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Question Paper Code : X 85082

M.E./M.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2020

First Semester

Applied Electronics

AP 5152 – ADVANCED DIGITAL SIGNAL PROCESSING

(Common to M.E. Communication Systems/M.E. Communication and Networking/M.E. Digital Signal Processing/M.E. Electronics and Communication Engineering /M.E. Electronics and Communication Engineering (Industry Integrated))

(Regulations 2017)

Time : Three Hours

Maximum : 100 Marks

Answer ALL questions

PART – A

(10×2=20 Marks)

1. State the Weiner-Khitchine relation and discuss about it.
2. List the necessary and sufficient condition for a random process is said to be wide sense stationary process.
3. Define bias, unbiased and asymptotically unbiased estimate.
4. Differentiate Non-parametric and Parametric method of power spectrum estimation.
5. Mention any two applications where Kalman filter is used.
6. What is lattice filter structure ? What is the advantage of such structure ?
7. What is the advantage of adaptive filters over optimum filters ?
8. Bring out the limitations of steepest descent algorithm.
9. Mention the necessity for multistage implementation of sampling rate conversion.
10. List out few applications of multirate signal processing.



11. a) i) With necessary equations, explain in detail about special types of random process. **(7)**
ii) Derive the spectral factorization of the power spectrum $P_x(e^{j\omega})$. **(6)**

(OR)

b) i) $x(t)$ is a wide sense stationary process with autocorrelation function
$$R_{X(\tau)} = 10 \frac{\sin(2000\pi\tau) + \sin(1000\pi\tau)}{2000\pi\tau}$$

The process $x(t)$ is sampled at rate $1/T_s = 4,000$ Hz, yielding the discrete-time-process x_n . What is the autocorrelation function $R_x[k]$ of x_n ? **(5)**
ii) State and explain Parseval's theorem with its properties. **(8)**
12. a) Explain the Bartlett and Welch method of smoothing the periodogram and evaluate the performance measures. **(13)**

(OR)

b) Explain the periodogram method of spectrum estimation in detail and also obtain the variance of the periodogram. **(13)**

13. a) i) Explain about stochastic ARMA model in detail. **(7)**
ii) How the yule walker method to solve the AR model parameters? **(6)**

(OR)

b) Explain the Kalman filter estimation approach in detail. Derive the expression for Kalman gain that minimizes mean square error. **(13)**

14. a) Starting from the basic principles, derive the LMS weight update equation and explain the LMS adaptive algorithm in detail. **(13)**

(OR)

b) Explain in detail about exponentially weighted RLS and sliding window RLS algorithms. **(13)**

15. a) With neat diagram and relevant expressions, explain the time domain and frequency domain characteristics of a decimator with a decimation factor of 'D'. **(13)**

(OR)

b) Draw the polyphase decomposed structure of a 15-tap FIR filter with a decomposition factor of '3'. **(13)**



PART – C

(1×15=15 Marks)

16. a) Assume that $v(n)$ is a real-valued zero-mean white Gaussian noise with $\sigma_v^2 = 1$, $x(n)$ and $y(n)$ are generated by the equations

$$x(n) = 0.5x(n - 1) + v(n),$$

$$y(n) = x(n - 1) + x(n).$$

- i) Compute the power spectrum of $x(n)$ and $y(n)$. (7)
- ii) Compute $R_y(k)$; for $k = 0, 1, 2, 3$. (4)
- iii) ARMA(1, 1) spectral estimate. (4)

(OR)

- b) A simple averaging filter is defined as

$$y[n] = \frac{1}{N}(x[n - 1] + \dots + x[n - N])$$

This is clearly an FIR filter.

- i) Let $N = 4$. Determine the transfer function, its zeros and poles ; (4)
- ii) determine a general form for zeros and poles for any N ; (4)
- iii) By comparing $y(n)$ and $y[n - 1]$ determine a recursive implementation.

Also the transfer function, together with its zeros and poles of the recursive implementation. Looking at this example, can we say that “any” recursive filter is IIR ? (7)
