Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
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1st SEMESTER M.TECH. (BME) DEGREE END SEM EXAMINATIONS, NOVEMBER 2017
SUBJECT: BIOMEDICAL SIGNAL PROCESSING (BME 5103)
(REVISED CREDIT SYSTEM)
Tuesday, 21st November 2017, 9 AM-12 NOON

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

Instructions to Candidates:

1. **Answer ALL questions.**
2. **Draw labeled diagram wherever necessary**

1. (a) Consider a LTI system with impulse response **[5]**

$$h(n) = u(n) - u(n-5)$$

if the input to this system is $x(n) = a^n u(n)$, then determine the response of the system.

(b) Explain Welch's method for estimating the Periodogram. **[5]**

(c) Explain the Recursive Least Squares (RLS) algorithm for sample adaptive filters. **[10]**

2. (a) Consider the system **[5]**

$$y(n) = x(n^2)$$

Determine whether the system is Linear and Time Invariant.

(b) Explain the Bartlett Method for estimating the Periodogram? **[5]**

(c) Consider the following linear constant coefficient difference equation: **[10]**

$$y(n) - \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = 2x(n-1)$$

Determine $y(n)$, when $x(n) = \delta(n)$ and $y(n) = 0, n < 0$.

3. (a) Consider a signal that is the sum of two real exponentials: **[5]**

$$x(n) = \left(\frac{1}{2}\right)^n u(n) + \left(-\frac{1}{3}\right)^n u(n)$$

Determine the z-transform $X(z)$ of $x(n)$. Identify the ROC in the pole-zero plot of $X(z)$? Justify why there exist Fourier Transform for $x(n)$ from pole-zero plot?

(b) Determine the eight-point DFT of the signal **[5]**

$$x(n) = \{\underset{\uparrow}{1}, 1, 1, 1, 1, 1, 0, 0\}$$

and sketch its magnitude and phase.

(c) Explain the Bias analysis of Periodogram. Explain the effect of the main lobe and the side lobe of the Bartlett window with appropriate spectrum density plots. **[10]**

4. (a) Explain Least Mean Squared (LMS) Error algorithm? How the stability and adaptability of LMS algorithm is improved further? **[5]**

(b) A continuous time signal $x(t)$ is band limited to 5 KHz. Only 10 seconds of signal has been recorded and is available for processing. Suppose that Bartlett's method is used for Periodogram estimation. If the data is sampled at the Nyquist rate, what is the minimum section length to be used to get the desired resolution? **[5]**

(c) Explain the Levinson-Durbin Algorithm to estimate the parameters for AR process. Express the computational complexity in terms of FLOPS. **[10]**

5. (a) Define Cepstrum. Why Cepstrum analysis is useful? Derive the complex Cepstrum expression for a stable sequence $x(n)$. **[5]**

(b) State and prove the convolution property of z-transform. **[5]**

(c) Derive the Wiener Filter Equation, and explain how Wiener filter is used for the reduction in the effect of additive noise. **[10]**