ROLL NO. _____

Code: AE77/AC77/AE121 Subject: DIGITAL SIGNAL PROCESSING

AMIETE – ET/CS (Current & New Scheme)

Time: 3 Hours **JUNE 2016** **Max. Marks: 100**

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.**
- **The answer sheet for the Q.1 will be collected by the invigilator after 45 minutes of the commencement of the examination.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or the best alternative in the following: (2×10)

a. Consider a real causal sequence $x(n)$ with $X_I(e^{j\omega}) = 3\sin(2\omega)$ which $X_R(e^{j\omega})$ is consistent with this information.

(A) $X_R(e^{j\omega}) = \frac{3}{2}\cos(2\omega)$ **(B)** $X_R(e^{j\omega}) = -3\cos(2\omega)$

(C) $X_R(e^{j\omega}) = 2\cos(3\omega)$ **(D)** None of these

b. As the window becomes shorter, the ability to resolve closely spaced sinusoids in the spectral estimate

(A) decreases **(B)** increases

(C) does not change **(D)** increases then decreases

c. Consider the butterfly in Fig.1, choose the most accurate statement.

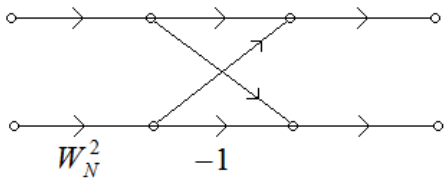

Fig.1

(A) The butterfly was extracted from DIT-FFT algorithm

(B) The butterfly was extracted from DIF-FFT algorithm

(C) It is not possible to say from the figure

(D) None of these

d. In FIR filter design, a lower order filter can be designed using

(A) Window method **(B)** Parks-Mc Clellan algorithm

(C) Both yield the same order **(D)** None of these

e. $x(n) \otimes \sum_{r=-\infty}^{\infty} \delta(n - rN) =$

(A) $\sum_{r=-\infty}^{\infty} x(rN)$ **(B)** $\sum_{r=0}^{\infty} x(n - rN)$

(C) $\sum_{r=-\infty}^{\infty} x(n - rN)$ **(D)** None of these

f. Consider the flow graph shown in fig. 2 and determine the system function.

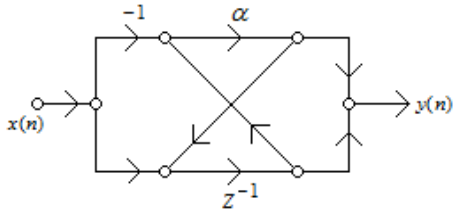

Fig.2

(A) $H(z)=\dfrac{\alpha\left(z^{-1}-1\right)}{1-\alpha\, z^{-1}}$ **(B)** $H(z)=\dfrac{z^{-1}(1-\alpha)}{1-\alpha\, z^{-1}}$

(C) $H(z)=\dfrac{z^{-1}-\alpha}{1-\alpha\, z^{-1}}$ **(D)** None of these

g. For the LTI system shown in Figure 3, the number of real multiplications and real additions to compute each sample of output (assuming $x(n)$ is real and neglecting multiplication by 1) is

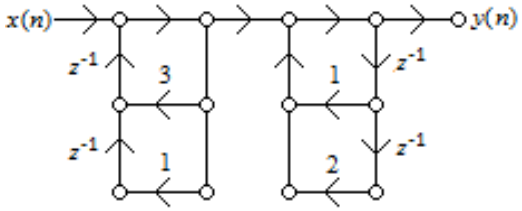

Fig.3

(A) two, two **(B)** two, four

(C) four, two **(D)** four, four

h. For the pole zero plot shown in figure 4, $H(z)$ will be neither causal nor stable if ROC is

(A) $|z|<\dfrac{1}{2}$

(B) $|z|>2$

(C) $\dfrac{1}{2}<|z|<2$

(D) None of these

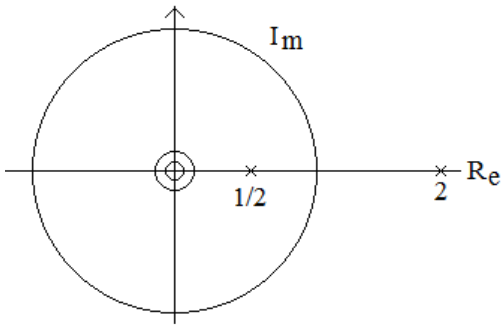

Fig.4

i. Group delay of a system is defined as

(A) $\tau(\omega)=-\dfrac{d}{d\omega}\left[H\left(e^{j\omega}\right)\right]$ **(B)** $\tau(\omega)=\dfrac{d}{d\omega}\left[\arg\left(H\left(e^{j\omega}\right)\right)\right]$

(C) $\tau(\omega)=-\dfrac{d}{d\omega}\left[\arg\left(H\left(e^{j\omega}\right)\right)\right]$ **(D)** $\tau(\omega)=-\dfrac{d}{d\omega}\left[\arg\left(H\left(e^{-j\omega}\right)\right)\right]$

j. A stable, even symmetric discrete time signal $x(n)$ with $X\left(e^{j\omega}\right)=X\left(e^{j(\omega-\pi)}\right)$

(A) is periodic with period π **(B)** is periodic with period 2π

(C) is aperiodic **(D)** none of these

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. For an ideal C/D converter, derive the frequency domain relation between input and output. **(8)**

b. By sampling a continuous time ideal low pass filter with cut-off frequency Ω_C, obtain an ideal low pass discrete time filter with cut-off frequency $\omega_C < \pi$, derived using impulse invariance. **(8)**

Q.3 a. A discrete time causal LTI system has the system function $H(z) = \dfrac{1+3z^{-1}}{1+\frac{1}{2}z^{-1}}$. Is the system stable? Find expressions for a minimum phase system $H_1(z)$ and an all pass system $H_{ap}(z)$ such that $H(z) = H_1(z)H_{ap}(z)$. **(8)**

b. Show that ideal low pass filters are non causal and computationally unrealizable. **(8)**

Q.4 a. By what factor do coefficient multipliers reduce/increase in Direct Form structures for linear phase FIR systems? Draw the structures. **(8)**

b. Realize $H(z) = \dfrac{1+2z^{-1}+z^{-2}}{1-0.75z^{-1}+0.125z^{-2}}$ using parallel form with first order sections. **(8)**

Q.5 a. Write a note on bilinear transformation for IIR filter design. **(8)**

b. Discuss the properties of commonly used windows for design of FIR filters. **(8)**

Q.6 a. A length 7 sequence $x(n)$ is given by $x(0)=5,\ x(1)=3,\ x(2)=-2,\ x(3)=-4,\ x(4)=1,\ x(5)=2,\ x(6)=0$. Let $X(k)$ denote the 7 point DFT of $x(n)$. Without computing the IDFT, determine the sequence $y(n)$ whose 7 point DFT is given by $Y(k) = W_7^{4k} X(k)$. **(8)**

b. Compute the circular convolution of two length 4 sequences $g(n) = \{1,2,0,1\}$ and $h(n) = \{2,2,1,1\}$ using DFT based approach. **(8)**

Q.7 a. Explain DIF(Decimation-in-frequency)-FFT algorithm using signal flow graph for N=8. **(8)**

b. Write a note on Goertzel's Algorithm. **(8)**

Q.8 a. Consider a band limited continuous time signal $x_c(t)$. Assume an ideal antialiasing filter $H_{aa}(j\Omega)$ and a sampling rate for C/D converter of 1/5000 samples/sec. The DFT size is N=512. If it is determined that $V[11] = 2000(1+j)$, what can be said about other values of $V[k]$ or about $X_c(j\Omega)$ if $x_c(t)$ is real valued and sufficiently band limited to avoid aliasing with the given sampling rate. Refer to Fig 5. **(8)**

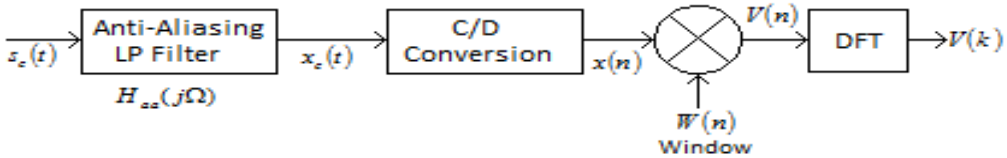

Fig.5

b. Write a note on computation of average Periodograms using the DFT. **(8)**

Q.9 a. Derive the impulse response for an ideal 90° phase shifter. **(8)**

b. Consider a real, causal sequence $x(n)$ for which $X_R(e^{j\omega}) = 1+\cos 2\omega$. Determine $x(n)$, $X(e^{j\omega})$ and $X_I(e^{j\omega})$, where symbols have their usual meanings. **(8)**