5	State the Wiener Hopf equations for the causal and noncausal filter.	2	3	2
6	Draw the block diagram of Wiener noise canceller with a secondary sensor and write the corresponding Wiener Hopf equation.	2	3	1
7	What is the convergence condition on step size in steepest descent method?	2	4	2
8	Define misadjustment error for adaptive filter.	2	4	1
9	Draw the efficient direct form realization structure of Decimation by a factor D.	2	5	1
10	State any two cascade equivalent of a complex multirate system.	2	5	2

PART- B(5x 13=65Marks)
(Restrict to a maximum of 2 subdivisions)

Q.No.	Questions	Marks	CO	BL
11 (a)	Determine the impulse response of the minimum phase filter whose system function is given as $H(z) = \frac{1}{1-0.5z^{-1}}$. Compute and plot the autocorrelation of the random process generated by this filter for a unit variance white noise.	13	1	3
OR				
11 (b)	A LTI system with system function $H(z) = \frac{1+\frac{1}{3}z^{-1}}{1-0.5z^{-1}}$ is excited by	13	1	3

	zero mean exponentially correlated noise $x(n)$ with an autocorrelation sequence $r_x(k) = (-\frac{1}{3})^{ k }$. Determine the cross correlation $r_{xy}(k)$ between $x(n)$ and $y(n)$.			
12 (a)	Using Levinson-Durbin recursion, determine a third order all pole model for a signal having autocorrelation values $r_x(0) = 1.33$, $r_x(1) = -0.33$, $r_x(2) = -0.542$, $r_x(3) = 0.135$.	13	2	3
OR				
12 (b)	i) Estimate the power spectrum of a random process given by $x(n) = w(n) - w(n-2)$, where $w(n)$ is unit variance white noise. ii) Determine the power spectrum of AR(2) process using autocorrelation method if the estimated autocorrelation sequence of a random process $x(n)$ is given as $r_x(0) = 5$, $r_x(1) = 2$, and $r_x(2) = 0$.	13 (6+7)	2	3
13 (a)	Design an optimum three step predictor using a first order filter if the values of $r_x(k)$ for lags $k=0$ to $k=4$ are given as 1, 0, 0.1, -0.2 and -0.9. Also determine the mean square prediction error of the first order Wiener filter.	13	3	3
OR				
13 (b)	Design a first order FIR linear predictor in a noisy environment for a random process given by $d(n) = 0.5d(n-1) + v(n)$ corrupted by noise as given by $x(n) = d(n) + w(n)$ where $v(n)$ is a unit variance white noise, $r_w(k) = 0.5\delta(k)$ and $r_{dw}(k) = 0$.	13	3	3
14 (a)	Describe using appropriate equations how weight update is implemented in steepest descent algorithm, LMS and normalized LMS algorithms.	13	4	2
OR				
14 (b)	i) Design a two coefficient LMS adaptive linear predictor for a process $x(n)$ with autocorrelation values $r_x(0) = 1$, $r_x(1) = 0.5$ and $r_x(2) = 0.5$ and determine the minimum mean square error. ii) Explain noise cancellation using adaptive filtering with and without reference signal.	13 (7+6)	4	2
15 (a)	Explain decimation and interpolation with appropriate equations and plots for the output signals in time and frequency domain.	13	5	2
OR				
15 (b)	i) Determine the spectrum of the output signal of a sampling rate converter with $I/D = 5/3$ and $I/D = 3/5$. Plot the spectrum of signals assuming that the spectrum of the input signal occupies the frequency range $-\pi$ to π . ii) Explain with neat block diagram the implementation of Quadrature mirror filter bank.	13	5	2

PART- C(1x 15=15Marks)
(Q.No.16 is compulsory)



Q.No.	Questions	Marks	CO	BL
16.	Design an optimum causal Wiener filter for the estimation of the signal $d(n)$ given in a noisy observation $x(n) = d(n) + v(n)$ where $v(n)$ is unit variance white noise uncorrelated with $d(n)$. The signal $d(n)$ is given by $d(n) = 0.4d(n-1) + w(n)$ where $w(n)$ is white noise with variance of 0.24.	15	3	4