Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

VII SEMESTER B.TECH. (BME) DEGREE MAKE UP EXAMINATIONS DECEMBER 2017
Subject: Biomedical Signal Processing (BME 4101)
(REVISED CREDIT SYSTEM)
Tuesday, 26th December 2017: 2PM to 5 PM

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

Instructions to Candidates:

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

1 (a) Consider a system with input $x(n)$ and output $y(n)$, that satisfies the difference equation $y(n) = n\,y(n-1) + x(n)$.
i) Is the system linear? Justify.
ii) Is the system shift invariant? Justify.
iii) Determine $y(n)$ for all n, if $x(n) = \delta(n)$. 8

(b) Considering a rectangular data window, obtain the expected value of the PSD estimator in terms of the DFT of the multiplication of two correlation sequences. Further show that the expected value of the periodogram is the true PSD viewed through the filter. 6

(c) Explain how the power spectrum estimation method is used in the analysis of HRV signals to diagnose sudden cardiac deaths. 6

2. (a) Perform convolution of the following two sequences: $x(n) = 0.5\,n\,\{u(n) - u(n-6)\}$ and $h(n) = \begin{cases} 1, & 0 \le n < 5 \\ 0, & elsewhere \end{cases}$ Sketch $x(n), h(n)$ & $y(n)$. 8

(b) How do you analyze the ECG signals using the complex cepstrum in order to successfully discriminate among the pathological states? Explain with illustration. 6

(c) How does the homomorphic filter separate the components present in a composite signal? Explain with mathematical terms. 6

3. (a) A biomedical signal is expected to be band-limited to 100 Hz, with significant components of interest up to 80 Hz. But, the signal is contaminated with a periodic artifact having fundamental frequency of 60 Hz and significant third and fifth harmonics. This signal is sampled at 200 Hz without pre-filtering. What kind of filter will be of help to remove the artifact? Mathematically explain the filter. 8

(b) Justify mathematically, as to how the adaptive noise canceller works with the least mean square algorithm, to remove a non-stationary interference from a non-stationary signal. 6

(c) What is the use of sequence number with two synchronized switches incorporated into the adaptive filter scheme that helps to enhance the fetal ECG monitoring? Explain with illustration. 6

4. (a) Consider a random signal $x(n) = s(n) + e(n)$, where both $s(n)$ & $e(n)$ are independent, stationary random signals having zero mean with autocorrelation functions $\Phi_{ss}(m)$ & $\Phi_{ee}(m)$ respectively.

Determine the expressions for $\Phi_{xx}(m)$, $\Phi_{xe}(m)$, $\Phi_{xs}(m)$ and their respective fourier transforms. 8

(b) Design an adaptive filter that works recursively and uses the method of least squares. Provide the general structure of the filter. 6

(c) Explain how the adaptive noise canceller is used to enhance the speech intelligibility in hearing impaired children in a school environment, where the required speech signal is buried under the influence of non-stationary interference due to sound pollution. 6

5. (a) A filter is described by the difference equation $y(n) = y(n-1) + \frac{1}{4}x(n) - \frac{1}{4}x(n-4)$. 8

What is its transfer function? Also, draw the signal flow diagram and the pole-zero plot.

(b) Explain the auto regressive method employed in the analysis of diastolic heart sounds to detect coronary artery disease non-invasively? Give suitable explanation. Draw the spectrum for patients and normal subjects. Interpret the results. 6

(c) What are the advantages of autoregressive methods over the fourier based methods in analyzing the breathing movements of the fetus. 6