MANIPAL INSTITUTE OF TECHNOLOGY
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I SEM M.TECH. (BME) DEGREE MAKE-UP EXAMINATIONS, DECEMBER 2017
SUBJECT: BIOMEDICAL SIGNAL PROCESSING (BME 5103)
(REVISED CREDIT SYSTEM)
Tuesday, 26th December 2017, 9 AM to 12 NOON

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

Instructions to Candidates:

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

Consider the following

DFT	Discrete Fourier Transform	LTI	Linear Time Invariant
AR	Auto Regression	BIBO	Bounded Input Bounded Output
ROC	Region Of Convergence		

1. (a) Consider the LTI system with impulse response **[5]**
$$h(n) = \begin{cases} a^n & n \geq 0 \\ b^n & n < 0 \end{cases}$$

Determine the range of values of 'a' and 'b' for the system to be stable.

(b) State and prove the convolution property of DFT. **[5]**

(c) Explain Welch's method for estimating the Periodogram. **[10]**

2. (a) Explain how Wiener filter is used to reduce the effect of additive noise. **[5]**

(b) Determine the 4-point DFT of the sequence, $x(n) : \{0, -1, 2, -3\}$. **[5]**

(c) Explain the Variance analysis of Periodogram. **[10]**

3. (a) Consider the following linear constant coefficient difference equation: **[5]**
$$y(n) - \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = 2x(n-1)$$
Determine $y(n)$, when $x(n) = u(n)$ and $y(n) = 0, n < 0$.

(b) Explain the Leaky Least Mean Squared error Algorithm with neat diagram. **[5]**

(c) A continuous time signal $x(t)$ is band limited to 5 KHz. Only 20 seconds of signal **[10]** has been recorded and is available for processing. The Power Spectrum of $x(t)$ is estimated and it is required that the estimate has a resolution of at least 10 Hz. 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?

4. (a) Classify the Discrete-Time System whose input-output relation is given by
$$y(n) = x(n) + nx(n-1)$$
with respect to the properties: Linearity and Time invariance **[5]**

(b) Derive the complex Cepstrum expression for a stable sequence $x(n)$. **[5]**

(c) Explain the Least Squares method to estimate the filter parameters for AR process. **[10]**

5. (a) Explain the Modified Yule-Walker method to compute the AR parameters and to **[10]** estimate the spectrum Moving Average signal.

(b) Determine the Discrete Time sequence $x(n)$ if z-transform $X(z)$ is given by **[10]**
$$X(z) = \frac{1 + 3z^{-1}}{1 + 3z^{-1} + 2z^{-2}}$$
using the Partial Fraction Expansion Method. Sketch the pole-zero plot with possible ROCs