Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

I SEMESTER M.Tech. (BME) DEGREE END SEMESTER EXAMINATIONS NOV/DEC 2016
SUBJECT: BIOMEDICAL SIGNAL PROCESSING (BME 5103)
(REVISED CREDIT SYSTEM)
Tuesday, 29th November 2016, 9 AM to 12 NOON

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

Instructions to Candidates:

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

1. (a) For each of the following discrete systems, determine whether the system is linear, shift-invariant, causal or stable: **8**

i) $y(n) = \ln x(n)$ ii) $y(n) = \cos\big(x(n)\big)$ iii) $y(n) = x(2n)$

(b) How different is Welch power spectral density estimate in comparison with Bartlett power spectral density estimate? Justify your answer with mathematical explanation. **6**

(c) What is the reason behind the interpretation of an ECG signal? Provide appropriate approach so that the features of the signal can be extracted and analyzed. **6**

2. (a) i) Find the inverse discrete time Fourier transform of function sketched in Fig.Q2A **5+3**

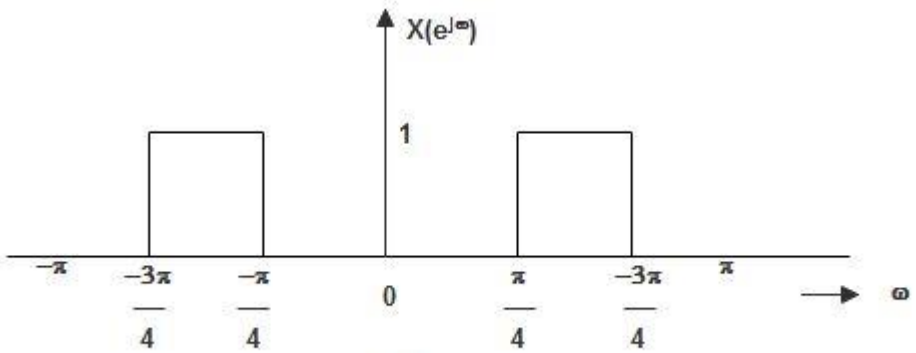

Fig.Q2A

ii) Let $h(n)$ be the unit sample response of a linear shift invariant system. Find the frequency response when $h(n) = (2)^{n+2}u(n-2)$

(b) Which algorithm is best suited to detect the QRS complex from an ECG signal? Describe the same with suitable sketches and neat diagrams. **6**

(c) How does adaptive noise canceler help in reducing the noise heard by a hearing-impaired child in a school environment? Justify your answer by comparing this situation with a scenario in an auditorium. **6**

3. **(a)** i) Find the four-point circular convolution of the sequences: **4+4**

$$h(n)=\begin{cases}1, n=0,1,2,3\\ \\ 0, else\end{cases} \quad \text{and} \quad x(n)=\begin{cases}1, n=0\\ 2, n=1\\ 3, n=2,3\\ 0, else\end{cases}$$

ii) Starting with the definition of the autocorrelation as the discrete time average, prove that the Fourier transform of the autocorrelation function is the power spectral density of the signal.

(b) What kind of role is played by homomorphic filter in complex cepstrum analysis of speech signals? Justify by providing a flow diagram with explanation. **6**

(c) What is the role played by the sequence number adopted in the modified adaptive filter scheme to enhance fetal ECG signal? What are the advantages and disadvantages associated with the modified filter scheme? Provide the exact structure with description. **6**

4. **(a)** Using the method based on partial fraction expansion, find x[n] if X(z) equals: **4+4**

i) $\dfrac{(z+1)}{(z-2)(z+3)}$ ii) $\dfrac{(2z-3)}{z(z-0.5)(z+0.3)}$

Plot $x(n)$ for $0<n<4$ for both.

(b) Explain with an adaptive linear combiner scheme, the gradient descent method to minimize the error so that best possible estimate of the desired signal is achieved. **6**

(c) What is the reason behind the use of adaptive line enhancer in autoregressive power spectrum analysis of fetal breathing movement transmitted through the maternal abdominal walls? Justify your answer with an appropriate flow diagram. **6**

5. **(a)** The $N-point$ DFT $X(k)$ is defined as: **4+4**

i) $N=4 \quad X(k)=\begin{cases}1, \ for k=4l \ \& \ k=4l+1 \ \& \ k=4l+2 \ \& \ k=4l+3 \\ \\ 0, elsewhere\end{cases}$

ii) $N=4 \quad X(k)=\begin{cases}2, \ for k=4l+1 \\ 2, \ for k=4l+3 \\ 0, elsewhere\end{cases}$

with $l=0,\pm1,\pm2.....$

For each $X(k)$: Plot fundamental interval for $X(k)$, Calculate the N- point IDFT of $X(k)$, plot the fundamental interval for $x(n)$.

(b) Derive time series models based on the transfer function of a predictive system. Draw the respective signal flow diagrams with respective difference equations. **6**

(c) Why is the linear prediction approach used to detect cartilage pathology, of patients with and without knee injuries during physical activity? Explain with a suitable block diagram. **6**