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**MANIPAL INSTITUTE OF TECHNOLOGY**
(A Constituent Institute of Manipal University)
Manipal – 576 104

**SEVENTH SEMESTER B.Tech (BME) DEGREE END-SEM EXAMINATIONS, NOV/DEC 2015**
**SUBJECT: ADVANCED BIOMEDICAL SIGNAL PROCESSING (BME 401)**
**Tuesday, December 8, 2015 (2.00 p.m. - 5.00 p.m.)**

**TIME: 3 HOURS** **MAX. MARKS: 100**

**Instruction to Candidates:**

**Answer any FIVE full questions.**
**Assume relevant data if missing.**
**Give diagrams wherever necessary.**

1. (A) A stationary random process $x(n)$ has the following autocorrelation function $R_x(n) = \sigma^2 e^{-\mu|n|}$ where $\sigma^2$ & $\mu$ are constants. $x(n)$ is passed through a filter whose impulse response is $h(n) = \alpha\, e^{-\alpha n}\, u(n)$, where $\alpha$ is a constant. Find the power spectral density (PSD) of $x(n)$ and also of the output $y(n)$. 8

   (B) How different is the modified periodogram in comparison with the periodogram in estimating the PSD of a given signal? Justify your answer with mathematical explanation. 6

   (C) Which method is used to understand the mechanisms underlying the human auditory system? By sketching a neat diagram, explain the method. 6

2. (A) Let $x(n)$ & $X(e^{j\omega})$ represent a sequence and its Fourier transform. Determine, in terms of $X(e^{j\omega})$, the transform of each of the following: 8

   i) $k\ x(n)$, ii) $x(n-n_0)$, iii) $n\ x(n)$

   (B) Consider 10,000 samples of ECG data. Assume that total number of samples $N = 1000 + 10 \times RXR$ where $R = 25$. Write a program in MATLAB to obtain the cepstrum of the x(n) and recover $h(n)$ & $u(n)$. Compare multiplicative homomorphic filtering with homomorphic deconvolution. 6

   (C) Consider speech samples of male voice, uttering the word 'wah'. Use spectrum analysis followed by suitable filter, to separate any two constituents of the samples. 6

3. (A) Consider the real finite length sequence $x(n)$ shown in Fig 3A: 8

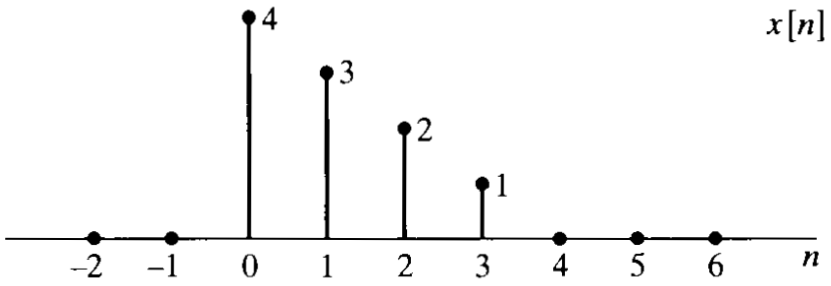


Fig 3A

i) Sketch a finite length sequence $y(n)$, whose six-point DFT is $Y(k) = W_6^{4k} X(k)$, where $X(k)$ is the six-point DFT of $x(n)$.

ii) Sketch the finite length sequence $p(n)$, whose six-point DFT is $P(k) = \mathrm{Re}\{X(k)\}$

(B) How does adaptive noise canceler help in reducing the noise heard by a hearing-impaired child in a school environment? Justify your answer by comparing this situation with a scenario in an aircraft. 6

(C) What is the role played by the sequence-number adopted in the modified adaptive filter scheme to enhance fetal ECG? What are the advantages and disadvantages associated with the modified filter scheme? Provide the exact structure with description. 6

4. (A) The impulse response associated with the linear shift invariant system is shown in Fig 4A. Determine and sketch the response of the specified system to the input sequence $x(n) = u(n-4)$. 4+4

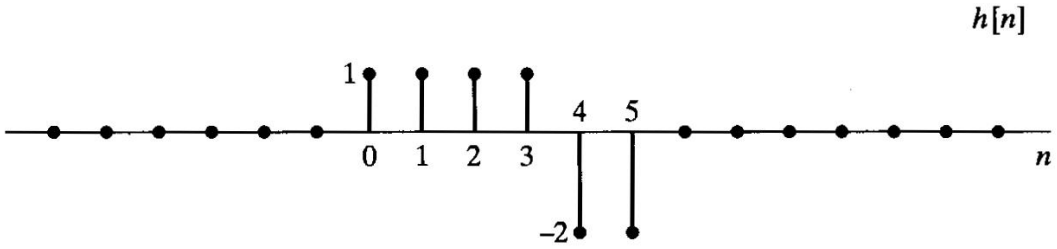


Fig 4A

(B) What is the reason behind the use of adaptive line enhancer in autoregressive power spectrum analysis of fetal breathing movement transmitted through the maternal abdominal walls? Justify your answer with an appropriate flow diagram. 6

(C) How do you analyze the activation wave from His-purkinje system to detect heart defects originating from the “bundle of His”? What is it that the system tracks leading to the better health condition? Explain. 6

5. (A) Consider a system with input $x(n)$ and output $y(n)$ that satisfies the difference equation $y(n) = ny(n-1) + x(n)$. If $x(n) = \delta(n)$, determine $y(n)$ for all $n$. Is the system causal, linear and shift invariant? Justify your answer. 8

(B) How different is the parametric modelling approach compared to non-parametric approach (taught in the class)? Give proper justification. 6

(C) Why is the linear prediction approach preferred to detect cartilage pathology, of patients with and without knee injuries during physical activity? Explain with a suitable block diagram, and specify the method of selecting the model-order. 6

6. (A) Explain with an adaptive linear combiner scheme, the gradient descent method to minimize the error so that best possible estimate of the desired signal is achieved. 8

(B) Derive time series models based on the transfer function of a predictive system. Draw the respective signal flow diagrams with respective difference equations. 6

(C) How can we obtain the linear prediction model coefficients, when the input to the system that caused the EEG signal as its output, is unknown? Interpret the model by formulation in the time domain. 6