Reg. No.											

MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal 576104)

I SEM M.Tech (BME) DEGREE END-SEMESTER EXAMINATIONS, NOVEMBER 2019.

SUBJECT: ADVANCED BIOMEDICAL SIGNAL PROCESSING ANALYSIS AND MODELING. (BME 5151)

(REVISED CREDIT SYSTEM)

Thursday, 21st November, 2019: 2 PM to 5 PM

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to Candidates:

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

1. a) Evaluate the inverse z-transform for all possible ROCs and also mention the ROC for which inverse z-transform doesn't exist for the given z-transforms: (5)

$$X(z) = \frac{1}{4}\frac{1 + 0.6z^{-1}}{(1-0.3z^{-1} - 0.15z^{-2})(1 - 0.3z^{-1})}$$

   b) Consider a biomedical signal with power-line interference at $f_0 = 60Hz$ and with a sampling frequency of $f_s = 1\,kHz$. Design a frequency domain filter to remove this periodic artifact. (5)

2. a) Design a time-domain filter to remove random noise with zero mean and variance σ_n^2 in a biomedical signal if there is a possibility of acquiring multiple realizations of the signal or event of interest. (5)

   b) Design an optimal filter to remove noise $\eta(n)$ from a signal $x(n) = d(n) + \eta(n)$, given that the desired signal $d(n)$ and noise processes $\eta(n)$are independent, stationary random processes. You may assume that the "desired" characteristics of the uncorrupted signal are known. The noise characteristics may also be assumed to be known. (5)

3. a) Draw a block diagram representing various steps in the Pan-Tompkins method to detect QRS complex in ECG signals. Explain the purpose and nature of each step in the procedure. (4)

   b) Explain the adaptive thresholding used in Pan-Tompkins algorithm to detect R-peaks. (3)

   c) Explain the search back technique in Pan-Tompkins algorithm to detect missed RR-intervals. (3)

4. a) Design an Autoregressive model when the input to the system that caused the given signal as its output is unknown. (5)

   b) Given a noisy observation of the output of a linear system in response to a certain input, develop an iterative system identification based method to estimate the numerator and denominator polynomials of a rational z-domain of the system. (5)

5. a) Discuss the importance of the Fixed segmentation to analyze a non-stationary signal. Explain Short Time Fourier Transform to achieve fixed segmentation. (5)

   b) Discuss the signal decomposition using the Matching Pursuit algorithm. (5)