

VII SEM B. Tech (BME) DEGREE END-SEMESTER EXAMINATIONS, DEC/JAN 2020-21

SUBJECT: BIOMEDICAL SIGNAL PROCESSING (BME 4101)

Saturday, 26th December 2020, 2 PM to 5 PM

MAX. MARKS: 50

Instructions to Candidates:

Answer ALL questions. Draw labeled diagram wherever necessary

- 1A. A digital filter that can be used to filter an ECG signal has zeros at $0.5 \pm j0.5$ and 5 poles at $-0.6 \pm j0.3$.
 - (i) Derive the transfer function of the filter.
 - (ii) Derive the time-domain difference equation of the filter.
 - (iii) If the filter is used at a sampling frequency of 1000 Hz, what are the frequencies at which the gain of the filter is maximum and minimum?
- 1B. What are the differences between ANC and ALE? Consider foetal ECG signal with 5 muscle contraction interference and mother's ECG as noise. Design an adaptive noise filter that provides the least squares estimate of the signal of interest.
- 2A. Derive time series models based on the transfer function of a predictive system. Draw 5 the respective signal flow diagrams with respective difference equations
- 2B. Explain the role played by differentiator, squaring operator and the moving window 5 integrator in detecting the QRS complex from an ECG signal. Draw necessary block diagram and waveforms with proper mathematical reasoning.
- 3A. Identify the measures of waveform complexity that may be used to analyze the event 4 of variability in the case of samples of EMG or PCG signals? Express each one of them in mathematical terms with a brief explanation.
- 3B. How the adaptive thresholding method does detects the R-peaks? Also, explain the 3 role of a suitable technique that helps in detecting the missed RR-intervals.
- 3C. What role does adaptive filter play in enhancing the ECG in an operation theatre 3 environment? Explain with a proper structure.

- 4A. How do you say that the modified periodogram is a consistent estimate of the power 5 spectrum? Provide the mathematical explanation in detail.
- 4B. What is the role played by autoregressive moving average modeling method in 5 analyzing diastolic heart sounds to help in detecting the coronary artery disease? With necessary spectrum plots and pole models, explain the method.
- 5A. How can we obtain the linear prediction model coefficients, when the input to the 5 system that caused the EEG signal as its output, is unknown? Interpret the model by formulation in the time domain.
- 5B. A signal x(t) is transmitted through a channel. The signal y(t) received is a scaled, 5 shifted and noisy version of x(t) given as $y(t) = \alpha x(t - t_o) + \eta(t)$ where α is a scale factor, t_o is the time delay and $\eta(t)$ is noise. Assume that the noise process has zero mean and is statistically independent of the signal process, and all processes are stationary. Derive expressions for the mean and autocorrelation function of y(t).