Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

VII SEMESTER B.Tech.(BME) DEGREE END SEM EXAMINATIONS NOV/DEC 2016
SUBJECT: ADVANCED BIOMEDICAL SIGNAL PROCESSING (BME 401)
(REVISED CREDIT SYSTEM)
Tuesday, 6th December 2016, 2 to 5 PM

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

Instructions to Candidates:

1. **Answer any FIVE full 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 $y(n) = ny(n-1) + x(n)$. **8**

i) Is the system linear? Justify.

ii) Is the system shift invariant? Justify.

iii) Determine $y(n)$ for all n, if $x(n) = \delta(n)$.

(b) How Bartlett method is different from Welch method in estimating the power spectral density? Mathematically arrive at the power spectral density estimate using the Bartlett method. **6**

(c) Visually evoked responses are recorded from a patient having seizure. How do you identify the segment corresponding to seizure - activity from the normal EEG? Describe the method. **6**

2) (a) i) Find the convolution of the two finite-length sequences: **8**

$$x(n) = 0.5n\{u(n) - u(n-6)\} \;\&\; h(n) = 2\sin\left(\frac{n\pi}{2}\right)\{u(n+3) - u(n-4)\}$$

ii) If the sequence $x(n) = \left(\frac{3}{2}\right)^n u(-n)$ is an input to a time varying system $y(n) = nx(n)$, determine the power of the output signal.

(b) How recursive least square algorithm is different from least mean square algorithm? Justify the answer with mathematical description regarding recursive least square method. **6**

(c) How do you separate the components present in a speech signal? Discuss the same with a flow diagram. **6**

3) **(a)** As we know that the DTFT of the output of a linear shift-invariant filter with frequency response $H(e^{j\omega})$ is $Y(e^{j\omega}) = X(e^{j\omega})H(e^{j\omega})$ where $X(e^{j\omega})$ is the DTFT of the input, it follows that an linear shift-invariant system cannot produce frequencies in the output that are not present in the input. Therefore, if a system introduces new frequencies, the system must be nonlinear or shift-varying. For each of the following systems, find the frequencies that are present in the output when $x(n) = \cos(n\omega_o)$: **8**

i) $y(n) = x^2(n)$ ii) $y(n) = x(n)\cos(\frac{n\pi}{4})$ iii) $y(n) = x(2n)$

(b) How different is adaptive noise canceler in comparison with adaptive line enhancer? Justify your answer by describing both, with respect to the least mean square algorithm. **6**

(c) Take the case of an operation theatre in a hospital. The ECG signal is buried under the influence of non-stationary interferences. Illustrate with a schematic diagram, a procedure for enhancing of the ECG signal. **6**

4) **(a)** Consider the periodic sequences $x_p(n)$ & $h_p(n)$ with period $N = 4$. **8**

$x_p(n) = 1, n = 1, n = 2$ & $x_p(n) = 0, elsewhere$

$h_p(n) = n + 1, 0 \le n \le 3$ & $h_p(n) = 0, elsewhere$

Determine the output $y_p(n) = x_p(n) \otimes h_p(n)$ using both i) graphical discrete time circular convolution and ii) DFT method

(b) In what way the time sequenced adaptive filter structure helps in enhancing the fetal ECG in an ECG monitoring system? Explain with a proper structure. **6**

(c) What is the role played by adaptive line enhancer in enhancing the His-Purkinje system signal? Explain how effectively the signal is made noise free? **6**

5) **(a)** i) Determine the frequency response when $h(n) = (\frac{1}{3})^{n+2}u(n-2)$ and assume that $h(n)$ be the unit sample response of a linear shift invariant system. **4+4**

ii) Determine $N-$point circular convolution of $x_1(n)$ & $x_2(n)$.

$x_1(n) = x_2(n) = 1$; $0 \le n \le N-1$

(b) How can we obtain the linear prediction model coefficients, when the input to the system that caused the EEG signal as its output, is unknown? Interpret the model by formulation in the time domain. **6**

(c) Which is the 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**

6) **(a)** Consider an ECG signal $x(n)$ with the total no. of samples N = 2000 + 10 (R x R), where R = your Roll Number. Write a program in MATLAB to obtain the periodogram of $x(n)$ and calculate the normalized energy in $x(n)$. **8**

(b) Starting from the fundamentals, arrive at the time series models by illustrating their structure, features, difference equation and functions. **6**

(c) i) What are the typical characteristics of the gastric signal, observed over a long duration? **2+4**

ii) What approach would you adopt, to analyze such a signal? Describe the approach in detail.