Register Number:……….……

M.E DEGREE EXAMINATIONS: JAN 2015

(Regulation 2014)

First Semester

P14AET103: ADVANCED SIGNAL PROCESSING

(Common to Communication Systems/Applied Electronics)

Time: Three Hours   **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Which of these statements are correct?   [K$_2$]

    1) Any random process could be modeled as ARMA process.

    2) The auto correlation matrix of a WSS process x(n) is a Hermitian Toeplitz matrix.

    3) The power in a zero mean WSS random process is proportional to mean value

    4) Any process can be factored using spectral factorization.

    a) 1&2   b) 2&4

    c) 2&3   d) 1&4

2. The correlation coefficient $\left|\rho_{xy}\right|$ is   [K$_1$]

    a) ≥ 1 b) ≤ 1

    c) ≥ 0 d) ≤ 0

3. Assertion (A) : The resolution of the modified periodogram is window dependent.   [K$_4$]

    Reason (R)   : It is a consistent estimate.

    a) both A and R are individually true and R is the correct explanation of A   b) both A and R are individually true but R is not the correct explanation of A

    c) A is true but R is false   d) A is false but R is true.

4. Smaller value of the model order in the parametric power spectral estimation method causes   [K$_2$]

    a) Spectral smoothing   b) Spurious peaks in the spectrum

    c) Noisy estimate   d) Spectral convolution

5. In backward linear prediction the estimate is   [K$_2$]

    a) $\hat{x}(n-p)$ b) $\hat{x}(n+1)$

    c) $\hat{x}(n+p)$ d) $\hat{x}(n)$

6. Match the following [K₁]

    A) $\sum_{i=0}^{n}|e(i)|^2$ 1) Squared error

    B) $E\{|e(n)|^2\}$ 2) Least Square Error

    C) $\sum_{n=q+1}^{\infty}|e(n)|^2$ 3) Mean Square Error

    a)   2-1-3   b)   2-3-1

    c)   1-3-2   d)   1-2-3

7. The number of additions and multiplications needed to update a FIR adaptive filter with p [K₃] coefficients in LMS algorithm is

    a)   p+1, p+1   b)   p+1,p

    c)   p, p+1   d)   p , p

8. Which of these statements are correct? [K₂]

    1) In growing window RLS algorithm, $\lambda=1$ indicates each of the squared error from $i=0$ to $i=n$ are equally weighted.

    2) In growing window RLS algorithm, $\lambda<1$ indicates squared errors become more important for the value of i that are smaller than n.

    3) The sliding window RLS algorithm needs infinite memory.

    4) The growing window RLS algorithm needs infinite memory.

    a)   1,4   b)   2,3

    c)   2,4   d)   1,3

9. Assertion (A) : Multistage signal processing is preferred when the rate conversion factor is [K₄] large

Reason (R) : Poly phase structure reduces the computational complexity

    a)   both A and R are individually true and   b)   both A and R are individually true but R is R is the correct explanation of A   not the correct explanation of A

    c)   A is true but R is false   d)   A is false but R is true.

10. Multirate system is used for [K₂]

    a)   Reducing the power of the signal   b)   Data compression

    c)   Increasing the maximum frequency   d)   Data compatibility content of the signal

PART B (10 x 2 = 20 Marks)

11. State Wiener-Khintchine relation. [K₁]

12. Define Wold Decomposition Theorem. [K₁]

13. Compare Bartlett and Welch method of spectrum estimation. [K₂]

14. When is the parametric method of power spectral estimation preferred? [K₂]

15. What is the Wiener Hopf solution to estimate d(n), where x(n) =d(n)+v(n) is the noisy observation of d(n)? [K₂]

16. What is Lattice structure? What is the advantage? [K₂]

17. What is the significance of minimum error in adaptive algorithm? [K₂]

18. Under what conditions IIR adaptive filters are preferred? [K₂]

19. Draw the polyphase structure for an interpolator with I=4 and 16th order FIR filter is used as anti imaging filter [K₂]

20. What are the applications of Subband coding? [K₂]

PART C (10 x 5 = 50 Marks)

21. Find the auto correlation for random process with power spectral density [K₃]
$$P_x(z) = \frac{-2Z^2 + 5z - 2}{3z^2 + 10z + 3}.$$

22. Explain ergodic process with necessary equations. [K₂]

23. Derive the variance of the Periodogram estimate. [K₂]

24. Explain Periodogram smoothing method. [K₂]

25. Distinguish between normalized LMS and LMS algorithm. [K₂]

26. Let $r_x(k)$ be a complex autocorrelation sequence given by [K₃]

$$\mathbf{r_x}=[2 \quad 0.5(1+j), \quad 0.5j]$$

Use the Levinson- Durbin recursion to solve the autocorrelation normal equation for a second order all-pole model.

27. Derive the Wiener Hopf equation for FIR adaptive filter. [K₃]

28. Explain the principle of adaptive noise cancellation technique with an example. [K₂]

29. The spectrum of the discrete time signal is given in the following figure. Draw the spectrum of upsampled signal for I = 2, 3 and 4 and determine the cutoff frequency of the anti imaging filter. [K₃]
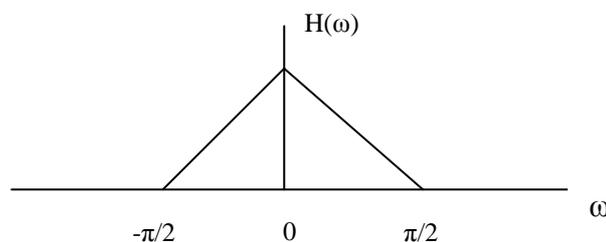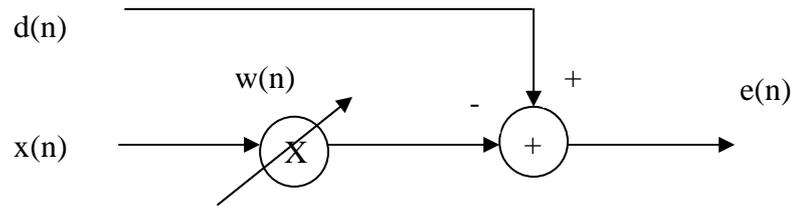

30. What is the need for QMF and derive necessary condition for perfect reconstruction. [K₂]

PART D (2 x 10 = 20 Marks)

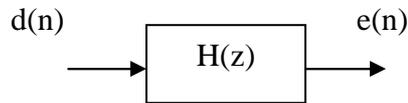31.   Consider a single weight adaptive filter shown in the figure below   [K₃]

d(n)

w(n)   +   e(n)
                                                    -

x(n)

a) Write the LMS algorithm for updating the weight w(n).

b) Suppose x(n) is given by:
$$x(n) = \begin{cases} K & ; & n \geq 0 \\ 0 & ; & \text{otherwise} \end{cases}$$
Find the system function relating d(n) to e(n) using LMS algorithm, i.e., find H(z) as given in the figure below.

d(n)   e(n)
                    H(z)

c) Compare LMS with RLS algorithm.

32.   Derive Kalman gain which will minimize the mean squared error of the estimate.   [K₃]

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