Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

VII SEMESTER B.Tech. (BME) DEGREE END SEM EXAMINATIONS NOVEMBER 2017

SUBJECT: Biomedical Signal Processing (BME 4101)

(REVISED CREDIT SYSTEM)

Tuesday, 21st November 2017: 2 to 5 PM

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

Instructions to Candidates:

1. **Answer any FIVE full questions.**
2. **Draw labeled diagram wherever necessary**

1. (a) An input to a linear shift invariant system is $x(n)=\left(\frac{1}{3}\right)^n u(n)+2^n u(-n-1)$, and the corresponding output is $y(n)=5\left(\frac{1}{3}\right)^n u(n)-5\left(\frac{2}{3}\right)^n u(n)$. Determine the transfer function and the impulse response of the system. Find the difference equation that satisfies the given output and the input relation. 8

(b) How can we obtain an averaged periodogram when we are given only one signal record of finite duration? Provide mathematical explanation. 6

(c) A voiced-speech signal $y(n)$ is the result of convolution of a slowly varying vocal tract response $h(n)$ with a relatively fast varying glottal pulse train $x(n)$. Apply suitable non-parametric method and a filter to separate the glottal pulse from the vocal tract response. 6

2. (a) Perform convolution of the following two sequences: $x(n)=\begin{cases}0.5^n, & -2\le n\le 2\\ 0, & elsewhere\end{cases}$ and $h(n)=\begin{cases}1, & 0\le n\le 5\\ 0, & elsewhere\end{cases}$ Sketch $x(n), h(n)$ & $y(n)$. 8

(b) Auditory evoked responses are recorded from a patient having hearing loss. How does Welch's method analyze these responses to understand the auditory system? 6

(c) What kind of role is played by a homomorphic filter in the context of complex cepstrum analysis of diastolic heart sounds? Justify by providing a flow diagram with explanation. 6

3. (a) i) Let $y(n) = \dfrac{x(n) + x(n-1)}{2}$, where $x(n)$ is white noise. Calculate the autocorrelation function and the power spectrum density of $y(n)$. 4+4

ii) Consider $x(n)$ & $y(n)$ to be stationary, uncorrelated random signals. Show that, if $w(n) = x(n) + y(n)$, then $m_w = m_x + m_y$ and $\sigma^2{}_w = \sigma^2{}_x + \sigma^2{}_y$

(b) How different is the least mean square algorithm in comparison with the recursive least square algorithm? Justify your answer by describing both, and mathematically show as to how the gradient descent method works. 6

(c) In what way does an adaptive linear combiner scheme work in an operation theatre of a hospital to enhance the ECG that is buried under the influence of non-stationary interferences from an electro-surgical unit? Provide a digital adaptive noise canceler scheme and explain. 6

4. (a) i) Let $y(n) = x_1(n) + x_2(n)$, where $x_1(n)$ & $x_2(n)$ are independent and zero mean, implying that $E\{x_1(n)x_2(n)\} = 0$, $\forall n_1, n_2$ Show that $S_{yy}(\Omega) = S_{x_1x_1}(\Omega) + S_{x_2x_2}(\Omega)$ 5+3

ii) Show that the power spectrum density function of a random signal is an even function

(b) In what way does an adaptive line enhancer help to enhance the evoked potential signals in a multichannel signal monitoring system? Explain with a proper structure. 6

(c) What is the role played by the least mean square algorithm together with autoregressive moving average model to analyze a slowly varying ECG signals? Draw the adaptive predictor model and explain. 6

5. (a) A model is described by the difference equation:

$$y(n) = -0.5y(n-1) - y(n-2) + x(n) + 0.5x(n-1) - x(n-2)$$

i. What is the type of this system (among AR, MA and ARMA systems)? 8

ii. What is the model order?

iii. What is the transfer function?

iv. Draw the pole-zero diagram of the system.

v. Is the system stable? Give reason.

(b) Illustrate parametric modelling approach of a signal with the help of transfer function, difference equation and flow diagrams. 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 frequency domain. 6